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Important Information about Cisco IOS XE 16

Effective Cisco IOS XE Release 3.7.0E for Catalyst Switching and Cisco IOS XE Release 3.17S (for Access and Edge Routing) the two releases evolve (merge) into a single version of converged release—the Cisco IOS XE 16—providing one release covering the extensive range of access and edge products in the Switching and Routing portfolio.

Feature Information

Use Cisco Feature Navigator to find information about feature support, platform support, and Cisco software image support. An account on Cisco.com is not required.

Related References

- Cisco IOS Command References, All Releases

Obtaining Documentation and Submitting a Service Request

- To receive timely, relevant information from Cisco, sign up at Cisco Profile Manager.
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- To submit a service request, visit Cisco Support.
- To discover and browse secure, validated enterprise-class apps, products, solutions and services, visit Cisco Marketplace.
- To obtain general networking, training, and certification titles, visit Cisco Press.
- To find warranty information for a specific product or product family, access Cisco Warranty Finder.
Cisco BGP Overview

Border Gateway Protocol (BGP) is an interdomain routing protocol designed to provide loop-free routing between separate routing domains that contain independent routing policies (autonomous systems). The Cisco software implementation of BGP version 4 includes support for 4-byte autonomous system numbers and multiprotocol extensions to allow BGP to carry routing information for IP multicast routes and multiple Layer 3 protocol address families including IP Version 4 (IPv4), IP Version 6 (IPv6), Virtual Private Networks Version 4 (VPNv4), Connectionless Network Services (CLNS), and Layer 2 VPN (L2VPN). This module contains conceptual material to help you understand how BGP is implemented in Cisco software.

- Finding Feature Information, on page 3
- Prerequisites for Cisco BGP, on page 3
- Restrictions for Cisco BGP, on page 4
- Information About Cisco BGP, on page 4
- Additional References, on page 18
- Feature Information for Cisco BGP Overview, on page 19

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for Cisco BGP

This document assumes knowledge of CLNS, IPv4, IPv6, multicast, VPNv4, and Interior Gateway Protocols (IGPs). The amount of knowledge required for each technology is dependent on your deployment.
Restrictions for Cisco BGP

A router that runs Cisco software can be configured to run only one BGP routing process and to be a member of only one BGP autonomous system. However, a BGP routing process and autonomous system can support multiple concurrent BGP address family and subaddress family configurations.

Information About Cisco BGP

BGP Version 4

Border Gateway Protocol (BGP) is an interdomain routing protocol designed to provide loop-free routing between separate routing domains that contain independent routing policies (autonomous systems). The Cisco software implementation of BGP version 4 includes multiprotocol extensions to allow BGP to carry routing information for IP multicast routes and multiple Layer 3 protocol address families including IP Version 4 (IPv4), IP Version 6 (IPv6), Virtual Private Networks version 4 (VPNv4), and Connectionless Network Services (CLNS).

BGP is mainly used to connect a local network to an external network to gain access to the Internet or to connect to other organizations. When connecting to an external organization, external BGP (eBGP) peering sessions are created. For more details about connecting to external BGP peers, see the “Connecting to a Service Provider Using External BGP” chapter.

Although BGP is referred to as an exterior gateway protocol (EGP), many networks within an organization are becoming so complex that BGP can be used to simplify the internal network used within the organization. BGP peers within the same organization exchange routing information through internal BGP (iBGP) peering sessions. For more details about internal BGP peers, see the “Configuring Internal BGP Features” chapter of the Cisco IOS IP Routing Configuration Guide.

Note

BGP requires more configuration than other routing protocols and the effects of any configuration changes must be fully understood. Incorrect configuration can create routing loops and negatively impact normal network operation.

BGP Version 4 Functional Overview

BGP is an interdomain routing protocol designed to provide loop-free routing links between organizations. BGP is designed to run over a reliable transport protocol; it uses TCP (port 179) as the transport protocol because TCP is a connection-oriented protocol. The destination TCP port is assigned 179, and the local port is assigned a random port number. Cisco software supports BGP version 4 and it is this version that has been used by Internet service providers (ISPs) to help build the Internet. RFC 1771 introduced and discussed a number of new BGP features to allow the protocol to scale for Internet use. RFC 2858 introduced multiprotocol extensions to allow BGP to carry routing information for IP multicast routes and multiple Layer 3 protocol address families, including IPv4, IPv6, and CLNS.

BGP is mainly used to connect a local network to an external network to gain access to the Internet or to connect to other organizations. When connecting to an external organization, external BGP (eBGP) peering sessions are created. Although BGP is referred to as an exterior gateway protocol (EGP), many networks
within an organization are becoming so complex that BGP can be used to simplify the internal network used within the organization. BGP peers within the same organization exchange routing information through internal BGP (iBGP) peering sessions.

BGP uses a path-vector routing algorithm to exchange network reachability information with other BGP-speaking networking devices. Network reachability information is exchanged between BGP peers in routing updates. Network reachability information contains the network number, path-specific attributes, and the list of autonomous system numbers that a route must transit to reach a destination network. This list is contained in the AS-path attribute. BGP prevents routing loops by rejecting any routing update that contains the local autonomous system number because this indicates that the route has already traveled through that autonomous system and a loop would therefore be created. The BGP path-vector routing algorithm is a combination of the distance-vector routing algorithm and the AS-path loop detection.

BGP selects a single path, by default, as the best path to a destination host or network. The best path selection algorithm analyzes path attributes to determine which route is installed as the best path in the BGP routing table. Each path carries well-known mandatory, well-known discretionary, and optional transitive attributes that are used in BGP best path analysis. Cisco software provides the ability to influence BGP path selection by altering some of these attributes using the command-line interface (CLI.) BGP path selection can also be influenced through standard BGP policy configuration. For more details about using BGP to influence path selection and configuring BGP policies to filter traffic, see the “BGP 4 Prefix Filter and Inbound Route Maps” module and the “BGP Prefix-Based Outbound Route Filtering” module.

BGP uses the best-path selection algorithm to find a set of equally good routes. These routes are the potential multipaths. In Cisco IOS Release 12.2(33)SRD and later releases, when there are more equally good multipaths available than the maximum permitted number, the oldest paths are selected as multipaths.

BGP can be used to help manage complex internal networks by interfacing with Interior Gateway Protocols (IGPs). Internal BGP can help with issues such as scaling the existing IGPs to match the traffic demands while maintaining network efficiency.

Note

BGP requires more configuration than other routing protocols and the effects of any configuration changes must be fully understood. Incorrect configuration can create routing loops and negatively impact normal network operation.

BGP Autonomous Systems

An autonomous system is a network controlled by a single technical administration entity. BGP autonomous systems are used to divide global external networks into individual routing domains where local routing policies are applied. This organization simplifies routing domain administration and simplifies consistent policy configuration. Consistent policy configuration is important to allow BGP to efficiently process routes to destination networks.

Each routing domain can support multiple routing protocols. However, each routing protocol is administered separately. Other routing protocols can dynamically exchange routing information with BGP through redistribution. Separate BGP autonomous systems dynamically exchange routing information through eBGP peering sessions. BGP peers within the same autonomous system exchange routing information through iBGP peering sessions.

The figure below illustrates two routers in separate autonomous systems that can be connected using BGP. Router A and Router B are ISP routers in separate routing domains that use public autonomous system numbers.
These routers carry traffic across the Internet. Router A and Router B are connected through eBGP peering sessions.

![Figure 1: BGP Topology with Two Autonomous Systems](image)

Each public autonomous system that directly connects to the Internet is assigned a unique number that identifies both the BGP routing process and the autonomous system.

### BGP Autonomous System Number Formats

Prior to January 2009, BGP autonomous system numbers that were allocated to companies were two-octet numbers in the range from 1 to 65535 as described in RFC 4271, *A Border Gateway Protocol 4 (BGP-4)*. Due to increased demand for autonomous system numbers, the Internet Assigned Number Authority (IANA) will start in January 2009 to allocate four-octet autonomous system numbers in the range from 65536 to 4294967295. RFC 5396, *Textual Representation of Autonomous System (AS) Numbers*, documents three methods of representing autonomous system numbers. Cisco has implemented the following two methods:

- **Asplain**—Decimal value notation where both 2-byte and 4-byte autonomous system numbers are represented by their decimal value. For example, 65526 is a 2-byte autonomous system number and 234567 is a 4-byte autonomous system number.

- **Asdot**—Autonomous system dot notation where 2-byte autonomous system numbers are represented by their decimal value and 4-byte autonomous system numbers are represented by a dot notation. For example, 65526 is a 2-byte autonomous system number and 1.169031 is a 4-byte autonomous system number (this is dot notation for the 234567 decimal number).

For details about the third method of representing autonomous system numbers, see RFC 5396.

#### Asdot Only Autonomous System Number Formatting

In Cisco IOS Release 12.0(32)S12, 12.4(24)T, and later releases, the 4-octet (4-byte) autonomous system numbers are entered and displayed only in asdot notation, for example, 1.10 or 45000.64000. When using regular expressions to match 4-byte autonomous system numbers the asdot format includes a period which is a special character in regular expressions. A backslash must be entered before the period for example, 1\14, to ensure the regular expression match does not fail. The table below shows the format in which 2-byte and
4-byte autonomous system numbers are configured, matched in regular expressions, and displayed in `show` command output in Cisco IOS images where only `asdot` formatting is available.

**Table 1: Asdot Only 4-Byte Autonomous System Number Format**

<table>
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<tr>
<th>Format</th>
<th>Configuration Format</th>
<th>Show Command Output and Regular Expression Match Format</th>
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<tr>
<td>asdot</td>
<td>2-byte: 1 to 65535 4-byte: 1.0 to 65535.65535</td>
<td>2-byte: 1 to 65535 4-byte: 1.0 to 65535.65535</td>
</tr>
</tbody>
</table>

**Asplain as Default Autonomous System Number Formatting**

In Cisco IOS Release 12.0(32)SY8, 12.0(33)S3, 12.2(33)SRE, 12.2(33)XNE, 12.2(33)SX11, and later releases, the Cisco implementation of 4-byte autonomous system numbers uses `asplain` as the default display format for autonomous system numbers, but you can configure 4-byte autonomous system numbers in both the `asplain` and `asdot` format. In addition, the default format for matching 4-byte autonomous system numbers in regular expressions is `asplain`, so you must ensure that any regular expressions to match 4-byte autonomous system numbers are written in the `asplain` format. If you want to change the default `show` command output to display 4-byte autonomous system numbers in the `asdot` format, use the `bgp asnotation dot` command under router configuration mode. When the `asdot` format is enabled as the default, any regular expressions to match 4-byte autonomous system numbers must be written using the `asdot` format, or the regular expression match will fail. The tables below show that although you can configure 4-byte autonomous system numbers in either `asplain` or `asdot` format, only one format is used to display `show` command output and control 4-byte autonomous system number matching for regular expressions, and the default is `asplain` format. To display 4-byte autonomous system numbers in the `asdot` format, you must configure the `bgp asnotation dot` command. After enabling the `bgp asnotation dot` command, a hard reset must be initiated for all BGP sessions by entering the `clear ip bgp *` command.

**Table 2: Default Asplain 4-Byte Autonomous System Number Format**

<table>
<thead>
<tr>
<th>Format</th>
<th>Configuration Format</th>
<th>Show Command Output and Regular Expression Match Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>asplain</td>
<td>2-byte: 1 to 65535 4-byte: 65536 to 4294967295</td>
<td>2-byte: 1 to 65535 4-byte: 65536 to 4294967295</td>
</tr>
<tr>
<td>asdot</td>
<td>2-byte: 1 to 65535 4-byte: 1.0 to 65535.65535</td>
<td>2-byte: 1 to 65535 4-byte: 65536 to 4294967295</td>
</tr>
</tbody>
</table>

Note: If you are upgrading to an image that supports 4-byte autonomous system numbers, you can still use 2-byte autonomous system numbers. The `show` command output and regular expression match are not changed and remain in `asplain` (decimal value) format for 2-byte autonomous system numbers regardless of the format configured for 4-byte autonomous system numbers.
### Table 3: Asdot 4-Byte Autonomous System Number Format

<table>
<thead>
<tr>
<th>Format</th>
<th>Configuration Format</th>
<th>Show Command Output and Regular Expression Match Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>asplain</td>
<td>2-byte: 1 to 65535 4-byte: 65536 to 4294967295</td>
<td>2-byte: 1 to 65535 4-byte: 1.0 to 65535.65535</td>
</tr>
<tr>
<td>asdot</td>
<td>2-byte: 1 to 65535 4-byte: 1.0 to 65535.65535</td>
<td>2-byte: 1 to 65535 4-byte: 1.0 to 65535.65535</td>
</tr>
</tbody>
</table>

### Reserved and Private Autonomous System Numbers

In Cisco IOS Release 12.0(32)S12, 12.0(32)SY8, 12.0(33)S3, 12.2(33)SRE, 12.2(33)XNE, 12.2(33)SXI1, 12.4(24)T, and later releases, the Cisco implementation of BGP supports RFC 4893. RFC 4893 was developed to allow BGP to support a gradual transition from 2-byte autonomous system numbers to 4-byte autonomous system numbers. A new reserved (private) autonomous system number, 23456, was created by RFC 4893 and this number cannot be configured as an autonomous system number in the Cisco IOS CLI.

RFC 5398, *Autonomous System (AS) Number Reservation for Documentation Use*, describes new reserved autonomous system numbers for documentation purposes. Use of the reserved numbers allow configuration examples to be accurately documented and avoids conflict with production networks if these configurations are literally copied. The reserved numbers are documented in the IANA autonomous system number registry. Reserved 2-byte autonomous system numbers are in the contiguous block, 64496 to 64511 and reserved 4-byte autonomous system numbers are from 65536 to 65551 inclusive.

Private 2-byte autonomous system numbers are still valid in the range from 64512 to 65534 with 65535 being reserved for special use. Private autonomous system numbers can be used for internal routing domains but must be translated for traffic that is routed out to the Internet. BGP should not be configured to advertise private autonomous system numbers to external networks. Cisco IOS software does not remove private autonomous system numbers from routing updates by default. We recommend that ISPs filter private autonomous system numbers.

---

**Note**: Autonomous system number assignment for public and private networks is governed by the IANA. For information about autonomous-system numbers, including reserved number assignment, or to apply to register an autonomous system number, see the following URL: http://www.iana.org/.

### Classless Interdomain Routing

BGP version 4 supports classless interdomain routing (CIDR). CIDR eliminates classful network boundaries, providing more efficient usage of the IPv4 address space. CIDR provides a method to reduce the size of routing tables by configuring aggregate routes (or supernets). CIDR processes a prefix as an IP address and bit mask (bits are processed from left to right) to define each network. A prefix can represent a network, subnetwork, supernet, or single host route.

For example, using classful IP addressing, the IP address 192.168.2.1 is defined as a single host in the Class C network 192.168.2.0. Using CIDR, the IP address can be shown as 192.168.2.1/16, which defines a network (or supernet) of 192.168.0.0.

CIDR is enabled by default for all routing protocols in Cisco software. Enabling CIDR affects how packets are forwarded, but it does not change the operation of BGP.
Multiprotocol BGP

Cisco software supports multiprotocol BGP extensions as defined in RFC 2858, *Multiprotocol Extensions for BGP-4*. The extensions introduced in this RFC allow BGP to carry routing information for multiple network-layer protocols, including CLNS, IPv4, IPv6, and VPNv4. These extensions are backward-compatible to enable routers that do not support multiprotocol extensions to communicate with those routers that do support multiprotocol extensions. Multiprotocol BGP carries routing information for multiple network-layer protocols and IP multicast routes. BGP carries different sets of routes depending on the protocol. For example, BGP can carry one set of routes for IPv4 unicast routing, one set of routes for IPv4 multicast routing, and one set of routes for MPLS VPNv4 routes.

Note

A multiprotocol BGP network is backward-compatible with a BGP network, but BGP peers that do not support multiprotocol extensions cannot forward routing information, such as address family identifier information, that the multiprotocol extensions carry.

Benefits of Using Multiprotocol BGP Versus BGP

In complex networks with multiple network layer protocols, multiprotocol BGP must be used. In less complex networks we recommend using multiprotocol BGP because it offers the following benefits:

- All of the BGP commands and routing policy capabilities of BGP can be applied to multiprotocol BGP.
- A network can carry routing information for multiple network layer protocol address families (for example, IP Version 4 or VPN Version 4) as specified in RFC 1700, *Assigned Numbers*.
- A network can support incongruent unicast and multicast topologies.
- A multiprotocol BGP network is backward compatible because the routers that support the multiprotocol extensions can interoperate with routers that do not support the extensions.

In summary, multiprotocol BGP support for multiple network layer protocol address families provides a flexible and scalable infrastructure that allows you to define independent policy and peering configurations on a per-address family basis.

Multiprotocol BGP Extensions for IP Multicast

The routes associated with multicast routing are used by the Protocol Independent Multicast (PIM) feature to build data distribution trees. Multiprotocol BGP is useful when you want a link that is dedicated to multicast traffic, perhaps to limit which resources are used for which traffic. For example, you want all multicast traffic exchanged at one network access point (NAP). Multiprotocol BGP allows you to have a unicast routing topology different from a multicast routing topology, which allows you more control over your network and resources.

In BGP, the only way to perform interdomain multicast routing is to use the BGP infrastructure that is in place for unicast routing. If the routers are not multicast-capable, or if there are differing policies about where multicast traffic should flow, multicast routing cannot be supported without multiprotocol BGP.

A multicast routing protocol, such as PIM, uses both the multicast and unicast BGP database to source the route, perform Reverse Path Forwarding (RPF) lookups for multicast-capable sources, and build a multicast distribution tree (MDT). The multicast table is the primary source for the router, but if the route is not found
in the multicast table, the unicast table is searched. Although multicast can be performed with unicast BGP, multicast BGP routes allow an alternative topology to be used for RPF.

It is possible to configure BGP peers that exchange both unicast and multicast Network Layer Reachability Information (NLRI) where multiprotocol BGP routes can be redistributed into BGP. Multiprotocol extensions, however, will be ignored by any peers that do not support multiprotocol BGP. When PIM builds a multicast distribution tree through a unicast BGP network (because the route through the unicast network is the most attractive), the RPF check may fail, preventing the MDT from being built. If the unicast network runs multiprotocol BGP, peering can be configured using the appropriate multicast address family. The multicast address family configuration enables multiprotocol BGP to carry the multicast information and the RPF lookup will succeed.

The figure below illustrates a simple example of unicast and multicast topologies that are incongruent; these topologies cannot exchange information without implementing multiprotocol BGP. Autonomous systems 100, 200, and 300 are each connected to two NAPs that are FDDI rings. One is used for unicast peering (and therefore the exchanging of unicast traffic). The Multicast Friendly Interconnect (MFI) ring is used for multicast peering (and therefore the exchanging of multicast traffic). Each router is unicast- and multicast-capable.

**Figure 2: Incongruent Unicast and Multicast Routes**

The figure below is a topology of unicast-only routers and multicast-only routers. The two routers on the left are unicast-only routers (that is, they do not support or are not configured to perform multicast routing). The two routers on the right are multicast-only routers. Routers A and B support both unicast and multicast routing. The unicast-only and multicast-only routers are connected to a single NAP.

In the figure below, only unicast traffic can travel from Router A to the unicast routers to Router B and back. Multicast traffic could not flow on that path, because multicast routing is not configured on the unicast routers and therefore the BGP routing table does not contain any multicast routes. On the multicast routers, multicast routes are enabled and BGP builds a separate routing table to hold the multicast routes. Multicast traffic uses the path from Router A to the multicast routers to Router B and back.

The figure below illustrates a multiprotocol BGP environment with a separate unicast route and multicast route from Router A to Router B. Multiprotocol BGP allows these routes to be noncongruent. Both of the autonomous systems must be configured for internal multiprotocol BGP (labeled “IMBGP” in the figure).
For more information about IP multicast, see the “Configuring IP Multicast” configuration library.

**NLRI Configuration CLI**

BGP was designed to carry only unicast IPv4 routing information. BGP configuration used the Network NLRI format CLI in Cisco software. The NLRI format offers only limited support for multicast routing information and does not support multiple network layer protocols. We do not recommend using NLRI format CLI for BGP configuration.

Using the BGP hybrid CLI feature, you can configure commands in the address family VPNv4 format and save these command configurations without modifying an existing NLRI formatted configuration. If you want to use other address family configurations such as IPv4 unicast or multicast, then you must upgrade the configuration using the `bgp upgrade-cli` command.

For more details about using BGP hybrid CLI commands, see the "Configuring a Basic BGP Network” module. See the “Multiprotocol BGP” and “Cisco BGP Address Family Model” sections for more information about address family configuration format and the limitations of the NLRI CLI format.

**Cisco BGP Address Family Model**

The Cisco BGP address family identifier (AFI) model was introduced with multiprotocol BGP and is designed to be modular and scalable, and to support multiple AFI and subsequent address family identifier (SAFI) configurations. Networks are increasing in complexity and many companies are now using BGP to connect
to many autonomous systems, as shown in the network topology in the figure below. Each of the separate autonomous systems shown in the figure below may be running several routing protocols such as Multiprotocol Label Switching (MPLS) and IPv6 and require both unicast and multicast routes to be transported via BGP.

Figure 4: BGP Network Topology for Multiple Address Families

The Cisco BGP AFI model introduced new command-line interface (CLI) commands supported by a new internal structure. Multiprotocol BGP carries routing information for multiple network layer protocols and IP multicast routes. This routing information is carried in the AFI model as appended BGP attributes (multiprotocol extensions). Each address family maintains a separate BGP database, which allows you to configure BGP policy on per-address family basis. SAFI configurations are subsets of the parent AFI. SAFIs can be used to refine BGP policy configurations.

The AFI model was created because of scalability limitations of the NLRI format. A router that is configured in NLRI format has IPv4 unicast but limited multicast capabilities. Networks that are configured in the NLRI format have the following limitations:

- No support for AFI and SAFI configuration information. Many new BGP (and other protocols such as MPLS) features are supported only in AFI and SAFI configuration modes and cannot be configured in NLRI configuration modes.
- No support for IPv6. A router that is configured in the NLRI format cannot establish peering with an IPv6 neighbor.
- Limited support for multicast interdomain routing and incongruent multicast and unicast topologies. In the NLRI format, not all configuration options are available and there is no support for VPNv4. The NLRI format configurations can be more complex than configurations that support the AFI model. If the routers in the infrastructure do not have multicast capabilities, or if policies differ as to where multicast traffic is configured to flow, multicast routing cannot be supported.

The AFI model in multiprotocol BGP supports multiple AFIs and SAFIs, all NLRI-based commands and policy configurations, and is backward compatible with routers that support only the NLRI format. A router that is configured using the AFI model has the following features:
• AFI and SAFI information and configurations are supported. A router that is configured using the AFI model can carry routing information for multiple network layer protocol address families (for example, IPv4 and IPv6).

• AFI configuration is similar in all address families, making the CLI syntax easier to use than the NLRI format syntax.

• All BGP routing policy capabilities and commands are supported.

• Congruent unicast and multicast topologies that have different policies (BGP filtering configurations) are supported, as are incongruent multicast and unicast topologies.

• CLNS is supported.

• Interoperation between routers that support only the NLRI format (AFI-based networks are backward compatible) is supported. This includes both IPv4 unicast and multicast NLRI peers.

• Virtual Private Networks (VPNs) and VPN routing and forwarding (VRF) instances are supported. Unicast IPv4 for VRFs can be configured from a specific address family IPv4 VRF; this configuration update is integrated into the BGP VPNv4 database.

Within a specific address family configuration mode, the question mark (?) online help function can be used to display supported commands. The BGP commands supported in address family configuration mode configure the same functionality as the BGP commands supported in router configuration mode; however, the BGP commands in router configuration mode configure functionality only for the IPv4 unicast address prefix. To configure BGP commands and functionality for other address family prefixes (for example, the IPv4 multicast or IPv6 unicast address prefixes), you must enter address family configuration mode for those address prefixes.

The BGP address family model consists of four address families in Cisco IOS software: IPv4, IPv6, CLNS, and VPNv4. In Cisco IOS Release 12.2(33)SRB, and later releases, support for the L2VPN address family was introduced, and within the L2VPN address family the VPLS SAFI is supported. Within the IPv4 and IPv6 address families, SAFIs such as Multicast Distribution Tree (MDT), tunnel, and VRF exist. The table below shows the list of SAFIs supported by Cisco IOS software. To ensure compatibility between networks running all types of AFI and SAFI configuration, we recommend configuring BGP on Cisco IOS devices using the multiprotocol BGP address family model.

### Table 4: SAFIs Supported by Cisco IOS Software

<table>
<thead>
<tr>
<th>SAFI Field Value</th>
<th>Description</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NLRI used for unicast forwarding.</td>
<td>RFC 2858</td>
</tr>
<tr>
<td>2</td>
<td>NLRI used for multicast forwarding.</td>
<td>RFC 2858</td>
</tr>
<tr>
<td>3</td>
<td>NLRI used for both unicast and multicast forwarding.</td>
<td>RFC 2858</td>
</tr>
<tr>
<td>4</td>
<td>NLRI with MPLS labels.</td>
<td>RFC 3107</td>
</tr>
<tr>
<td>64</td>
<td>Tunnel SAFI.</td>
<td>draft-nalawade-kapoor-tunnel-safi-01.txt</td>
</tr>
<tr>
<td>65</td>
<td>Virtual Private LAN Service (VPLS).</td>
<td>—</td>
</tr>
<tr>
<td>66</td>
<td>BGP MDT SAFI.</td>
<td>draft-nalawade-idr-mdt-safi-00.txt</td>
</tr>
</tbody>
</table>
### IPv4 Address Family

The IPv4 address family is used to identify routing sessions for protocols such as BGP that use standard IP version 4 address prefixes. Unicast or multicast address prefixes can be specified within the IPv4 address family. Routing information for address family IPv4 unicast is advertised by default when a BGP peer is configured unless the advertisement of unicast IPv4 information is explicitly turned off.

VRF instances can also be associated with IPv4 AFI configuration mode commands.

In Cisco IOS Release 12.0(28)S, the tunnel SAFI was introduced to support multipoint tunneling IPv4 routing sessions. The tunnel SAFI is used to advertise the tunnel endpoints and the SAFI specific attributes that contain the tunnel type and tunnel capabilities. Redistribution of tunnel endpoints into the BGP IPv4 tunnel SAFI table occurs automatically when the tunnel address family is configured. However, peers need to be activated under the tunnel address family before the sessions can exchange tunnel information.

In Cisco IOS Release 12.0(29)S, the multicast distribution tree (MDT) SAFI was introduced to support multicast VPN architectures. The MDT SAFI is a transitive multicast capable connector attribute that is defined as an IPv4 address family in BGP. The MDT address family session operates as a SAFI under the IPv4 multicast address family, and is configured on provider edge (PE) routers to establish VPN peering sessions with customer edge (CE) routers that support inter-AS multicast VPN peering sessions.

### IPv6 Address Family

The IPv6 address family is used to identify routing sessions for protocols such as BGP that use standard IPv6 address prefixes. Unicast or multicast address prefixes can be specified within the IPv6 address family.

---

**Note**

Routing information for address family IPv4 unicast is advertised by default when you configure a BGP peer unless you explicitly turn off the advertisement of unicast IPv4 information.

### CLNS Address Family

The CLNS address family is used to identify routing sessions for protocols such as BGP that use standard network service access point (NSAP) address prefixes. Unicast address prefixes are the default when NSAP address prefixes are configured.

CLNS routes are used in networks where CLNS addresses are configured. This is typically a telecommunications Data Communications Network (DCN). Peering is established using IP addresses, but update messages contain CLNS routes.

For more details about configuring BGP support for CLNS, which provides the ability to scale CLNS networks, see the “Configuring Multiprotocol BGP (MP-BGP) support for CLNS” module.
VPNv4 Address Family

The VPNv4 multicast address family is used to identify routing sessions for protocols such as BGP that use standard VPN Version 4 address prefixes. Unicast address prefixes are the default when VPNv4 address prefixes are configured. VPNv4 routes are the same as IPv4 routes, but VPNv4 routes have a route descriptor (RD) prepended that allows replication of prefixes. It is possible to associate every different RD with a different VPN. Each VPN needs its own set of prefixes.

Companies use an IP VPN as the foundation for deploying or administering value-added services including applications and data hosting network commerce, and telephony services to business customers.

In private LANs, IP-based intranets have fundamentally changed the way companies conduct their business. Companies are moving their business applications to their intranets to extend over a WAN. Companies are also addressing the needs of their customers, suppliers, and partners by using extranets (an intranet that encompasses multiple businesses). With extranets, companies reduce business process costs by facilitating supply-chain automation, electronic data interchange (EDI), and other forms of network commerce. To take advantage of this business opportunity, service providers must have an IP VPN infrastructure that delivers private network services to businesses over a public infrastructure.

VPNs, when used with MPLS, allow several sites to transparently interconnect through a service provider's network. One service provider network can support several different IP VPNs. Each of these appears to its users as a private network, separate from all other networks. Within a VPN, each site can send IP packets to any other site in the same VPN. Each VPN is associated with one or more VPN VRFs. VPNv4 routes are a superset of routes from all VRFs, and route injection is done per VRF under the specific VRF address family. The router maintains a separate routing and Cisco Express Forwarding (CEF) table for each VRF. This prevents information from being sent outside the VPN and allows the same subnet to be used in several VPNs without causing duplicate IP address problems. The router using BGP distributes the VPN routing information using the BGP extended communities.

The VPN address space is isolated from the global address space by design. BGP distributes reachability information for VPN-IPv4 prefixes for each VPN using the VPNv4 multiprotocol extensions to ensure that the routes for a given VPN are learned only by other members of that VPN, enabling members of the VPN to communicate with each other.

RFC 3107 specifies how to add label information to multiprotocol BGP address families using a SAFI. The Cisco IOS implementation of MPLS uses RFC 3107 to provide support for sending IPv4 routes with a label. VPNv4 routes implicitly have a label associated with each route.

L2VPN Address Family

L2VPN is defined as a secure network that operates inside an unsecured network by using an encryption technology such as IP security (IPsec) or Generic Routing Encapsulation (GRE). The L2VPN address family is configured under BGP routing configuration mode, and within the L2VPN address family the VPLS subsequent address family identifier (SAFI) is supported.

BGP support for the L2VPN address family introduces a BGP-based autodiscovery mechanism to distribute L2VPN endpoint provisioning information. BGP uses a separate L2VPN routing information base (RIB) to store endpoint provisioning information, which is updated each time any Layer 2 VFI is configured. Prefix and path information is stored in the L2VPN database, allowing BGP to make best-path decisions. When BGP distributes the endpoint provisioning information in an update message to all its BGP neighbors, the endpoint information is used to set up a pseudowire mesh to support L2VPN-based services.

The BGP autodiscovery mechanism facilitates the setting up of L2VPN services, which are an integral part of the Cisco IOS Virtual Private LAN Service (VPLS) feature. VPLS enables flexibility in deploying services
by connecting geographically dispersed sites as a large LAN over high-speed Ethernet in a robust and scalable IP MPLS network. For more details about VPLS, see the “VPLS Autodiscovery: BGP Based” feature.

Under L2VPN address family the following BGP command-line interface (CLI) commands are supported:

- bgp scan-time
- bgp next-hop
- neighbor activate
- neighbor advertisement-interval
- neighbor allowas-in
- neighbor capability
- neighbor inherit
- neighbor peer-group
- neighbor maximum-prefix
- neighbor next-hop-self
- neighbor next-hop-unchanged
- neighbor remove-private-as
- neighbor route-map
- neighbor route-reflector-client
- neighbor send-community
- neighbor soft-reconfiguration
- neighbor soo
- neighbor weight

For route reflectors using L2VPNs, the neighbor next-hop-self and neighbor next-hop-unchanged commands are not supported.

For route maps used within BGP, all commands related to prefix processing, tag processing, and automated tag processing are ignored when used under L2VPN address family configuration. All other route map commands are supported.

BGP multipaths and confederations are not supported under the L2VPN address family.

For details on configuring BGP under the L2VPN address family, see the “BGP Support for the L2VPN Address Family” module.

**BGP CLI Removal Considerations**

BGP CLI configuration can become quite complex even in smaller BGP networks. If you need to remove any CLI configuration, you must consider all the implications of removing the CLI. Analyze the current running
configuration to determine the current BGP neighbor relationships, any address family considerations, and even other routing protocols that are configured. Many BGP CLI commands affect other parts of the CLI configuration. For example, in the following configuration, a route map is used to match a BGP autonomous system number and then set the matched routes with another autonomous system number for EIGRP:

```
route-map bgp-to-eigrp permit 10
match tag 50000
set tag 65000
```

BGP neighbors in three different autonomous systems are configured and activated:

```
router bgp 45000
  bgp log-neighbor-changes
  address-family ipv4
    neighbor 172.16.1.2 remote-as 45000
    neighbor 192.168.1.2 remote-as 40000
    neighbor 192.168.3.2 remote-as 50000
    neighbor 172.16.1.2 activate
    neighbor 192.168.1.2 activate
    neighbor 192.168.3.2 activate
    network 172.17.1.0 mask 255.255.255.0
  exit-address-family
```

An EIGRP routing process is then configured and BGP routes are redistributed into EIGRP with a route map filtering the routes:

```
router eigrp 100
  redistribute bgp 45000 metric 10000 100 255 1 1500 route-map bgp-to-eigrp
  no auto-summary
  exit
```

If you later decide to remove the route map, you will use the `no` form of the `route-map` command. Almost every configuration command has a `no` form, and the `no` form generally disables a function. However, in this configuration example, if you disable only the route map, the route redistribution will continue, but without the filtering or matching from the route map. Redistribution without the route map may cause unexpected behavior in your network. When you remove an access list or route map, you must also review the commands that referenced that access list or route map to consider whether the command will give you the behavior you intended.

The following configuration will remove both the route map and the redistribution:

```
configure terminal
  no route-map bgp-to-eigrp
  router eigrp 100
    no redistribute bgp 45000
  end
```

For details on configuring the removal of BGP CLI configuration, see the “Configuring a Basic BGP Network” module.
## Additional References

### Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
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<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
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### Standards

<table>
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<td>MDT SAFI</td>
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### MIBs

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<th>MIB</th>
<th>MIBs Link</th>
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<tr>
<td>CISCO-BGP4-MIB</td>
<td>To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
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### RFCs

<table>
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<tbody>
<tr>
<td>RFC 1700</td>
<td>Assigned Numbers</td>
</tr>
<tr>
<td>RFC 2858</td>
<td>Multiprotocol Extensions for BGP-4</td>
</tr>
<tr>
<td>RFC 3107</td>
<td>Carrying Label Information in BGP-4</td>
</tr>
<tr>
<td>RFC 4271</td>
<td>A Border Gateway Protocol 4 (BGP-4)</td>
</tr>
<tr>
<td>RFC 4893</td>
<td>BGP Support for Four-Octet AS Number Space</td>
</tr>
<tr>
<td>RFC 5396</td>
<td>Textual Representation of Autonomous System (AS) Numbers</td>
</tr>
<tr>
<td>RFC 5398</td>
<td>Autonomous System (AS) Number Reservation for Documentation Use</td>
</tr>
</tbody>
</table>
Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

Feature Information for Cisco BGP Overview

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 5: Feature Information for Cisco BGP Overview

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
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<tbody>
<tr>
<td>Multiprotocol BGP</td>
<td>Cisco IOS XE 3.1.0SG</td>
<td>Cisco IOS software supports multiprotocol BGP extensions as defined in RFC 2858, <em>Multiprotocol Extensions for BGP-4</em>. The extensions introduced in this RFC allow BGP to carry routing information for multiple network layer protocols including CLNS, IPv4, IPv6, and VPNv4. These extensions are backward compatible to enable routers that do not support multiprotocol extensions to communicate with those routers that do support multiprotocol extensions. Multiprotocol BGP carries routing information for multiple network layer protocols and IP multicast routes.</td>
</tr>
</tbody>
</table>
CHAPTER 3

BGP 4

BGP is an interdomain routing protocol designed to provide loop-free routing between separate routing domains that contain independent routing policies (autonomous systems).

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Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About BGP 4

BGP Version 4 Functional Overview

BGP is an interdomain routing protocol designed to provide loop-free routing links between organizations. BGP is designed to run over a reliable transport protocol; it uses TCP (port 179) as the transport protocol because TCP is a connection-oriented protocol. The destination TCP port is assigned 179, and the local port is assigned a random port number. Cisco software supports BGP version 4 and it is this version that has been used by Internet service providers (ISPs) to help build the Internet. RFC 1771 introduced and discussed a number of new BGP features to allow the protocol to scale for Internet use. RFC 2858 introduced multiprotocol extensions to allow BGP to carry routing information for IP multicast routes and multiple Layer 3 protocol address families, including IPv4, IPv6, and CLNS.

BGP is mainly used to connect a local network to an external network to gain access to the Internet or to connect to other organizations. When connecting to an external organization, external BGP (eBGP) peering
sessions are created. Although BGP is referred to as an exterior gateway protocol (EGP), many networks within an organization are becoming so complex that BGP can be used to simplify the internal network used within the organization. BGP peers within the same organization exchange routing information through internal BGP (iBGP) peering sessions.

BGP uses a path-vector routing algorithm to exchange network reachability information with other BGP-speaking networking devices. Network reachability information is exchanged between BGP peers in routing updates. Network reachability information contains the network number, path-specific attributes, and the list of autonomous system numbers that a route must transit to reach a destination network. This list is contained in the AS-path attribute. BGP prevents routing loops by rejecting any routing update that contains the local autonomous system number because this indicates that the route has already traveled through that autonomous system and a loop would therefore be created. The BGP path-vector routing algorithm is a combination of the distance-vector routing algorithm and the AS-path loop detection.

BGP selects a single path, by default, as the best path to a destination host or network. The best path selection algorithm analyzes path attributes to determine which route is installed as the best path in the BGP routing table. Each path carries well-known mandatory, well-known discretionary, and optional transitive attributes that are used in BGP best path analysis. Cisco software provides the ability to influence BGP path selection by altering some of these attributes using the command-line interface (CLI) BGP path selection can also be influenced through standard BGP policy configuration. For more details about using BGP to influence path selection and configuring BGP policies to filter traffic, see the “BGP 4 Prefix Filter and Inbound Route Maps” module and the “BGP Prefix-Based Outbound Route Filtering” module.

BGP uses the best-path selection algorithm to find a set of equally good routes. These routes are the potential multipaths. In Cisco IOS Release 12.2(33)SRD and later releases, when there are more equally good multipaths available than the maximum permitted number, the oldest paths are selected as multipaths.

BGP can be used to help manage complex internal networks by interfacing with Interior Gateway Protocols (IGPs). Internal BGP can help with issues such as scaling the existing IGPs to match the traffic demands while maintaining network efficiency.

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**Note**

BGP requires more configuration than other routing protocols and the effects of any configuration changes must be fully understood. Incorrect configuration can create routing loops and negatively impact normal network operation.

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**BGP Router ID**

BGP uses a router ID to identify BGP-speaking peers. The BGP router ID is a 32-bit value that is often represented by an IPv4 address. By default, the Cisco software sets the router ID to the IPv4 address of a loopback interface on the router. If no loopback interface is configured on the device, the software chooses the highest IPv4 address configured on a physical interface of the device to represent the BGP router ID. The BGP router ID must be unique to the BGP peers in a network.

**BGP-Speaker and Peer Relationships**

A BGP-speaking device does not discover another BGP-speaking device automatically. A network administrator usually manually configures the relationships between BGP-speaking devices. A peer device is a BGP-speaking device that has an active TCP connection to another BGP-speaking device. This relationship between BGP devices is often referred to as a neighbor, but because this can imply the idea that the BGP devices are directly
connected with no other device in between, the term *neighbor* will be avoided whenever possible in this document. A BGP speaker is the local device, and a peer is any other BGP-speaking network device.

When a TCP connection is established between peers, each BGP peer initially exchanges all its routes—the complete BGP routing table—with the other peer. After this initial exchange, only incremental updates are sent when there has been a topology change in the network, or when a routing policy has been implemented or modified. In the periods of inactivity between these updates, peers exchange special messages called *keepalives*.

A BGP autonomous system is a network that is controlled by a single technical administration entity. Peer devices are called external peers when they are in different autonomous systems and internal peers when they are in the same autonomous system. Usually, external peers are adjacent and share a subnet; internal peers may be anywhere in the same autonomous system.

### BGP Peer Session Establishment

When a BGP routing process establishes a peering session with a peer, it goes through the following state changes:

- **Idle**—The initial state that the BGP routing process enters when the routing process is enabled or when the device is reset. In this state, the device waits for a start event, such as a peering configuration with a remote peer. After the device receives a TCP connection request from a remote peer, the device initiates another start event to wait for a timer before starting a TCP connection to a remote peer. If the device is reset, the peer is reset and the BGP routing process returns to the Idle state.

- **Connect**—The BGP routing process detects that a peer is trying to establish a TCP session with the local BGP speaker.

- **Active**—In this state, the BGP routing process tries to establish a TCP session with a peer device using the ConnectRetry timer. Start events are ignored while the BGP routing process is in the Active state. If the BGP routing process is reconfigured or if an error occurs, the BGP routing process will release system resources and return to an Idle state.

- **OpenSent**—The TCP connection is established, and the BGP routing process sends an OPEN message to the remote peer, and transitions to the OpenSent state. The BGP routing process can receive other OPEN messages in this state. If the connection fails, the BGP routing process transitions to the Active state.

- **OpenReceive**—The BGP routing process receives the OPEN message from the remote peer and waits for an initial keepalive message from the remote peer. When a keepalive message is received, the BGP routing process transitions to the Established state. If a notification message is received, the BGP routing process transitions to the Idle state. If an error or configuration change occurs that affects the peering session, the BGP routing process sends a notification message with the Finite State Machine (FSM) error code and then transitions to the Idle state.

- **Established**—The initial keepalive is received from the remote peer. Peering is now established with the remote neighbor and the BGP routing process starts exchanging update messages with the remote peer. The hold timer restarts when an update or keepalive message is received. If the BGP process receives an error notification, it will transition to the Idle state.
BGP Session Reset

Whenever the routing policy changes due to a configuration change, BGP peering sessions must be reset by using the `clear ip bgp` command. Cisco software supports the following three mechanisms to reset BGP peering sessions:

- **Hard reset**—A hard reset tears down the specified peering sessions including the TCP connection and deletes routes coming from the specified peer.

- **Soft reset**—A soft reset uses stored prefix information to reconfigure and activate BGP routing tables without tearing down existing peering sessions. Soft reconfiguration uses stored update information, at the cost of additional memory for storing the updates, to allow you to apply new BGP policy without disrupting the network. Soft reconfiguration can be configured for inbound or outbound sessions.

- **Dynamic inbound soft reset**—The route refresh capability, as defined in RFC 2918, allows the local device to reset inbound routing tables dynamically by exchanging route refresh requests to supporting peers. The route refresh capability does not store update information locally for nondisruptive policy changes. It instead relies on dynamic exchange with supporting peers. Route refresh must first be advertised through BGP capability negotiation between peers. All BGP devices must support the route refresh capability. To determine if a BGP device supports this capability, use the `show ip bgp neighbors` command. The following message is displayed in the output when the device supports the route refresh capability:

  Received route refresh capability from peer.

The `bgp soft-reconfig-backup` command was introduced to configure BGP to perform inbound soft reconfiguration for peers that do not support the route refresh capability. The configuration of this command allows you to configure BGP to store updates (soft reconfiguration) only as necessary. Peers that support the route refresh capability are unaffected by the configuration of this command.

BGP Route Aggregation

BGP peers store and exchange routing information and the amount of routing information increases as more BGP speakers are configured. The use of route aggregation reduces the amount of information involved. Aggregation is the process of combining the attributes of several different routes so that only a single route is advertised. Aggregate prefixes use the classless interdomain routing (CIDR) principle to combine contiguous networks into one classless set of IP addresses that can be summarized in routing tables. Fewer routes now need to be advertised.

Two methods are available in BGP to implement route aggregation. You can redistribute an aggregated route into BGP or you can use a form of conditional aggregation. Basic route redistribution involves creating an aggregate route and then redistributing the routes into BGP. Conditional aggregation involves creating an aggregate route and then advertising or suppressing the advertising of certain routes on the basis of route maps, autonomous system set path (AS-SET) information, or summary information.

The `bgp suppress-inactive` command configures BGP to not advertise inactive routes to any BGP peer. A BGP routing process can advertise routes that are not installed in the routing information database (RIB) to BGP peers by default. A route that is not installed into the RIB is an inactive route. Inactive route advertisement can occur, for example, when routes are advertised through common route aggregation. Inactive route advertisements can be suppressed to provide more consistent data forwarding.
BGP Route Aggregation Generating AS_SET Information

AS_SET information can be generated when BGP routes are aggregated using the `aggregate-address` command. The path advertised for such a route is an AS_SET consisting of all the elements, including the communities, contained in all the paths that are being summarized. If the AS_PATHs to be aggregated are identical, only the AS_PATH is advertised. The ATOMIC-AGGREGATE attribute, set by default for the `aggregate-address` command, is not added to the AS_SET.

Routing Policy Change Management

Routing policies for a peer include all the configurations for elements such as a route map, distribute list, prefix list, and filter list that may impact inbound or outbound routing table updates. Whenever there is a change in the routing policy, the BGP session must be soft-cleared, or soft-reset, for the new policy to take effect. Performing inbound reset enables the new inbound policy configured on the device to take effect. Performing outbound reset causes the new local outbound policy configured on the device to take effect without resetting the BGP session. As a new set of updates is sent during outbound policy reset, a new inbound policy of the neighbor can also take effect. This means that after changing inbound policy, you must do an inbound reset on the local device or an outbound reset on the peer device. Outbound policy changes require an outbound reset on the local device or an inbound reset on the peer device.

There are two types of reset: hard reset and soft reset. The table below lists their advantages and disadvantages.

### Table 6: Advantages and Disadvantages of Hard and Soft Resets

<table>
<thead>
<tr>
<th>Type of Reset</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hard reset</td>
<td>No memory overhead.</td>
<td>The prefixes in the BGP, IP, and Forwarding Information Base (FIB) tables provided by the neighbor are lost. A hard reset is not recommended.</td>
</tr>
<tr>
<td>Outbound soft reset</td>
<td>No configuration, and no storing of routing table updates.</td>
<td>Does not reset inbound routing table updates.</td>
</tr>
<tr>
<td>Dynamic inbound soft reset</td>
<td>Does not clear the BGP session and cache.</td>
<td>Both BGP devices must support the route refresh capability.</td>
</tr>
<tr>
<td></td>
<td>Does not require storing of routing table updates, and has no memory overhead.</td>
<td><strong>Note</strong> Does not reset outbound routing table updates.</td>
</tr>
<tr>
<td>Configured inbound soft reset</td>
<td>Can be used when both BGP devices do not support the automatic route refresh capability.</td>
<td>Requires preconfiguration. Stores all received (inbound) routing policy updates without modification; is memory-intensive.</td>
</tr>
<tr>
<td></td>
<td>The <code>bgp soft-reconfig-backup</code> command was introduced to configure inbound soft reconfiguration for peers that do not support the route refresh capability.</td>
<td>Recommended only when absolutely necessary, such as when both BGP devices do not support the automatic route refresh capability.</td>
</tr>
<tr>
<td></td>
<td><strong>Note</strong> Does not reset outbound routing table updates.</td>
<td></td>
</tr>
</tbody>
</table>
Once you have defined two devices to be BGP neighbors, they will form a BGP connection and exchange routing information. If you subsequently change a BGP filter, weight, distance, version, or timer, or if you make a similar configuration change, you must reset BGP connections in order for the configuration change to take effect.

A soft reset updates the routing table for inbound and outbound routing updates. Cisco software supports soft reset without any prior configuration. This soft reset allows the dynamic exchange of route refresh requests and routing information between BGP devices, and allows the subsequent readvertisement of the respective outbound routing table. There are two types of soft reset:

- When soft reset is used to generate inbound updates from a neighbor, it is called dynamic inbound soft reset.
- When soft reset is used to send a new set of updates to a neighbor, it is called outbound soft reset.

To use soft reset without preconfiguration, both BGP peers must support the soft route refresh capability, which is advertised in the OPEN message sent when the peers establish a TCP session.

**BGP Peer Groups**

Often, in a BGP network, many neighbors are configured with the same update policies (that is, the same outbound route maps, distribute lists, filter lists, update source, and so on). Neighbors with the same update policies can be grouped into BGP peer groups to simplify configuration and, more importantly, to make configuration updates more efficient. When you have many peers, this approach is highly recommended.

**BGP Backdoor Routes**

In a BGP network topology with two border devices using eBGP to communicate to a number of different autonomous systems, using eBGP to communicate between the two border devices may not be the most efficient routing method. In the figure below, Router B as a BGP speaker will receive a route to Router D through eBGP, but this route will traverse at least two autonomous systems. Router B and Router D are also connected through an Enhanced Interior Gateway Routing Protocol (EIGRP) network (any IGP can be used here), and this route has a shorter path. EIGRP routes, however, have a default administrative distance of 90, and eBGP routes have a default administrative distance of 20, so BGP will prefer the eBGP route. Changing the default administrative distances is not recommended because changing the administrative distance may lead to routing loops. To cause BGP to prefer the EIGRP route, you can use the `network backdoor` command. BGP treats the network specified by the `network backdoor` command as a locally assigned network, except that it does not advertise the specified network in BGP updates. In the figure below, this means that Router B will communicate to Router D using the shorter EIGRP route instead of the longer eBGP route.
How to Configure BGP 4

Configuring a basic BGP network consists of a few required tasks and many optional tasks. A BGP routing process must be configured and BGP peers must be configured, preferably using the address family configuration model. If the BGP peers are part of a VPN network, the BGP peers must be configured using the IPv4 VRF address family task.

Configuring a BGP Routing Process

Perform this task to configure a BGP routing process. You must perform the required steps at least once to enable BGP. The optional steps here allow you to configure additional features in your BGP network. Several of the features, such as logging neighbor resets and immediate reset of a peer when its link goes down, are enabled by default but are presented here to enhance your understanding of how your BGP network operates.

Note

A device that runs Cisco software can be configured to run only one BGP routing process and to be a member of only one BGP autonomous system. However, a BGP routing process and autonomous system can support multiple concurrent BGP address family and subaddress family configurations.

The configuration in this task is done at Router A in the figure below and would need to be repeated with appropriate changes to the IP addresses (for example, at Router B) to fully achieve a BGP process between the two devices. No address family is configured here for the BGP routing process, so routing information for the IPv4 unicast address family is advertised by default.
### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `network network-number [mask network-mask] [route-map route-map-name]`
5. `bgp router-id ip-address`
6. `timers bgp keepalive holdtime`
7. `bgp fast-external-fallover`
8. `bgp log-neighbor-changes`
9. `end`
10. `show ip bgp [network] [network-mask]`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>2</td>
<td><code>configure terminal</code></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td><code>router bgp autonomous-system-number</code></td>
<td>Configures a BGP routing process, and enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
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<td></td>
</tr>
<tr>
<td><code>Device(config)# router bgp 40000</code></td>
<td>• Use the <code>autonomous-system-number</code> argument to specify an integer, from 0 and 65534, that identifies the device to other BGP speakers.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> <code>network network-number [mask network-mask] [route-map route-map-name]</code></td>
<td>(Optional) Specifies a network as local to this autonomous system and adds it to the BGP routing table.</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong> <code>Device(config-router)# network 10.1.1.0 mask 255.255.255.0</code></td>
<td>• For exterior protocols, the <code>network</code> command controls which networks are advertised. Interior protocols use the <code>network</code> command to determine where to send updates.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> <code>bgp router-id ip-address</code></td>
<td>(Optional) Configures a fixed 32-bit router ID as the identifier of the local device running BGP.</td>
<td></td>
</tr>
</tbody>
</table>
| **Example:** `Device(config-router)# bgp router-id 10.1.1.99` | • Use the `ip-address` argument to specify a unique router ID within the network.  
| **Note** | Configuring a router ID using the `bgp router-id` command resets all active BGP peering sessions. |
| **Step 6** `timers bgp keepalive holdtime` | (Optional) Sets BGP network timers. |
| **Example:** `Device(config-router)# timers bgp 70 120` | • Use the `keepalive` argument to specify the frequency, in seconds, with which the software sends keepalive messages to its BGP peer. By default, the keepalive timer is set to 60 seconds.  
• Use the `holdtime` argument to specify the interval, in seconds, after which the software, having not received a keepalive message, declares a BGP peer dead. By default, the holdtime timer is set to 180 seconds. |
<p>| <strong>Step 7</strong> <code>bgp fast-external-fallover</code> | (Optional) Enables the automatic resetting of BGP sessions. |
| <strong>Example:</strong> <code>Device(config-router)# bgp fast-external-fallover</code> | • By default, the BGP sessions of any directly adjacent external peers are reset if the link used to reach them goes down. |
| <strong>Step 8</strong> <code>bgp log-neighbor-changes</code> | (Optional) Enables logging of BGP neighbor status changes (up or down) and neighbor resets. |
| <strong>Example:</strong> <code>Device(config-router)# bgp log-neighbor-changes</code> | • Use this command for troubleshooting network connectivity problems and measuring network stability. Unexpected neighbor resets might indicate high error rates or high packet loss in the network and should be investigated. |</p>
<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td><strong>end</strong></td>
<td>Exits router configuration mode and enters privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config-router)# end</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td><strong>show ip bgp</strong> [network] [network-mask]</td>
<td>(Optional) Displays the entries in the BGP routing table. Only the syntax applicable to this task is used in this example. For more details, see the Cisco IOS IP Routing: BGP Command Reference.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device# show ip bgp</td>
<td></td>
</tr>
</tbody>
</table>

**Examples**

The following sample output from the `show ip bgp` command shows the BGP routing table for Router A in the figure above after this task has been configured on Router A. You can see an entry for the network 10.1.1.0 that is local to this autonomous system.

```
BGP table version is 12, local router ID is 10.1.1.99
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

Network Next Hop Metric LocPrf Weight Path
*> 10.1.1.0/24 0.0.0.0 0 32768 i
```

**Troubleshooting Tips**

Use the `ping` command to check basic network connectivity between the BGP routers.

**Configuring a BGP Peer**

Perform this task to configure BGP between two IPv4 devices (peers). The address family configured here is the default IPv4 unicast address family, and the configuration is done at Router A in the figure above. Remember to perform this task for any neighboring devices that are to be BGP peers.

**Before you begin**

Before you perform this task, perform the “Configuring a BGP Routing Process” task.

**Note**

By default, neighbors that are defined using the `neighbor remote-as` command in router configuration mode exchange only IPv4 unicast address prefixes. To exchange other address prefix types, such as IPv6 prefixes, neighbors must also be activated using the `neighbor activate` command in address family configuration mode for the other prefix types, such as IPv6 prefixes.

**SUMMARY STEPS**

1. `enable`
2. configure terminal
3. router bgp autonomous-system-number
4. neighbor ip-address remote-as autonomous-system-number
5. address-family ipv4 [unicast | multicast | vrf vrf-name]
6. neighbor ip-address activate
7. end
8. show ip bgp [network] [network-mask]
9. show ip bgp neighbors [neighbor-address]

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>configure terminal</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td>router bgp autonomous-system-number</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config)# router bgp 40000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>Adds the IP address of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local device.</td>
</tr>
<tr>
<td>neighbor ip-address remote-as autonomous-system-number</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config-router)# neighbor 192.168.1.1 remote-as 45000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>Specifies the IPv4 address family and enters address family configuration mode.</td>
</tr>
<tr>
<td>address-family ipv4 [unicast</td>
<td>multicast</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config-router)# address-family ipv4 unicast</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• The <strong>unicast</strong> keyword specifies the IPv4 unicast address family. By default, the device is placed in configuration mode for the IPv4 unicast address family if the <strong>unicast</strong> keyword is not specified with the <strong>address-family ipv4</strong> command.</td>
</tr>
<tr>
<td></td>
<td>• The <strong>multicast</strong> keyword specifies IPv4 multicast address prefixes.</td>
</tr>
<tr>
<td></td>
<td>• The <strong>vrf</strong> keyword and <strong>vrf-name</strong> argument specify the name of the virtual routing and forwarding (VRF) instance to associate with subsequent IPv4 address family configuration mode commands.</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td></td>
</tr>
<tr>
<td>neighbor ip-address activate</td>
<td>Enables the neighbor to exchange prefixes for the IPv4 unicast address</td>
</tr>
<tr>
<td>Example:</td>
<td>family with the local device.</td>
</tr>
<tr>
<td>Device(config-router-af)# neighbor 192.168.1.1 activate</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td></td>
</tr>
<tr>
<td>end</td>
<td>Exits address family configuration mode and returns to privileged EXEC</td>
</tr>
<tr>
<td>Example:</td>
<td>mode.</td>
</tr>
<tr>
<td>Device(config-router-af)# end</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td></td>
</tr>
<tr>
<td>show ip bgp [network] [network-mask]</td>
<td>(Optional) Displays the entries in the BGP routing table.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device# show ip bgp</td>
<td></td>
</tr>
<tr>
<td><strong>Step 9</strong></td>
<td></td>
</tr>
<tr>
<td>show ip bgp neighbors [neighbor-address]</td>
<td>(Optional) Displays information about the TCP and BGP connections</td>
</tr>
<tr>
<td>Example:</td>
<td>to neighbors.</td>
</tr>
<tr>
<td>Device(config-router-af)# show ip bgp neighbors 192.168.2.2</td>
<td></td>
</tr>
</tbody>
</table>

Examples

The following sample output from the `show ip bgp` command shows the BGP routing table for Router A in the figure above after this task has been configured on Router A and Router B. You can now see an entry for the network 172.17.1.0 in autonomous system 45000.

```
BGP table version is 13, local router ID is 10.1.1.99
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
             r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete
Network     Next Hop     Metric LocPrf Weight Path
*> 10.1.1.0/24 0.0.0.0     0     32768 i
*> 172.17.1.0/24 192.168.1.1 0     0     45000 i
```

The following sample output from the `show ip bgp neighbors` command shows information about the TCP and BGP connections to the BGP neighbor 192.168.1.1 of Router A in the figure above after this task has been configured on Router A:

```
BGP neighbor is 192.168.1.1, remote AS 45000, external link
BGP version 4, remote router ID 172.17.1.99
BGP state - Established, up for 00:06:55
Last read 00:00:15, last write 00:00:15, hold time is 120, keepalive intervals
Configured hold time is 120, keepalive interval is 70 seconds, Minimum holdtime
Neighbor capabilities: Route refresh: advertised and received (old & new)
                        Address family IPv4 Unicast: advertised and received
Message statistics:
                      InQ depth is 0
```
OutQ depth is 0

<table>
<thead>
<tr>
<th>Sent</th>
<th>Rcvd</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>15</td>
<td>16</td>
</tr>
</tbody>
</table>

Default minimum time between advertisement runs is 30 seconds
For address family: IPv4 Unicast
BGP table version 13, neighbor version 13/0
Output queue size : 0
Index 1, Offset 0, Mask 0x2
1 update-group member

Prefix activity: ---- ----
Prefixes Current: 1 1 (Consumes 52 bytes)
Prefixes Total: 1 1
Implicit Withdraw: n/a
Explicit Withdraw: n/a
Used as bestpath: n/a 1
Used as multipath: n/a 0
Local Policy Denied Prefixes: n/a
AS_PATH loop: n/a 1
Bestpath from this peer: 1 n/a
Total: 1 1
Number of NLRIIs in the update sent: max 0, min 0
Connections established 1; dropped 0
Last reset never
Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Connection is ECN Disabled
Local host: 192.168.1.2, Local port: 179
Foreign host: 192.168.1.1, Foreign port: 37725
Enqueued packets for retransmit: 0, input: 0 mis-ordered: 0 (0 bytes)
Event Timers (current time is 0x12F4F2C):
- Retrans: 14 0 0x0
- TimeWait: 0 0 0x0
- AckHold: 13 8 0x0
- SendWnd: 0 0 0x0
- KeepAlive: 0 0 0x0
- GiveUp: 0 0 0x0
- PmtuAger: 0 0 0x0
- DeadWait: 0 0 0x0
- iiss: 165379618 snduna: 165379963 sndnxt: 165379963 sndwnd: 16040
- irs: 3127821601 rcvnxn: 3127821993 rcvwnd: 15993 delrcvwnd: 391
- SRTT: 254 ms, RTTO: 619 ms, RTV: 365 ms, KRTT: 0 ms
- minRTT: 12 ms, maxRTT: 300 ms, ACK hold: 200 ms
- Flags: passive open, nagle, gen tcbs
- IP Precedence value : 6
- Datagrams (max data segment is 1460 bytes):

Rcvd: 20 (out of order: 0), with data: 15, total data bytes: 391
Sent: 22 (retransmit: 0, fastretransmit: 0, partialack: 0, Second Congestion: 04

Troubleshooting Tips

Use the ping command to verify basic network connectivity between the BGP devices.
Configuring a BGP Peer for the IPv4 VRF Address Family

Perform this optional task to configure BGP between two IPv4 devices (peers) that must exchange IPv4 VRF information because they exist in a VPN. The address family configured here is the IPv4 VRF address family, and the configuration is done at Router B in the figure below with the neighbor 192.168.3.2 at Router E in autonomous system 50000. Remember to perform this task for any neighboring devices that are to be BGP IPv4 VRF address family peers.

Figure 7: BGP Topology for IPv4 VRF Address Family

Before you begin

Before you perform this task, perform the “Configuring a BGP Routing Process” task.

SUMMARY STEPS

1. enable
2. configure terminal
3. interface type number
4. vrf forwarding vrf-name
5. ip address ip-address mask [secondary [vrf vrf-name]]
6. exit
7. ip vrf vrf-name
8. rd route-distinguisher
9. route-target {import | export | both} route-target-ext-community
10. exit
11. router bgp autonomous-system-number
12. address-family ipv4 [unicast | multicast | vrf vrf-name]
13. neighbor ip-address remote-as autonomous-system-number
14. neighbor [ip-address | peer-group-name] maximum-prefix maximum [threshold] [restart restart-interval] [warning-only]
15. neighbor ip-address activate
16. end
## Detailed Steps

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** | `enable` | Enables privileged EXEC mode.  
**Example:**  
Device> enable |  
• Enter your password if prompted. |
| **Step 2** | `configure terminal` | Enters global configuration mode.  
**Example:**  
Device# configure terminal |  |
| **Step 3** | `interface type number` | Enters interface configuration mode.  
**Example:**  
Device(config-if)# |  |
| **Step 4** | `vrf forwarding vrf-name` | Associates a VPN VRF instance with an interface or subinterface.  
**Example:**  
Device(config-if)# vrf forwarding vpn1 |  |
| **Step 5** | `ip address ip-address mask [secondary [vrf vrf-name]]` | Sets an IP address for an interface.  
**Example:**  
Device(config-if)# ip address 192.168.3.1 255.255.255.0 |  |
| **Step 6** | `exit` | Exits interface configuration mode and enters global configuration mode.  
**Example:**  
Device(config-if)# exit |  |
| **Step 7** | `ip vrf vrf-name` | Configures a VRF routing table and enters VRF configuration mode.  
**Example:**  
Device(config)# ip vrf vpn1  
• Use the `vrf-name` argument to specify a name to be assigned to the VRF. |
| **Step 8** | `rd route-distinguisher` | Creates routing and forwarding tables and specifies the default route distinguisher for a VPN.  
**Example:**  
Device(config-vrf)# rd 45000:5  
• Use the `route-distinguisher` argument to add an 8-byte value to an IPv4 prefix to create a unique VPN IPv4 prefix. |
| **Step 9** | `route-target {import | export | both} route-target-ext-community` | Creates a route target extended community for a VRF.  
**Example:**  
Device(config-vrf)# route-target both 45000:100  
• Use the `import` keyword to import routing information from the target VPN extended community. |
## Configuring a BGP Peer for the IPv4 VRF Address Family

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 10</strong></td>
<td>Exits VRF configuration mode and enters global configuration mode.</td>
</tr>
<tr>
<td><code>exit</code></td>
<td>Exits VRF configuration mode and enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config-vrf)# exit</code></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td><strong>Step 11</strong></td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td><code>router bgp autonomous-system-number</code></td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config)# router bgp 45000</code></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td><strong>Step 12</strong></td>
<td>Specifies the IPv4 address family and enters address family configuration mode.</td>
</tr>
<tr>
<td>`address-family ipv4 [unicast</td>
<td>multicast</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Specifies the IPv4 address family and enters address family configuration mode.</td>
</tr>
<tr>
<td><code>Device(config-router)# address-family ipv4 vrf vpn1</code></td>
<td>Specifies the IPv4 address family and enters address family configuration mode.</td>
</tr>
<tr>
<td><strong>Step 13</strong></td>
<td>Adds the IP address of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local device.</td>
</tr>
<tr>
<td><code>neighbor ip-address remote-as autonomous-system-number</code></td>
<td>Adds the IP address of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local device.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Adds the IP address of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local device.</td>
</tr>
<tr>
<td><code>Device(config-router-af)# neighbor 192.168.3.2 remote-as 50000</code></td>
<td>Adds the IP address of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local device.</td>
</tr>
<tr>
<td><strong>Step 14</strong></td>
<td>Controls how many prefixes can be received from a neighbor.</td>
</tr>
<tr>
<td>`neighbor {ip-address</td>
<td>peer-group-name} maximum-prefix maximum [threshold] [restart restart-interval] [warning-only]`</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Controls how many prefixes can be received from a neighbor.</td>
</tr>
<tr>
<td><strong>Purpose</strong></td>
<td>Controls how many prefixes can be received from a neighbor.</td>
</tr>
</tbody>
</table>
Device(config-router-af)# neighbor 192.168.3.2 maximum-prefix 10000 warning-only

The number of prefixes that can be configured is limited only by the available system resources on a device.

- Use the `threshold` argument to specify an integer representing a percentage of the maximum prefix limit at which the device starts to generate a warning message.
- Use the `warning-only` keyword to allow the device to generate a log message when the maximum prefix limit is exceeded, instead of terminating the peering session.

### Step 15

**Command:**
```
neighbor ip-address activate
```
**Example:**
```
Device(config-router-af)# neighbor 192.168.3.2 activate
```

Enables the neighbor to exchange prefixes for the IPv4 VRF address family with the local device.

### Step 16

**Command:**
```
end
```
**Example:**
```
Device(config-router-af)# end
```

Exits address family configuration mode and enters privileged EXEC mode.

---

**Troubleshooting Tips**

Use the `ping vrf` command to verify basic network connectivity between the BGP devices, and use the `show ip vrf` command to verify that the VRF instance has been created.

**Customizing a BGP Peer**

Perform this task to customize your BGP peers. Although many of the steps in this task are optional, this task demonstrates how the neighbor and address family configuration command relationships work. Using the example of the IPv4 multicast address family, neighbor address family-independent commands are configured before the IPv4 multicast address family is configured. Commands that are address family-dependent are then configured and the `exit address-family` command is shown. An optional step shows how to disable a neighbor.

The configuration in this task is done at Router B in the figure below and would need to be repeated with appropriate changes to the IP addresses, for example, at Router E to fully configure a BGP process between the two devices.
By default, neighbors that are defined using the `neighbor remote-as` command in router configuration mode exchange only IPv4 unicast address prefixes. To exchange other address prefix types, such as IPv6 prefixes, neighbors must also be activated using the `neighbor activate` command in address family configuration mode for the other prefix types, such as IPv6 prefixes.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `no bgp default ipv4-unicast`
5. `neighbor [ip-address | peer-group-name] remote-as autonomous-system-number`
6. `neighbor [ip-address | peer-group-name] description text`
7. `address-family ipv4 [unicast | multicast | vrf vrf-name]`
8. `network network-number [mask network-mask] [route-map route-map-name]`
9. `neighbor [ip-address | peer-group-name] activate`
10. `neighbor [ip-address | peer-group-name] advertisement-interval seconds`
11. `neighbor [ip-address | peer-group-name] default-originate [route-map map-name]`
12. `exit-address-family`
13. `neighbor [ip-address | peer-group-name] shutdown`
14. `end`
15. `show ip bgp ipv4 multicast [command]`
16. `show ip bgp neighbors [neighbor-address] [received-routes | routes | advertised-routes | paths | regexp | dampened-routes | received prefix-filter]`
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** | **enable** | Enables privileged EXEC mode.  
- Enter your password if prompted. |

**Example:**
```
Device> enable
```

| **Step 2** | **configure terminal** | Enters global configuration mode. |

**Example:**
```
Device# configure terminal
```

| **Step 3** | **router bgp autonomous-system-number** | Enters router configuration mode for the specified routing process. |

**Example:**
```
Device(config)# router bgp 45000
```

| **Step 4** | **no bgp default ipv4-unicast** | Disables the IPv4 unicast address family for the BGP routing process.  
**Note** Routing information for the IPv4 unicast address family is advertised by default for each BGP routing session configured with the **neighbor remote-as** router configuration command unless you configure the **no bgp default ipv4-unicast** router configuration command before configuring the **neighbor remote-as** command. Existing neighbor configurations are not affected. |

**Example:**
```
Device(config-router)# no bgp default ipv4-unicast
```

| **Step 5** | **neighbor {ip-address | peer-group-name} remote-as autonomous-system-number** | Adds the IP address of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local device. |

**Example:**
```
Device(config-router)# neighbor 192.168.3.2 remote-as 50000
```

| **Step 6** | **neighbor {ip-address | peer-group-name} description text** | (Optional) Associates a text description with the specified neighbor. |

**Example:**
```
Device(config-router)# neighbor 192.168.3.2 description finance
```

| **Step 7** | **address-family ipv4 [unicast | multicast | vrf vrf-name]** | Specifies the IPv4 address family and enters address family configuration mode.  
- The **unicast** keyword specifies the IPv4 unicast address family. By default, the device is placed in configuration mode for the IPv4 unicast address. |

**Example:**
```
Device(config-router)# address-family ipv4 multicast
```
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 8</strong> network network-number [mask network-mask] [route-map route-map-name]</td>
<td>Specifies a network as local to this autonomous system and adds it to the BGP routing table.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config-router-af)# network 172.17.1.0 mask 255.255.255.0</td>
<td></td>
</tr>
<tr>
<td><strong>Step 9</strong> neighbor {ip-address</td>
<td>peer-group-name} activate</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config-router-af)# neighbor 192.168.3.2 activate</td>
<td></td>
</tr>
<tr>
<td><strong>Step 10</strong> neighbor {ip-address</td>
<td>peer-group-name} advertisement-interval seconds</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config-router-af)# neighbor 192.168.3.2 advertisement-interval 25</td>
<td></td>
</tr>
<tr>
<td><strong>Step 11</strong> neighbor {ip-address</td>
<td>peer-group-name} default-originate [route-map map-name]</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config-router-af)# neighbor 192.168.3.2 default-originate</td>
<td></td>
</tr>
<tr>
<td><strong>Step 12</strong> exit-address-family</td>
<td>Exits address family configuration mode and enters router configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config-router-af)# exit-address-family</td>
<td></td>
</tr>
<tr>
<td><strong>Step 13</strong> neighbor {ip-address</td>
<td>peer-group-name} shutdown</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config-router)# neighbor 192.168.3.2 shutdown</td>
<td><strong>Note</strong> If you perform this step you will not be able to run either of the subsequent show command steps because you have disabled the neighbor.</td>
</tr>
</tbody>
</table>

**Purpose**

- If the **unicast** keyword is not specified with the **address-family ipv4** command.
- The **multicast** keyword specifies IPv4 multicast address prefixes.
- The **vrf** keyword and **vrf-name** argument specify the name of the VRF instance to associate with subsequent IPv4 address family configuration mode commands.
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 14</strong></td>
<td>Exits router configuration mode and enters privileged EXEC mode.</td>
</tr>
<tr>
<td><code>end</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config-router)# end</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 15</strong></td>
<td>(Optional) Displays IPv4 multicast database-related information.</td>
</tr>
<tr>
<td><code>show ip bgp ipv4 multicast [command]</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device# show ip bgp ipv4 multicast</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 16</strong></td>
<td>(Optional) Displays information about the TCP and BGP connections to neighbors.</td>
</tr>
<tr>
<td><code>show ip bgp neighbors [neighbor-address]</code></td>
<td></td>
</tr>
<tr>
<td>`[received-routes</td>
<td>routes</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device# show ip bgp neighbors 192.168.3.2</code></td>
<td></td>
</tr>
</tbody>
</table>

**Examples**

The following sample output from the `show ip bgp ipv4 multicast` command shows BGP IPv4 multicast information for Router B in the figure above after this task has been configured on Router B and Router E. Note that the networks local to each device that were configured under IPv4 multicast address family appear in the output table.

BGP table version is 3, local router ID is 172.17.1.99
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal, r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

<table>
<thead>
<tr>
<th>Network</th>
<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>*&gt; 10.2.2.0/24</td>
<td>192.168.3.2</td>
<td>0</td>
<td>0</td>
<td>50000</td>
<td>i</td>
</tr>
<tr>
<td>*&gt; 172.17.1.0/24</td>
<td>0.0.0.0</td>
<td>0</td>
<td>32768</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

The following partial sample output from the `show ip bgp neighbors` command for neighbor 192.168.3.2 shows general BGP information and specific BGP IPv4 multicast address family information about the neighbor. The command was entered on Router B in the figure above after this task had been configured on Router B and Router E.

BGP neighbor is 192.168.3.2, remote AS 50000, external link
Description: finance
BGP version 4, remote router ID 10.2.2.99
BGP state = Established, up for 01:48:27
Last read 00:00:26, last write 00:00:26, hold time is 120, keepalive intervals
Configured hold time is 120, keepalive interval is 70 seconds, Minimum holdtime
Neighbor capabilities:
  - Route refresh: advertised and received (old & new)
  - Address family IPv4 Unicast: advertised
  - Address family IPv4 Multicast: advertised and received

For address family: IPv4 Multicast
Removing BGP Configuration Commands Using a Redistribution

BGP CLI configuration can become quite complex even in smaller BGP networks. If you need to remove any CLI configuration, you must consider all the implications of removing the CLI. Analyze the current running configuration to determine the current BGP neighbor relationships, any address family considerations, and even other routing protocols that are configured. Many BGP CLI commands affect other parts of the CLI configuration.

Perform this task to remove all the BGP configuration commands used in a redistribution of BGP routes into EIGRP. A route map can be used to match and set parameters or to filter the redistributed routes to ensure that routing loops are not created when these routes are subsequently advertised by EIGRP. When removing BGP configuration commands you must remember to remove or disable all the related commands. In this example, if the `route-map` command is omitted, then the redistribution will still occur and possibly with unexpected results as the route map filtering has been removed. Omitting just the `redistribute` command would mean that the route map is not applied, but it would leave unused commands in the running configuration.

For more details on BGP CLI removal, see the “BGP CLI Removal Considerations” concept in the “Cisco BGP Overview” module.

To view the redistribution configuration before and after the CLI removal, see the “Examples: Removing BGP Configuration Commands Using a Redistribution Example” section.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `no route-map map-name`
4. `router eigrp autonomous-system-number`
5. `no redistribute protocol [as-number]`
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> no route-map map-name</td>
<td>Removes a route map from the running configuration.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# no route-map bgp-to-eigrp</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> router eigrp autonomous-system-number</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# router eigrp 100</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> no redistribute protocol [as-number]</td>
<td>Disables the redistribution of routes from one routing domain into another routing domain.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router)# no redistribute bgp 45000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> end</td>
<td>Exits router configuration mode and enters privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router)# end</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong> show running-config</td>
<td>(Optional) Displays the current running configuration on the router.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
</tbody>
</table>

Note: If a route map was included in the original redistribute command configuration, remember to remove the route-map command configuration as in Step 3 in this example task.

Note: Only the syntax applicable to this task is used in this example. For more details, see the *Cisco IOS IP Routing: BGP Command Reference*. 
### Command or Action

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device# show running-config</td>
<td>• Use this command to verify that the <code>redistribute</code> and <code>route-map</code> commands are removed from the router configuration.</td>
</tr>
</tbody>
</table>

---

### Monitoring and Maintaining Basic BGP

The tasks in this section are concerned with the resetting and display of information about basic BGP processes and peer relationships. Once you have defined two devices to be BGP neighbors, they will form a BGP connection and exchange routing information. If you subsequently change a BGP filter, weight, distance, version, or timer, or make a similar configuration change, you may have to reset BGP connections for the configuration change to take effect.

### Configuring Inbound Soft Reconfiguration When Route Refresh Capability Is Missing

Perform this task to configure inbound soft reconfiguration using the `bgp soft-reconfig-backup` command for BGP peers that do not support the route refresh capability. BGP peers that support the route refresh capability are unaffected by the configuration of this command. Note that the memory requirements for storing the inbound update information can become quite large.

### SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. bgp log-neighbor-changes
5. bgp soft-reconfig-backup
6. neighbor {ip-address | peer-group-name} remote-as autonomous-system-number
7. neighbor {ip-address | peer-group-name} soft-reconfiguration [inbound]
8. neighbor {ip-address | peer-group-name} route-map map-name {in | out}
9. Repeat Steps 6 through 8 for every peer that is to be configured with inbound soft reconfiguration.
10. exit
11. route-map map-name [permit | deny] [sequence-number]
12. set ip next-hop ip-address
13. end
14. show ip bgp neighbors [neighbor-address]
15. show ip bgp [network] [network-mask]

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Device# configure terminal</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode for the specified routing process.</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Device(config)# router bgp 45000</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> bgp log-neighbor-changes</td>
<td>Enables logging of BGP neighbor resets.</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Device(config-router)# bgp log-neighbor-changes</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> bgp soft-reconfig-backup</td>
<td>Configures a BGP speaker to perform inbound soft reconfiguration for peers that do not support the route refresh capability.</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Device(config-router)# bgp soft-reconfig-backup</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• This command is used to configure BGP to perform inbound soft reconfiguration for peers that do not support the route refresh capability. The configuration of this command allows you to configure BGP to store updates (soft reconfiguration) only as necessary. Peers that support the route refresh capability are unaffected by the configuration of this command.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> neighbor {ip-address</td>
<td>peer-group-name} remote-as autonomous-system-number</td>
<td>Adds the IP address of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local device.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Device(config-router)# neighbor 192.168.1.2 remote-as 40000</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong> neighbor {ip-address</td>
<td>peer-group-name} soft-reconfiguration [inbound]</td>
<td>Configures the Cisco software to start storing updates.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Device(config-router)# neighbor 192.168.1.2 soft-reconfiguration inbound</td>
<td>All the updates received from this neighbor will be stored unmodified, regardless of the inbound policy. When inbound soft reconfiguration is done later, the stored information will be used to generate a new set of inbound updates.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong> neighbor {ip-address</td>
<td>peer-group-name} route-map map-name [in</td>
<td>out]</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Device(config-router)# neighbor 192.168.1.2 route-map LOCAL in</td>
<td>In this example, the route map named LOCAL will be applied to incoming routes.</td>
<td></td>
</tr>
</tbody>
</table>
### Configuring Inbound Soft Reconfiguration When Route Refresh Capability Is Missing

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 9</strong> Repeat Steps 6 through 8 for every peer that is to be configured with inbound soft reconfiguration.</td>
<td>—</td>
</tr>
<tr>
<td><strong>Step 10</strong> exit</td>
<td>Exits router configuration mode and enters global configuration mode.</td>
</tr>
<tr>
<td>Example: Device(config-router)# exit</td>
<td></td>
</tr>
<tr>
<td><strong>Step 11</strong> route-map <em>map-name</em> [permit</td>
<td>deny] [sequence-number]</td>
</tr>
<tr>
<td>Example: Device(config)# route-map LOCAL permit 10</td>
<td>• In this example, a route map named LOCAL is created.</td>
</tr>
<tr>
<td><strong>Step 12</strong> set ip next-hop <em>ip-address</em></td>
<td>Specifies where output packets that pass a match clause of a route map for policy routing.</td>
</tr>
<tr>
<td>Example: Device(config-route-map)# set ip next-hop 192.168.1.144</td>
<td>• In this example, the ip address is set to 192.168.1.144.</td>
</tr>
<tr>
<td><strong>Step 13</strong> end</td>
<td>Exits route-map configuration mode and enters privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Device(config-route-map)# end</td>
<td></td>
</tr>
<tr>
<td><strong>Step 14</strong> show ip bgp neighbors [neighbor-address]</td>
<td>(Optional) Displays information about the TCP and BGP connections to neighbors.</td>
</tr>
<tr>
<td>Example: Device# show ip bgp neighbors 192.168.1.2</td>
<td>Note: Only the syntax applicable to this task is used in this example. For more details, see the <em>Cisco IOS IP Routing: BGP Command Reference</em>.</td>
</tr>
<tr>
<td><strong>Step 15</strong> show ip bgp [network] [network-mask]</td>
<td>(Optional) Displays the entries in the BGP routing table.</td>
</tr>
<tr>
<td>Example: Device# show ip bgp</td>
<td>Note: Only the syntax applicable to this task is used in this example. For more details, see the <em>Cisco IOS IP Routing: BGP Command Reference</em>.</td>
</tr>
</tbody>
</table>

### Examples

The following partial output from the `show ip bgp neighbors` command shows information about the TCP and BGP connections to the BGP neighbor 192.168.2.1. This peer supports route refresh.

```
BGP neighbor is 192.168.1.2, remote AS 40000, external link
Neighbor capabilities:
  Route refresh: advertised and received(new)
```

The following partial output from the `show ip bgp neighbors` command shows information about the TCP and BGP connections to the BGP neighbor 192.168.3.2. This peer does not support route refresh.

```
BGP neighbor is 192.168.3.2, remote AS 40000, external link
Neighbor capabilities:
  Route refresh: advertised and received
```
refresh so the soft-reconfig inbound paths for BGP peer 192.168.3.2 will be stored because there is no other way to update any inbound policy updates.

BGP neighbor is 192.168.3.2, remote AS 50000, external link
Neighbor capabilities:
  Route refresh: advertised

The following sample output from the `show ip bgp` command shows the entry for the network 172.17.1.0. Both BGP peers are advertising 172.17.1.0/24, but only the received-only path is stored for 192.168.3.2.

BGP routing table entry for 172.17.1.0/24, version 11
Paths: (3 available, best #3, table Default-IP-Routing-Table, RIB-failure(4))
Flag: 0x820
  Advertised to update-groups:
    1
50000
  192.168.3.2 from 192.168.3.2 (172.17.1.0)
    Origin incomplete, metric 0, localpref 200, valid, external
50000, (received-only)
  192.168.3.2 from 192.168.3.2 (172.17.1.0)
    Origin incomplete, metric 0, localpref 100, valid, external
40000
  192.168.1.2 from 192.168.1.2 (172.16.1.0)
    Origin incomplete, metric 0, localpref 200, valid, external, best

Resetting and Displaying Basic BGP Information

Perform this task to reset and display information about basic BGP processes and peer relationships.

**SUMMARY STEPS**

1. `enable`
2. `clear ip bgp { * | autonomous-system-number | neighbor-address } [ soft [ in | out ] ]`
3. `show ip bgp [ network-address ] [ network-mask ] [ longer-prefixes ] [ prefix-list prefix-list-name ] [ route-map route-map-name ] [ shorter prefixes mask-length ]`
4. `show ip bgp neighbors [ neighbor-address ] [ received-routes | routes | advertised-routes | paths regexp | dampened-routes | received prefix-filter ]`
5. `show ip bgp paths`
6. `show ip bgp summary`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** enable | Enables privileged EXEC mode.  
  * Enter your password if prompted. |
| Example: Device> enable | |
| **Step 2** clear ip bgp { * | autonomous-system-number | neighbor-address } [ soft [ in | out ] ] | Clears and resets BGP neighbor sessions:  
  * In the example provided, all BGP neighbor sessions are cleared and reset. |
| Example: | |
### Purpose

**Command or Action**

Device# clear ip bgp *

**Step 3**

**show ip bgp**

- `[network-address] [network-mask]`  
- `[longer-prefixes] [prefix-list prefix-list-name] [route-map route-map-name]`  
- `[shorter prefixes mask-length]`

**Example:**

Device# show ip bgp 10.1.1.0 255.255.255.0

**Purpose**

Displays all the entries in the BGP routing table:

- In the example provided, the BGP routing table information for the 10.1.1.0 network is displayed.

### Step 4

**show ip bgp neighbors**

- `[neighbor-address] [received-routes | routes | advertised-routes | paths regexp | dampened-routes | received prefix-filter]`

**Example:**

Device# show ip bgp neighbors 192.168.3.2 advertised-routes

**Purpose**

Displays information about the TCP and BGP connections to neighbors:

- In the example provided, the routes advertised from the device to BGP neighbor 192.168.3.2 on another device are displayed.

### Step 5

**show ip bgp paths**

**Example:**

Device# show ip bgp paths

**Purpose**

Displays information about all the BGP paths in the database.

### Step 6

**show ip bgp summary**

**Example:**

Device# show ip bgp summary

**Purpose**

Displays information about the status of all BGP connections.

---

### Aggregating Route Prefixes Using BGP

BGP peers exchange information about local networks, but this can quickly lead to large BGP routing tables. CIDR enables the creation of aggregate routes (or supernets) to minimize the size of routing tables. Smaller BGP routing tables can reduce the convergence time of the network and improve network performance.

Aggregated routes can be configured and advertised using BGP. Some aggregations advertise only summary routes and other methods of aggregating routes allow more specific routes to be forwarded. Aggregation applies only to routes that exist in the BGP routing table. An aggregated route is forwarded if at least one more specific route of the aggregation exists in the BGP routing table. Perform one of the following tasks to aggregate routes within BGP:

---

### Redistributing a Static Aggregate Route into BGP

Use this task to redistribute a static aggregate route into BPG. A static aggregate route is configured and then redistributed into the BGP routing table. The static route must be configured to point to interface null 0 and the prefix should be a superset of known BGP routes. When a device receives a BGP packet, it will use the more specific BGP routes. If the route is not found in the BGP routing table, then the packet will be forwarded to null 0 and discarded.
SUMMARY STEPS

1. enable
2. configure terminal
3. ip route prefix mask {ip-address | interface-type interface-number [ip-address]} [distance] [name] [permanent | track number] [tag tag]
4. router bgp autonomous-system-number
5. redistribute static
6. end

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** enable | Enables privileged EXEC mode.  
  • Enter your password if prompted. |
| **Example:** Device> enable |
| **Step 2** configure terminal | Enters global configuration mode. |
| **Example:** Device# configure terminal |
| **Step 3** ip route prefix mask {ip-address | interface-type interface-number [ip-address]} [distance] [name] [permanent | track number] [tag tag] | Creates a static route. |
| **Example:** Device(config)# ip route 172.0.0.0 255.0.0.0 null 0 |
| **Step 4** router bgp autonomous-system-number | Enters router configuration mode for the specified routing process. |
| **Example:** Device(config)# router bgp 45000 |
| **Step 5** redistribute static | Redistributes routes into the BGP routing table. |
| **Example:** Device(config-router)# redistribute static |
| **Step 6** end | Exits router configuration mode and returns to privileged EXEC mode. |
| **Example:** Device(config-router)# end |
Configuring Conditional Aggregate Routes Using BGP

Use this task to create an aggregate route entry in the BGP routing table when at least one specific route falls into the specified range. The aggregate route is advertised as originating from your autonomous system. For more information, see the “BGP Route Aggregation Generating AS_SET Information” section.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router bgp** *autonomous-system-number*
4. **aggregate-address** *address mask* [*as-set*]
5. **end**

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode. Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config)# router bgp 45000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>Creates an aggregate entry in a BGP routing table.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>• A specified route must exist in the BGP table.</td>
</tr>
<tr>
<td>Device(config-router)# aggregate-address 172.0.0.0 255.0.0.0 as-set</td>
<td>• Use the <strong>aggregate-address</strong> command with no keywords to create an aggregate entry if any more-specific BGP routes are available that fall in the specified range.</td>
</tr>
<tr>
<td></td>
<td>• Use the <strong>as-set</strong> keyword to specify that the path advertised for this route is an AS_SET. Do not use the <strong>as-set</strong> keyword when aggregating many paths because this route is withdrawn and updated every time the reachability information for the aggregated route changes.</td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td>Only partial syntax is used in this example. For more details, see the <em>Cisco IOS IP Routing: BGP Command Reference</em>.</td>
</tr>
</tbody>
</table>
Suppressing and Unsuppressing the Advertisement of Aggregated Routes Using BGP

Use this task to create an aggregate route, suppress the advertisement of routes using BGP, and subsequently unsuppress the advertisement of routes. Routes that are suppressed are not advertised to any neighbors, but it is possible to unsuppress routes that were previously suppressed to specific neighbors.

SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. neighbor ip-address remote-as autonomous-system-number
5. Do one of the following:
   • aggregate-address address mask [summary-only]
   • aggregate-address address mask [suppress-map map-name]
6. neighbor {ip-address | peer-group-name} unsuppress-map map-name
7. end

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>terminal</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td>autonomous-system-number</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config)# router bgp 45000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> neighbor</td>
<td>Adds the IP address of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local device.</td>
</tr>
<tr>
<td>ip-address remote-as</td>
<td></td>
</tr>
<tr>
<td>autonomous-system-number</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
</tbody>
</table>
### Conditionally Advertising BGP Routes

Perform this task to conditionally advertise selected BGP routes. The routes or prefixes that will be conditionally advertised are defined in two route maps: an advertise map and either an exist map or nonexist map. The route map associated with the exist map or nonexist map specifies the prefix that the BGP speaker will track. The route map associated with the advertise map specifies the prefix that will be advertised to the specified neighbor when the condition is met.

- If a prefix is found to be present in the exist map by the BGP speaker, the prefix specified by the advertise map is advertised.
- If a prefix is found not to be present in the nonexist map by the BGP speaker, the prefix specified by the advertise map is advertised.

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device(config-router)# neighbor 192.168.1.2 remote-as 40000</td>
<td>Creates an aggregate route.</td>
</tr>
</tbody>
</table>

#### Step 5
Do one of the following:

- `aggregate-address address mask [summary-only]`
- `aggregate-address address mask [suppress-map map-name]`

**Example:**

Device(config-router)# aggregate-address 172.0.0.0 255.0.0.0 summary-only

**Note** Only partial syntax is used in this example. For more details, see the Cisco IOS IP Routing: BGP Command Reference.

#### Step 6
neighbor {ip-address | peer-group-name} unsuppress-map map-name

**Example:**

Device(config-router)# neighbor 192.168.1.2 unsuppress-map map1

(Optional) Selectively advertises routes previously suppressed by the `aggregate-address` command.

- In this example, the routes previously suppressed in Step 5 are advertised to neighbor 192.168.1.2.

#### Step 7
end

**Example:**

Device(config-router)# end

Exits router configuration mode and enters privileged EXEC mode.
If the condition is not met, the route is withdrawn and conditional advertisement does not occur. All routes that may be dynamically advertised or not advertised must exist in the BGP routing table in order for conditional advertisement to occur. These routes are referenced from an access list or an IP prefix list.

**SUMMARY STEPS**

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. neighbor {ip-address | peer-group-name} remote-as autonomous-system-number
5. neighbor ip-address advertise-map map-name {exist-map map-name | non-exist-map map-name}
6. exit
7. route-map map-tag [permit | deny] [sequence-number]
8. match ip address {access-list-number [access-list-number... | access-list-name...] | access-list-name [access-list-number... | access-list-name] | prefix-list prefix-list-name [prefix-list-name...]}
9. exit
10. route-map map-tag [permit | deny] [sequence-number]
11. match ip address {access-list-number [access-list-number... | access-list-name...] | access-list-name [access-list-number... | access-list-name] | prefix-list prefix-list-name [prefix-list-name...]}
12. exit
13. access-list access-list-number {deny | permit} source [source-wildcard] [log]
14. access-list access-list-number {deny | permit} source [source-wildcard] [log]
15. exit

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# router bgp 45000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> neighbor {ip-address</td>
<td>peer-group-name} remote-as autonomous-system-number</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router)# neighbor 192.168.1.2 remote-as 40000</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
</tbody>
</table>
| **Step 5** neighbor ip-address advertise-map map-name {exist-map map-name | non-exist-map map-name} | Adds the IP address of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local device.  
  • In this example, the prefix (172.17.0.0) matching the ACL in the advertise map (the route map named map1) will be advertised to the neighbor only when a prefix (192.168.50.0) matching the ACL in exist map (the route-map named map2) is in the local BGP table. |
| **Example:** Device(config-router)# neighbor 192.168.1.2 advertise-map map1 exist-map map2 | |
| **Step 6** exit | Exits router configuration mode and enters global configuration mode. |
| **Example:** Device(config-router)# exit | |
| **Step 7** route-map map-tag [permit | deny] [sequence-number] | Configures a route map and enters route map configuration mode.  
  • In this example, a route map named map1 is created. |
| **Example:** Device(config)# route-map map1 permit 10 | |
| **Step 8** match ip address {access-list-number [access-list-number... | access-list-name... | access-list-name] | access-list-name [access-list-number... | access-list-name] | prefix-list prefix-list-name [prefix-list-name...]} | Configures the route map to match a prefix that is permitted by a standard access list, an extended access list, or a prefix list.  
  • In this example, the route map is configured to match a prefix permitted by access list 1. |
| **Example:** Device(config-route-map)# match ip address 1 | |
| **Step 9** exit | Exits route map configuration mode and enters global configuration mode. |
| **Example:** Device(config-route-map)# exit | |
| **Step 10** route-map map-tag [permit | deny] [sequence-number] | Configures a route map and enters route map configuration mode.  
  • In this example, a route map named map2 is created. |
| **Example:** Device(config)# route-map map2 permit 10 | |
| **Step 11** match ip address {access-list-number [access-list-number... | access-list-name... | access-list-name] | access-list-name [access-list-number... | access-list-name] | prefix-list prefix-list-name [prefix-list-name...]} | Configures the route map to match a prefix that is permitted by a standard access list, an extended access list, or a prefix list.  
  • In this example, the route map is configured to match a prefix permitted by access list 2. |
| **Example:** Device(config-route-map)# match ip address 2 | |
### Purpose

#### Command or Action

**Step 12**
- **exit**
  - **Example:**
    ```
    Device(config-route-map)# exit
    ```

  Exits route map configuration mode and enters global configuration mode.

**Step 13**
- **access-list** `access-list-number` `{deny | permit} source [source-wildcard] [log]`
  - **Example:**
    ```
    Device(config)# access-list 1 permit 172.17.0.0
    ```

  Configures a standard access list.
  - In this example, access list 1 permits advertising of the 172.17.0.0 prefix, depending on other conditions set by the `neighbor advertise-map` command.

**Step 14**
- **access-list** `access-list-number` `{deny | permit} source [source-wildcard] [log]`
  - **Example:**
    ```
    Device(config)# access-list 2 permit 192.168.50.0
    ```

  Configures a standard access list.
  - In this example, access list 2 permits the 192.168.50.0 to be the prefix of the exist-map.

**Step 15**
- **exit**
  - **Example:**
    ```
    Device(config)# exit
    ```

  Exits global configuration mode and returns to privileged EXEC mode.

### Originating BGP Routes

Route aggregation is useful to minimize the size of the BGP table, but there are situations when you want to add more specific prefixes to the BGP table. Route aggregation can hide more specific routes. Using the `network` command as shown in the “Configuring a BGP Routing Process” section originates routes, and the following optional tasks originate BGP routes for the BGP table for different situations.

### Advertising a Default Route Using BGP

Perform this task to advertise a default route to BGP peers. The default route is locally originated. A default route can be useful to simplify configuration or to prevent the device from using too many system resources. If the device is peered with an Internet service provider (ISP), the ISP will carry full routing tables, so configuring a default route into the ISP network saves resources at the local device.

### SUMMARY STEPS

1. enable
2. configure terminal
3. ip prefix-list `list-name` [seq `seq-value`] {deny network / length | permit network / length} [ge `ge-value`] [le `le-value`]
4. route-map `map-tag` [permit | deny] [sequence-number]
5. match ip address {access-list-number [access-list-number] | access-list-name} [access-list-number] | access-list-name [access-list-number] | prefix-list `prefix-list-name` [prefix-list-name]
6. exit
7. router bgp `autonomous-system-number`
Advertising a Default Route Using BGP

8. `neighbor {ip-address | peer-group-name} default-originate [route-map map-name]`
9. `end`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> ip prefix-list  list-name [seq seq-value] {deny network / length</td>
<td>permit network / length} [ge ge-value] [le le-value]</td>
</tr>
<tr>
<td>Example:</td>
<td>• In this example, prefix list DEFAULT permits advertising of the 10.1.1.0/24. prefix depending on a match set by the <code>match ip address</code> command.</td>
</tr>
<tr>
<td>Device(config)# ip prefix-list DEFAULT permit 10.1.1.0/24</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> route-map  map-tag [permit</td>
<td>deny] [sequence-number]</td>
</tr>
<tr>
<td>Example:</td>
<td>• In this example, a route map named ROUTE is created.</td>
</tr>
<tr>
<td>Device(config)# route-map ROUTE</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> match ip address {access-list-number [access-list-number...</td>
<td>access-list-name...]</td>
</tr>
<tr>
<td>Example:</td>
<td>• In this example, the route map is configured to match a prefix permitted by prefix list DEFAULT.</td>
</tr>
<tr>
<td>Device(config-route-map)# match ip address prefix-list DEFAULT</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> exit</td>
<td>Exits route map configuration mode and enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config-route-map)# exit</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong> router bgp  autonomous-system-number</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config)# router bgp 40000</td>
<td></td>
</tr>
</tbody>
</table>
### Purpose

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>neighbor `ip-address</td>
<td>peer-group-name` default-originate [route-map map-name]</td>
</tr>
</tbody>
</table>

**Example:**

Device(config-router)# neighbor 192.168.3.2 default-originate

<table>
<thead>
<tr>
<th>Step 9</th>
<th>end</th>
<th>Exits router configuration mode and enters privileged EXEC mode.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config-router)# end</td>
<td></td>
</tr>
</tbody>
</table>

---

## Originating BGP Routes Using Backdoor Routes

Use this task to indicate to border devices which networks are reachable using a backdoor route. A backdoor network is treated the same as a local network, except that it is not advertised. For more information, see the BGP Backdoor Routes section.

### Before you begin

This task assumes that the IGP (EIGRP, in this example) is already configured for the BGP peers. The configuration is done at Router B in the in the “BGP Backdoor Routes” section, and the BGP peer is Router D.

### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `neighbor ip-address remote-as autonomous-system-number`
5. `network ip-address backdoor`
6. `end`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td><code>enable</code></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Device&gt; enable</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td><code>configure terminal</code></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Device# configure terminal</td>
</tr>
</tbody>
</table>
### Configuring a BGP Peer Group

This task explains how to configure a BGP peer group. Often, in a BGP speaker, many neighbors are configured with the same update policies (that is, the same outbound route maps, distribute lists, filter lists, update source, and so on). Neighbors with the same update policies can be grouped into peer groups to simplify configuration and, more importantly, to make updating more efficient. When you have many peers, this approach is highly recommended.

The three steps to configure a BGP peer group, described in the following task, are as follows:

- Creating the peer group
- Assigning options to the peer group
- Making neighbors members of the peer group

You can disable a BGP peer or peer group without removing all the configuration information using the `neighbor shutdown` router configuration command.

**Note**

By default, neighbors that are defined using the `neighbor remote-as` command in router configuration mode exchange only IPv4 unicast address prefixes. To exchange other address prefix types, such as IPv6 prefixes, neighbors must also be activated using the `neighbor activate` command in address family configuration mode for the other prefix types.
### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `neighbor peer-group-name peer-group`
5. `neighbor ip-address remote-as autonomous-system-number`
6. `neighbor ip-address peer-group peer-group-name`
7. `address-family ipv4 [unicast | multicast | vrf vrf-name]`
8. `neighbor peer-group-name activate`
9. `neighbor ip-address peer-group peer-group-name`
10. `end`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><code>enable</code></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device&gt; enable</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><code>configure terminal</code></td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td>Device# configure terminal</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td><code>router bgp autonomous-system-number</code></td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config)# router bgp 40000</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>Creates a BGP peer group.</td>
</tr>
<tr>
<td><code>neighbor peer-group-name peer-group</code></td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-router)# neighbor fingroup peer-group</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>Adds the IP address of the neighbor in the specified autonomous system to the multiprotocol BGP neighbor table of the local device.</td>
</tr>
<tr>
<td><code>neighbor ip-address remote-as autonomous-system-number</code></td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-router)# neighbor 192.168.1.1 remote-as 45000</td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>Assigns the IP address of a BGP neighbor to a peer group.</td>
</tr>
<tr>
<td><code>neighbor ip-address peer-group peer-group-name</code></td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-router)# neighbor 192.168.1.1 peer-group fingroup</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Step 7</strong> address-family ipv4 [unicast</td>
<td>multicast</td>
</tr>
<tr>
<td>Example: Device(config-router)# address-family ipv4 multicast</td>
<td>• The <strong>unicast</strong> keyword specifies the IPv4 unicast address family. This is the default.</td>
</tr>
<tr>
<td></td>
<td>• The <strong>multicast</strong> keyword specifies that IPv4 multicast address prefixes will be exchanged.</td>
</tr>
<tr>
<td></td>
<td>• The <strong>vrf</strong> keyword and <strong>vrf-name</strong> argument specify that IPv4 VRF instance information will be exchanged.</td>
</tr>
<tr>
<td><strong>Step 8</strong> neighbor peer-group-name activate</td>
<td>Enables the neighbor to exchange prefixes for the IPv4 address family with the local device.</td>
</tr>
<tr>
<td>Example: Device(config-router-af)# neighbor fingroup activate</td>
<td>Note: By default, neighbors that are defined using the neighbor remote-as command in router configuration mode exchange only unicast address prefixes. To allow BGP to exchange other address prefix types, such as multicast that is configured in this example, neighbors must also be activated using the neighbor activate command.</td>
</tr>
<tr>
<td><strong>Step 9</strong> neighbor ip-address peer-group peer-group-name</td>
<td>Assigns the IP address of a BGP neighbor to a peer group.</td>
</tr>
<tr>
<td>Example: Device(config-router-af)# neighbor 192.168.1.1 peer-group fingroup</td>
<td></td>
</tr>
<tr>
<td><strong>Step 10</strong> end</td>
<td>Exits address family configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Device(config-router-af)# end</td>
<td></td>
</tr>
</tbody>
</table>

## Configuration Examples for BGP 4

### Example: Configuring a BGP Process and Customizing Peers

The following example shows the configuration for Router B in the above (in the “Customizing a BGP Peer” section) with a BGP process configured with two neighbor peers (at Router A and at Router E) in separate autonomous systems. IPv4 unicast routes are exchanged with both peers and IPv4 multicast routes are exchanged with the BGP peer at Router E.

#### Router B

```
router bgp 45000
```
Examples: Removing BGP Configuration Commands Using a Redistribution Example

The following examples show first the CLI configuration to enable the redistribution of BGP routes into EIGRP using a route map and then the CLI configuration to remove the redistribution and route map. Some BGP configuration commands can affect other CLI commands and this example demonstrates how the removal of one command affects another command.

In the first configuration example, a route map is configured to match and set autonomous system numbers. BGP neighbors in three different autonomous systems are configured and activated. An EIGRP routing process is started, and the redistribution of BGP routes into EIGRP using the route map is configured.

CLI to Enable BGP Route Redistribution Into EIGRP

```
route-map bgp-to-eigrp permit 10
  match tag 50000
  set tag 65000
exit
router bgp 45000
  bgp log-neighbor-changes
  address-family ipv4
    neighbor 172.16.1.2 remote-as 45000
    neighbor 172.21.1.2 remote-as 45000
    neighbor 192.168.1.2 remote-as 40000
    neighbor 192.168.3.2 remote-as 50000
    neighbor 172.16.1.2 activate
    neighbor 172.21.1.2 activate
    neighbor 192.168.1.2 activate
    neighbor 192.168.3.2 activate
    network 172.17.1.0 mask 255.255.255.0
    exit-address-family
  !
  address-family ipv4 multicast
    neighbor 192.168.3.2 activate
    neighbor 192.168.3.2 advertisement-interval 25
    no auto-summary
    no synchronization
    network 172.17.1.0 mask 255.255.255.0
    exit-address-family
exit
router eigrp 100
  redistribute bgp 45000 metric 10000 100 255 1 1500 route-map bgp-to-eigrp
```
In the second configuration example, both the `route-map` command and the `redistribute` command are disabled. If only the route-map command is removed, it does not automatically disable the redistribution. The redistribution will now occur without any matching or filtering. To remove the redistribution configuration, the `redistribute` command must also be disabled.

**CLI to Remove BGP Route Redistribution Into EIGRP**

```
configure terminal
no route-map bgp-to-eigrp
router eigrp 100
no redistribute bgp 45000
end
```

**Examples: BGP Soft Reset**

The following examples show two ways to reset the connection for BGP peer 192.168.1.1.

**Example: Dynamic Inbound Soft Reset**

The following example shows the command used to initiate a dynamic soft reconfiguration in the BGP peer 192.168.1.1. This command requires that the peer support the route refresh capability.

```
clear ip bgp 192.168.1.1 soft in
```

**Example: Inbound Soft Reset Using Stored Information**

The following example shows how to enable inbound soft reconfiguration for the neighbor 192.168.1.1. All the updates received from this neighbor will be stored unmodified, regardless of the inbound policy. When inbound soft reconfiguration is performed later, the stored information will be used to generate a new set of inbound updates.

```
router bgp 100
neighbor 192.168.1.1 remote-as 200
neighbor 192.168.1.1 soft-reconfiguration inbound
```

The following example clears the session with the neighbor 192.168.1.1:

```
clear ip bgp 192.168.1.1 soft in
```

**Example: Resetting and Displaying Basic BGP Information**

The following example shows how to reset and display basic BGP information.

The `clear ip bgp *` command clears and resets all the BGP neighbor sessions. Specific neighbors or all peers in an autonomous system can be cleared by using the `neighbor-address` and `autonomous-system-number` arguments. If no argument is specified, this command will clear and reset all BGP neighbor sessions.
The `clear ip bgp *` command also clears all the internal BGP structures, which makes it useful as a troubleshooting tool.

Device# clear ip bgp *

The `show ip bgp` command is used to display all the entries in the BGP routing table. The following example displays BGP routing table information for the 10.1.1.0 network:

Device# show ip bgp 10.1.1.0 255.255.255.0

BGP routing table entry for 10.1.1.0/24, version 2
Paths: (1 available, best #1, table Default-IP-Routing-Table)
  Advertised to update-groups:
    1
    40000
    192.168.1.2 from 192.168.1.2 (10.1.1.99)
    Origin IGP, metric 0, localpref 100, valid, external, best

The `show ip bgp neighbors` command is used to display information about the TCP and BGP connections to neighbors. The following example displays the routes that were advertised from Router B in the figure above (in the “Configuring a BGP Peer for the IPv4 VRF Address Family” section) to its BGP neighbor 192.168.3.2 on Router E:

Device# show ip bgp neighbors 192.168.3.2 advertised-routes

BGP table version is 3, local router ID is 172.17.1.99
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
  r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

<table>
<thead>
<tr>
<th>Network</th>
<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>*&gt; 10.1.1.0/24</td>
<td>192.168.1.2</td>
<td>0</td>
<td>0</td>
<td>40000</td>
<td>i</td>
</tr>
<tr>
<td>*&gt; 172.17.1.0/24</td>
<td>0.0.0.0</td>
<td>0</td>
<td>0</td>
<td>32768</td>
<td>i</td>
</tr>
</tbody>
</table>

Total number of prefixes 2

The `show ip bgp paths` command is used to display all the BGP paths in the database. The following example displays BGP path information for Router B in the figure above (in the “Customizing a BGP Peer” section):

Device# show ip bgp paths

<table>
<thead>
<tr>
<th>Address</th>
<th>Hash</th>
<th>Refcount</th>
<th>Metric</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x2FB5DB0</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>i</td>
</tr>
<tr>
<td>0x2FB5C90</td>
<td>1</td>
<td>4</td>
<td>0</td>
<td>i</td>
</tr>
<tr>
<td>0x2FB5C00</td>
<td>1361</td>
<td>2</td>
<td>0</td>
<td>50000</td>
</tr>
<tr>
<td>0x2FB5D20</td>
<td>2625</td>
<td>2</td>
<td>0</td>
<td>40000</td>
</tr>
</tbody>
</table>

The `show ip bgp summary` command is used to display the status of all BGP connections. The following example displays BGP routing table information for Router B in the figure above (in the “Customizing a BGP Peer” section):

Device# show ip bgp summary

BGP router identifier 172.17.1.99, local AS number 45000
BGP table version is 3, main routing table version 3
2 network entries using 234 bytes of memory
2 path entries using 104 bytes of memory
4/2 BGP path/bestpath attribute entries using 496 bytes of memory
Examples: Aggregating Prefixes Using BGP

The following examples show how you can use aggregate routes in BGP either by redistributing an aggregate route into BGP or by using the BGP conditional aggregation routing feature.

In the following example, the `redistribute static` router configuration command is used to redistribute aggregate route 10.0.0.0:

```
ip route 10.0.0.0 255.0.0.0 null 0
router bgp 100
  redistribute static
```

The following configuration shows how to create an aggregate entry in the BGP routing table when at least one specific route falls into the specified range. The aggregate route will be advertised as coming from your autonomous system and has the atomic aggregate attribute set to show that information might be missing. (By default, atomic aggregate is set unless you use the `as-set` keyword in the `aggregate-address` router configuration command.)

```
router bgp 100
  aggregate-address 10.0.0.0 255.0.0.0
```

The following example shows how to create an aggregate entry using the same rules as in the previous example, but the path advertised for this route will be an AS_SET consisting of all elements contained in all paths that are being summarized:

```
routerr bgp 100
  aggregate-address 10.0.0.0 255.0.0.0 as-set
```

The following example shows how to create the aggregate route for 10.0.0.0 and also suppress advertisements of more specific routes to all neighbors:

```
routerr bgp 100
  aggregate-address 10.0.0.0 255.0.0.0 summary-only
```

The following example configures BGP to not advertise inactive routes:

```
Device(config)# router bgp 50000
Device(config-router)# address-family ipv4 unicast
Device(config-router-af)# bgp suppress-inactive
Device(config-router-af)# end
```

The following example configures a maximum route limit in the VRF named RED and configures BGP to not advertise inactive routes through the VRF named RED:

```
Device(config)# ip vrf RED
Device(config-vrf)# rd 50000:10
Device(config-vrf)# maximum routes 1000 10
```
Example: Configuring a BGP Peer Group

The following example shows how to use an address family to configure a peer group so that all members of the peer group are both unicast- and multicast-capable:

```
router bgp 45000
neighbor 192.168.1.2 remote-as 40000
neighbor 192.168.3.2 remote-as 50000
address-family ipv4 unicast
  neighbor mygroup peer-group
  neighbor 192.168.1.2 peer-group mygroup
  neighbor 192.168.3.2 peer-group mygroup
router bgp 45000
neighbor 192.168.1.2 remote-as 40000
neighbor 192.168.3.2 remote-as 50000
address-family ipv4 multicast
  neighbor mygroup peer-group
  neighbor 192.168.1.2 peer-group mygroup
  neighbor 192.168.3.2 peer-group mygroup
  neighbor 192.168.1.2 activate
  neighbor 192.168.3.2 activate
```

Additional References

### Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
</tbody>
</table>

### Standards and RFCs

<table>
<thead>
<tr>
<th>Standard/RFC</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFC 1772</td>
<td>Application of the Border Gateway Protocol in the Internet</td>
</tr>
<tr>
<td>RFC 1773</td>
<td>Experience with the BGP Protocol</td>
</tr>
<tr>
<td>RFC 1774</td>
<td>BGP-4 Protocol Analysis</td>
</tr>
<tr>
<td>RFC 1930</td>
<td>Guidelines for Creation, Selection, and Registration on an Autonomous System (AS)</td>
</tr>
<tr>
<td>Standard/RFC</td>
<td>Title</td>
</tr>
<tr>
<td>-------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>RFC 2519</td>
<td><em>A Framework for Inter-Domain Route Aggregation</em></td>
</tr>
<tr>
<td>RFC 2858</td>
<td><em>Multiprotocol Extensions for BGP-4</em></td>
</tr>
<tr>
<td>RFC 2918</td>
<td><em>Route Refresh Capability for BGP-4</em></td>
</tr>
<tr>
<td>RFC 3392</td>
<td><em>Capabilities Advertisement with BGP-4</em></td>
</tr>
<tr>
<td>RFC 4271</td>
<td><em>A Border Gateway Protocol 4 (BGP-4)</em></td>
</tr>
</tbody>
</table>

**MIBs**

<table>
<thead>
<tr>
<th>MIB</th>
<th>MIBs Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>CISCO-BGP4-MIB</td>
<td>To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
</tr>
</tbody>
</table>

**Technical Assistance**

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

**Feature Information for BGP 4**

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to [http://www.cisco.com/go/cfn](http://www.cisco.com/go/cfn). An account on Cisco.com is not required.
**Table 7: Feature Information for BGP 4**

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP 4</td>
<td>Cisco IOS XE Release 3.7S</td>
<td>BGP is an interdomain routing protocol designed to provide loop-free routing between separate routing domains that contain independent routing policies (autonomous systems). The Cisco software implementation of BGP Version 4 includes multiprotocol extensions to allow BGP to carry routing information for IP multicast routes and multiple Layer 3 protocol address families, including IP Version 4 (IPv4), IP Version 6 (IPv6), Virtual Private Networks version 4 (VPNv4), and Connectionless Network Services (CLNS).</td>
</tr>
</tbody>
</table>
Configuring a Basic BGP Network

This module describes the basic tasks to configure a basic Border Gateway Protocol (BGP) network. BGP is an interdomain routing protocol that is designed to provide loop-free routing between organizations. The Cisco IOS implementation of the neighbor and address family commands is explained. This module also contains tasks to configure and customize BGP peers, implement BGP route aggregation, configure BGP route origination, and define BGP backdoor routes. BGP peer group definition is documented, peer session templates are introduced, and update groups are explained.

- Finding Feature Information, on page 69
- Prerequisites for Configuring a Basic BGP Network, on page 69
- Restrictions for Configuring a Basic BGP Network, on page 70
- Information About Configuring a Basic BGP Network, on page 70
- How to Configure a Basic BGP Network, on page 85
- Configuration Examples for a Basic BGP Network, on page 143
- Where to Go Next, on page 158
- Additional References, on page 158
- Feature Information for Configuring a Basic BGP Network, on page 159

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for Configuring a Basic BGP Network

Before configuring a basic BGP network, you should be familiar with the “Cisco BGP Overview” module.
Restrictions for Configuring a Basic BGP Network

A device that runs Cisco software can be configured to run only one BGP routing process and to be a member of only one BGP autonomous system. However, a BGP routing process and autonomous system can support multiple address family configurations.

Information About Configuring a Basic BGP Network

BGP Version 4

Border Gateway Protocol (BGP) is an interdomain routing protocol designed to provide loop-free routing between separate routing domains that contain independent routing policies (autonomous systems). The Cisco software implementation of BGP version 4 includes multiprotocol extensions to allow BGP to carry routing information for IP multicast routes and multiple Layer 3 protocol address families including IP Version 4 (IPv4), IP Version 6 (IPv6), and Virtual Private Networks version 4 (VPNv4).

BGP is mainly used to connect a local network to an external network to gain access to the Internet or to connect to other organizations. When connecting to an external organization, external BGP (eBGP) peering sessions are created. Although BGP is referred to as an exterior gateway protocol (EGP) many networks within an organization are becoming so complex that BGP can be used to simplify the internal network used within the organization. BGP peers within the same organization exchange routing information through internal BGP (iBGP) peering sessions.

Note

BGP requires more configuration than other routing protocols, and the effects of any configuration changes must be fully understood. Incorrect configuration can create routing loops and negatively impact normal network operation.

BGP Router ID

BGP uses a router ID to identify BGP-speaking peers. The BGP router ID is a 32-bit value that is often represented by an IPv4 address. By default, the Cisco software sets the router ID to the IPv4 address of a loopback interface on the router. If no loopback interface is configured on the device, the software chooses the highest IPv4 address configured on a physical interface of the device to represent the BGP router ID. The BGP router ID must be unique to the BGP peers in a network.

BGP-Speaker and Peer Relationships

A BGP-speaking device does not discover another BGP-speaking device automatically. A network administrator usually manually configures the relationships between BGP-speaking devices. A peer device is a BGP-speaking device that has an active TCP connection to another BGP-speaking device. This relationship between BGP devices is often referred to as a neighbor, but because this can imply the idea that the BGP devices are directly connected with no other device in between, the term neighbor will be avoided whenever possible in this document. A BGP speaker is the local device, and a peer is any other BGP-speaking network device.
When a TCP connection is established between peers, each BGP peer initially exchanges all its routes—the complete BGP routing table—with the other peer. After this initial exchange, only incremental updates are sent when there has been a topology change in the network, or when a routing policy has been implemented or modified. In the periods of inactivity between these updates, peers exchange special messages called keepalives.

A BGP autonomous system is a network that is controlled by a single technical administration entity. Peer devices are called external peers when they are in different autonomous systems and internal peers when they are in the same autonomous system. Usually, external peers are adjacent and share a subnet; internal peers may be anywhere in the same autonomous system.

**BGP Autonomous System Number Formats**

Prior to January 2009, BGP autonomous system numbers that were allocated to companies were 2-octet numbers in the range from 1 to 65535 as described in RFC 4271, *A Border Gateway Protocol 4 (BGP-4)*. Due to increased demand for autonomous system numbers, the Internet Assigned Number Authority (IANA) will start in January 2009 to allocate four-octet autonomous system numbers in the range from 65536 to 4294967295. RFC 5396, *Textual Representation of Autonomous System (AS) Numbers*, documents three methods of representing autonomous system numbers. Cisco has implemented the following two methods:

- **Asplain**—Decimal value notation where both 2-byte and 4-byte autonomous system numbers are represented by their decimal value. For example, 65526 is a 2-byte autonomous system number and 234567 is a 4-byte autonomous system number.

- **Asdot**—Autonomous system dot notation where 2-byte autonomous system numbers are represented by their decimal value and 4-byte autonomous system numbers are represented by a dot notation. For example, 65526 is a 2-byte autonomous system number and 1.169031 is a 4-byte autonomous system number (this is dot notation for the 234567 decimal number).

For details about the third method of representing autonomous system numbers, see RFC 5396.

### Asdot Only Autonomous System Number Formatting

In Cisco IOS Release 12.0(32)S12, 12.4(24)T, and later releases, the 4-octet (4-byte) autonomous system numbers are entered and displayed only in asdot notation, for example, 1.10 or 45000.64000. When using regular expressions to match 4-byte autonomous system numbers the asdot format includes a period which is a special character in regular expressions. A backslash must be entered before the period (for example, 1\14) to ensure the regular expression match does not fail. The table below shows the format in which 2-byte and 4-byte autonomous system numbers are configured, matched in regular expressions, and displayed in *show* command output in Cisco IOS images where only asdot formatting is available.

**Table 8: Asdot Only 4-Byte Autonomous System Number Format**

<table>
<thead>
<tr>
<th>Format</th>
<th>Configuration Format</th>
<th>Show Command Output and Regular Expression Match Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>asdot</td>
<td>2-byte: 1 to 65535 4-byte: 1.0 to 65535.65535</td>
<td>2-byte: 1 to 65535 4-byte: 1.0 to 65535.65535</td>
</tr>
</tbody>
</table>

### Asplain as Default Autonomous System Number Formatting

In Cisco IOS Release 12.0(32)SY8, 12.0(33)S3, 12.2(33)SRE, 12.2(33)XNE, 12.2(33)SXI1, and later releases, the Cisco implementation of 4-byte autonomous system numbers uses asplain as the default display format.
for autonomous system numbers, but you can configure 4-byte autonomous system numbers in both the asplain and asdot format. In addition, the default format for matching 4-byte autonomous system numbers in regular expressions is asplain, so you must ensure that any regular expressions to match 4-byte autonomous system numbers are written in the asplain format. If you want to change the default show command output to display 4-byte autonomous system numbers in the asdot format, use the `bgp asnotation dot` command under router configuration mode. When the asdot format is enabled as the default, any regular expressions to match 4-byte autonomous system numbers must be written using the asdot format, or the regular expression match will fail. The tables below show that although you can configure 4-byte autonomous system numbers in either asplain or asdot format, only one format is used to display show command output and control 4-byte autonomous system number matching for regular expressions, and the default is asplain format. To display 4-byte autonomous system numbers in show command output and to control matching for regular expressions in the asdot format, you must configure the `bgp asnotation dot` command. After enabling the `bgp asnotation dot` command, a hard reset must be initiated for all BGP sessions by entering the `clear ip bgp *` command.

**Note**

If you are upgrading to an image that supports 4-byte autonomous system numbers, you can still use 2-byte autonomous system numbers. The show command output and regular expression match are not changed and remain in asplain (decimal value) format for 2-byte autonomous system numbers regardless of the format configured for 4-byte autonomous system numbers.

**Table 9: Default Asplain 4-Byte Autonomous System Number Format**

<table>
<thead>
<tr>
<th>Format</th>
<th>Configuration Format</th>
<th>Show Command Output and Regular Expression Match Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>asplain</td>
<td>2-byte: 1 to 65535 4-byte: 65536 to 4294967295</td>
<td>2-byte: 1 to 65535 4-byte: 65536 to 4294967295</td>
</tr>
<tr>
<td>asdot</td>
<td>2-byte: 1 to 65535 4-byte: 1.0 to 65535.65535</td>
<td>2-byte: 1 to 65535 4-byte: 65536 to 4294967295</td>
</tr>
</tbody>
</table>

**Table 10: Asdot 4-Byte Autonomous System Number Format**

<table>
<thead>
<tr>
<th>Format</th>
<th>Configuration Format</th>
<th>Show Command Output and Regular Expression Match Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>asplain</td>
<td>2-byte: 1 to 65535 4-byte: 65536 to 4294967295</td>
<td>2-byte: 1 to 65535 4-byte: 1.0 to 65535.65535</td>
</tr>
<tr>
<td>asdot</td>
<td>2-byte: 1 to 65535 4-byte: 1.0 to 65535.65535</td>
<td>2-byte: 1 to 65535 4-byte: 1.0 to 65535.65535</td>
</tr>
</tbody>
</table>

**Reserved and Private Autonomous System Numbers**

In Cisco IOS Release 12.0(32)S12, 12.0(32)SY8, 12.0(33)S3, 12.2(33)SRE, 12.2(33)XNE, 12.2(33)SXI1, 12.4(24)T, and later releases, the Cisco implementation of BGP supports RFC 4893. RFC 4893 was developed to allow BGP to support a gradual transition from 2-byte autonomous system numbers to 4-byte autonomous system numbers. A new reserved (private) autonomous system number, 23456, was created by RFC 4893 and this number cannot be configured as an autonomous system number in the Cisco IOS CLI.

RFC 5398, *Autonomous System (AS) Number Reservation for Documentation Use*, describes new reserved autonomous system numbers for documentation purposes. Use of the reserved numbers allow configuration examples to be accurately documented and avoids conflict with production networks if these configurations
are literally copied. The reserved numbers are documented in the IANA autonomous system number registry. Reserved 2-byte autonomous system numbers are in the contiguous block, 64496 to 64511 and reserved 4-byte autonomous system numbers are from 65536 to 65551 inclusive.

Private 2-byte autonomous system numbers are still valid in the range from 64512 to 65534 with 65535 being reserved for special use. Private autonomous system numbers can be used for internal routing domains but must be translated for traffic that is routed out to the Internet. BGP should not be configured to advertise private autonomous system numbers to external networks. Cisco IOS software does not remove private autonomous system numbers from routing updates by default. We recommend that ISPs filter private autonomous system numbers.

---

**Note**

Autonomous system number assignment for public and private networks is governed by the IANA. For information about autonomous-system numbers, including reserved number assignment, or to apply to register an autonomous system number, see the following URL: [http://www.iana.org/](http://www.iana.org/).

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### Cisco Implementation of 4-Byte Autonomous System Numbers

In Cisco IOS Release 12.0(32)SY8, 12.0(33)S3, 12.2(33)SRE, 12.2(33)XNE, 12.2(33)SX11, 15.1(1)SG, and later releases, the Cisco implementation of 4-byte autonomous system numbers uses asplain (65538, for example) as the default regular expression match and the output display format for AS numbers. However, you can configure 4-byte autonomous system numbers in both the asplain format and the asdot format as described in RFC 5396.

To change the default regular expression match and output display of 4-byte autonomous system numbers to asdot format, use the `bgp asnotation dot` command followed by the `clear ip bgp *` command to perform a hard reset of all current BGP sessions.

In Cisco IOS Release 12.0(32)S12, and 12.4(24)T, the Cisco implementation of 4-byte autonomous system numbers uses asdot (1.2, for example) as the only configuration format, regular expression match, and output display, with no asplain support.

For an example of BGP peers in two autonomous systems using 4-byte numbers, see the figure below. To view a configuration example of the configuration between three neighbor peers in separate 4-byte autonomous systems configured using asdot notation, see the Examples: Configuring a BGP Routing Process and Peers Using 4-Byte Autonomous System Numbers.

Cisco also supports RFC 4893, which was developed to allow BGP to support a gradual transition from 2-byte autonomous system numbers to 4-byte autonomous system numbers. To ensure a smooth transition, we recommend that all BGP speakers within an autonomous system that is identified using a 4-byte autonomous system number be upgraded to support 4-byte autonomous system numbers.

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**Note**

A new private autonomous system number, 23456, was created by RFC 4893, and this number cannot be configured as an autonomous system number in the Cisco IOS CLI.
BGP Peer Session Establishment

When a BGP routing process establishes a peering session with a peer, it goes through the following state changes:

- **Idle**—The initial state that the BGP routing process enters when the routing process is enabled or when the device is reset. In this state, the device waits for a start event, such as a peering configuration with a remote peer. After the device receives a TCP connection request from a remote peer, the device initiates another start event to wait for a timer before starting a TCP connection to a remote peer. If the device is reset, the peer is reset and the BGP routing process returns to the Idle state.

- **Connect**—The BGP routing process detects that a peer is trying to establish a TCP session with the local BGP speaker.

- **Active**—In this state, the BGP routing process tries to establish a TCP session with a peer device using the ConnectRetry timer. Start events are ignored while the BGP routing process is in the Active state. If the BGP routing process is reconfigured or if an error occurs, the BGP routing process will release system resources and return to an Idle state.

- **OpenSent**—The TCP connection is established, and the BGP routing process sends an OPEN message to the remote peer, and transitions to the OpenSent state. The BGP routing process can receive other OPEN messages in this state. If the connection fails, the BGP routing process transitions to the Active state.

- **OpenReceive**—The BGP routing process receives the OPEN message from the remote peer and waits for an initial keepalive message from the remote peer. When a keepalive message is received, the BGP routing process transitions to the Established state. If a notification message is received, the BGP routing process transitions to the Idle state. If an error or configuration change occurs that affects the peering session, the BGP routing process sends a notification message with the Finite State Machine (FSM) error code and then transitions to the Idle state.

- **Established**—The initial keepalive is received from the remote peer. Peering is now established with the remote neighbor and the BGP routing process starts exchanging update message with the remote peer.
The hold timer restarts when an update or keepalive message is received. If the BGP process receives an error notification, it will transition to the Idle state.

Cisco Implementation of BGP Global and Address Family Configuration Commands

The address family model for configuring BGP is based on splitting apart the configuration for each address family. All commands that are independent of the address family are grouped together at the beginning (highest level) of the configuration, and these are followed by separate submodes for commands specific to each address family (with the exception that commands relating to IPv4 unicast can also be entered at the beginning of the configuration). When a network operator configures BGP, the flow of BGP configuration categories is represented by the following bullets in order:

- Global configuration—Configuration that is applied to BGP in general, rather than to specific neighbors. For example, the `network`, `redistribute`, and `bgp bestpath` commands.
- Address family-dependent configuration—Configuration that applies to a specific address family such as policy on an individual neighbor.

The relationship between BGP global and BGP address family-dependent configuration categories is shown in the table below.

<table>
<thead>
<tr>
<th>BGP Configuration Category</th>
<th>Configuration Sets Within Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global address family-independent</td>
<td>One set of global address family-independent configurations</td>
</tr>
<tr>
<td>Address family-dependent</td>
<td>One set of global address family-dependent configurations per address family</td>
</tr>
</tbody>
</table>

Address family configuration must be entered within the address family submode to which it applies.

The following is an example of BGP configuration statements showing the grouping of global address family-independent and address family-dependent commands.

```bash
router bgp <AS>
  ! AF independent part
  neighbor <ip-address> <command> ! Session config; AF independent
  address-family ipv4 unicast
    ! AF dependant part
  neighbor <ip-address> <command> ! Policy config; AF dependant
  exit-address-family
  address-family ipv4 multicast
    ! AF dependant part
  neighbor <ip-address> <command> ! Policy config; AF dependant
  exit-address-family
  address-family ipv4 unicast vrf <vrf-name>
    ! VRF specific AS independent commands
  ! VRF specific AS dependant commands
  neighbor <ip-address> <command> ! Session config; AF independent
```
neighbor <ip-address> <command> ! Policy config; AF dependant
exit-address-family

The following example shows actual BGP commands that match the BGP configuration statements in the previous example:

router bgp 45000
  router-id 172.17.1.99
  bgp log-neighbor-changes
  neighbor 192.168.1.2 remote-as 40000
  neighbor 192.168.3.2 remote-as 50000
  address-family ipv4 unicast
    neighbor 192.168.1.2 activate
    network 172.17.1.0 mask 255.255.255.0
    exit-address-family
  address-family ipv4 multicast
    neighbor 192.168.3.2 activate
    neighbor 192.168.3.2 advertisement-interval 25
    network 172.16.1.0 mask 255.255.255.0
    exit-address-family
  address-family ipv4 vrf vpn1
    neighbor 192.168.3.2 activate
    network 172.21.1.0 mask 255.255.255.0
    exit-address-family

The `bgp upgrade-cli` command simplifies the migration of BGP networks and existing configurations from the network layer reachability information (NLRI) format to the address family format. Network operators can configure commands in the address family identifier (AFI) format and save these command configurations to existing NLRI formatted configurations. The BGP hybrid command-line interface (CLI) does not add support for complete AFI and NLRI integration because of the limitations of the NLRI format. For complete support of AFI commands and features, we recommend upgrading existing NLRI configurations with the `bgp upgrade-cli` command. For an example of migrating BGP configurations from the NLRI format to the address family format, see the “Example: NLRI to AFI Configuration” section later in this module.

**BGP Session Reset**

Whenever the routing policy changes due to a configuration change, BGP peering sessions must be reset by using the `clear ip bgp` command. Cisco software supports the following three mechanisms to reset BGP peering sessions:

- **Hard reset**—A hard reset tears down the specified peering sessions including the TCP connection and deletes routes coming from the specified peer.

- **Soft reset**—A soft reset uses stored prefix information to reconfigure and activate BGP routing tables without tearing down existing peering sessions. Soft reconfiguration uses stored update information, at the cost of additional memory for storing the updates, to allow you to apply new BGP policy without disrupting the network. Soft reconfiguration can be configured for inbound or outbound sessions.

- **Dynamic inbound soft reset**—The route refresh capability, as defined in RFC 2918, allows the local device to reset inbound routing tables dynamically by exchanging route refresh requests to supporting peers. The route refresh capability does not store update information locally for nondisruptive policy changes. It instead relies on dynamic exchange with supporting peers. Route refresh must first be advertised through BGP capability negotiation between peers. All BGP devices must support the route refresh capability. To determine if a BGP device supports this capability, use the `show ip bgp neighbors` command. The following message is displayed in the output when the device supports the route refresh capability:
Received route refresh capability from peer.

The `bgp soft-reconfig-backup` command was introduced to configure BGP to perform inbound soft reconfiguration for peers that do not support the route refresh capability. The configuration of this command allows you to configure BGP to store updates (soft reconfiguration) only as necessary. Peers that support the route refresh capability are unaffected by the configuration of this command.

**BGP Route Aggregation**

BGP peers store and exchange routing information and the amount of routing information increases as more BGP speakers are configured. The use of route aggregation reduces the amount of information involved. Aggregation is the process of combining the attributes of several different routes so that only a single route is advertised. Aggregate prefixes use the classless interdomain routing (CIDR) principle to combine contiguous networks into one classless set of IP addresses that can be summarized in routing tables. Fewer routes now need to be advertised.

Two methods are available in BGP to implement route aggregation. You can redistribute an aggregated route into BGP or you can use a form of conditional aggregation. Basic route redistribution involves creating an aggregate route and then redistributing the routes into BGP. Conditional aggregation involves creating an aggregate route and then advertising or suppressing the advertising of certain routes on the basis of route maps, autonomous system set path (AS-SET) information, or summary information.

The `bgp suppress-inactive` command configures BGP to not advertise inactive routes to any BGP peer. A BGP routing process can advertise routes that are not installed in the routing information database (RIB) to BGP peers by default. A route that is not installed into the RIB is an inactive route. Inactive route advertisement can occur, for example, when routes are advertised through common route aggregation. Inactive route advertisements can be suppressed to provide more consistent data forwarding.

**BGP Aggregation Route AS_SET Information Generation**

AS_SET information can be generated when BGP routes are aggregated using the `aggregate-address` command. The path advertised for such a route is an AS_SET consisting of all the elements, including the communities, contained in all the paths that are being summarized. If the AS_PATHs to be aggregated are identical, only the AS_PATH is advertised. The ATOMIC_AGGREGATE attribute, set by default for the `aggregate-address` command, is not added to the AS_SET.

**Routing Policy Change Management**

Routing policies for a peer include all the configurations for elements such as route map, distribute list, prefix list, and filter list that may impact inbound or outbound routing table updates. The policy changes are automatically updated to peers whenever there is a change in the routing policy. Performing inbound reset enables the new inbound policy configured on the router to take effect. Performing outbound reset causes the new local outbound policy configured on the router to take effect without resetting the BGP session. As a new set of updates is sent during outbound policy reset, a new inbound policy of the neighbor can also take effect. This means that after changing inbound policy you must do an inbound reset on the local router or an outbound reset on the peer router. Outbound policy changes require an outbound reset on the local router or an inbound reset on the peer router.

There are two types of reset: hard reset and soft reset. The table below lists their advantages and disadvantages.
### Table 12: Advantages and Disadvantages of Hard and Soft Resets

<table>
<thead>
<tr>
<th>Type of Reset</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hard reset</td>
<td>No memory overhead.</td>
<td>The prefixes in the BGP, IP, and Forwarding Information Base (FIB) tables provided by the neighbor are lost. Not recommended.</td>
</tr>
<tr>
<td>Outbound soft reset</td>
<td>No configuration, no storing of routing table updates.</td>
<td>Does not reset inbound routing table updates.</td>
</tr>
<tr>
<td>Dynamic inbound soft reset</td>
<td>Does not clear the BGP session and cache. Does not require storing of routing table updates, and has no memory overhead.</td>
<td>Both BGP routers must support the route refresh capability (in Cisco IOS Release 12.1 and later releases). <strong>Note</strong> Does not reset outbound routing table updates.</td>
</tr>
<tr>
<td>Configured inbound soft reset (uses the <code>neighbor soft-reconfiguration</code> router configuration command)</td>
<td>Can be used when both BGP routers do not support the automatic route refresh capability. In Cisco IOS Release 12.3(14)T, the <code>bgp soft-reconfig-backup</code> command was introduced to configure inbound soft reconfiguration for peers that do not support the route refresh capability.</td>
<td>Requires preconfiguration. Stores all received (inbound) routing policy updates without modification; is memory-intensive. Recommended only when absolutely necessary, such as when both BGP routers do not support the automatic route refresh capability. <strong>Note</strong> Does not reset outbound routing table updates.</td>
</tr>
</tbody>
</table>

Once you have defined two routers to be BGP neighbors, they will form a BGP connection and exchange routing information. If you subsequently change a BGP filter, weight, distance, version, or timer, or make a similar configuration change, you must reset BGP connections for the configuration change to take effect.

A soft reset updates the routing table for inbound and outbound routing updates. Cisco IOS Release 12.1 and later releases support soft reset without any prior configuration. This soft reset allows the dynamic exchange of route refresh requests and routing information between BGP routers, and the subsequent readvertisement of the respective outbound routing table. There are two types of soft reset:

- When soft reset is used to generate inbound updates from a neighbor, it is called dynamic inbound soft reset.
- When soft reset is used to send a new set of updates to a neighbor, it is called outbound soft reset.

To use soft reset without preconfiguration, both BGP peers must support the soft route refresh capability, which is advertised in the OPEN message sent when the peers establish a TCP session. Routers running Cisco IOS releases prior to Release 12.1 do not support the route refresh capability and must clear the BGP session using the `neighbor soft-reconfiguration` router configuration command. Clearing the BGP session in this way will have a negative impact upon network operations and should be used only as a last resort.
Conditional BGP Route Injection

Routes that are advertised through the BGP are commonly aggregated to minimize the number of routes that are used and reduce the size of global routing tables. However, common route aggregation can obscure more specific routing information that is more accurate but not necessary to forward packets to their destinations. Routing accuracy is obscured by common route aggregation because a prefix that represents multiple addresses or hosts over a large topological area cannot be accurately reflected in a single route. Cisco software provides several methods by which you can originate a prefix into BGP. Prior to the BGP conditional route injection feature, the existing methods included redistribution and using the network or aggregate-address command. However, these methods assume the existence of more specific routing information (matching the route to be originated) in either the routing table or the BGP table.

BGP conditional route injection allows you to originate a prefix into a BGP routing table without the corresponding match. This feature allows more specific routes to be generated based on administrative policy or traffic engineering information in order to provide more specific control over the forwarding of packets to these more specific routes, which are injected into the BGP routing table only if the configured conditions are met. Enabling this feature will allow you to improve the accuracy of common route aggregation by conditionally injecting or replacing less specific prefixes with more specific prefixes. Only prefixes that are equal to or more specific than the original prefix may be injected. BGP conditional route injection is enabled with the bgp inject-map exist-map command and uses two route maps (inject map and exist map) to install one (or more) more specific prefixes into a BGP routing table. The exist map specifies the prefixes that the BGP speaker will track. The inject map defines the prefixes that will be created and installed into the local BGP table.

Note: Inject maps and exist maps will only match a single prefix per route map clause. To inject additional prefixes, you must configure additional route map clauses. If multiple prefixes are used, the first prefix matched will be used.

BGP Peer Groups

Often, in a BGP network, many neighbors are configured with the same update policies (that is, the same outbound route maps, distribute lists, filter lists, update source, and so on). Neighbors with the same update policies can be grouped into BGP peer groups to simplify configuration and, more importantly, to make configuration updates more efficient. When you have many peers, this approach is highly recommended.

BGP Backdoor Routes

In a BGP network topology with two border devices using eBGP to communicate to a number of different autonomous systems, using eBGP to communicate between the two border devices may not be the most efficient routing method. In the figure below, Router B as a BGP speaker will receive a route to Router D through eBGP, but this route will traverse at least two autonomous systems. Router B and Router D are also connected through an Enhanced Interior Gateway Routing Protocol (EIGRP) network (any IGP can be used here), and this route has a shorter path. EIGRP routes, however, have a default administrative distance of 90, and eBGP routes have a default administrative distance of 20, so BGP will prefer the eBGP route. Changing the default administrative distances is not recommended because changing the administrative distance may lead to routing loops. To cause BGP to prefer the EIGRP route, you can use the network backdoor command. BGP treats the network specified by the network backdoor command as a locally assigned network, except
Peer Groups and BGP Update Messages

In Cisco IOS software releases prior to Release 12.0(24)S, 12.2(18)S, or 12.3(4)T, BGP update messages were grouped based on peer group configurations. This method of grouping neighbors for BGP update message generation reduced the amount of system processing resources needed to scan the routing table. This method, however, had the following limitations:

• All neighbors that shared peer group configuration also had to share outbound routing policies.
• All neighbors had to belong to the same peer group and address family. Neighbors configured in different address families could not belong to different peer groups.

These limitations existed to balance optimal update generation and replication against peer group configuration. These limitations could cause the network operator to configure smaller peer groups, which reduced the efficiency of update message generation and limited the scalability of neighbor configuration.

BGP Update Group

The introduction of the BGP (dynamic) update group provides a different type of BGP peer grouping from existing BGP peer groups. Existing peer groups are not affected but peers with the same outbound policy configured that are not members of a current peer group can be grouped into an update group. The members of this update group will use the same update generation engine. When BGP update groups are configured an algorithm dynamically calculates the BGP update group membership based on outbound policies. Optimal BGP update message generation occurs automatically and independently. BGP neighbor configuration is no longer restricted by outbound routing policies, and update groups can belong to different address families.
BGP Dynamic Update Group Configuration

In Cisco IOS Release 12.0(24)S, 12.2(18)S, 12.3(4)T, 12.2(27)SBC, and later releases, a new algorithm was introduced that dynamically calculates and optimizes update groups of neighbors that share the same outbound policies and can share the same update messages. No configuration is required to enable the BGP dynamic update group and the algorithm runs automatically. When a change to outbound policy occurs, the router automatically recalculates update group memberships and applies the changes by triggering an outbound soft reset after a 1-minute timer expires. This behavior is designed to provide the network operator with time to change the configuration if a mistake is made. You can manually enable an outbound soft reset before the timer expires by entering the clear ip bgp ip-address soft out command.

---

**Note**

In Cisco IOS Release 12.0(22)S, 12.2(14)S, 12.3(2)T, and prior releases, the update group recalculation delay timer is set to 3 minutes.

For the best optimization of BGP update group generation, we recommend that the network operator keeps outbound routing policy the same for neighbors that have similar outbound policies.

BGP Peer Templates

To address some of the limitations of peer groups such as configuration management, BGP peer templates were introduced to support the BGP update group configuration.

A peer template is a configuration pattern that can be applied to neighbors that share policies. Peer templates are reusable and support inheritance, which allows the network operator to group and apply distinct neighbor configurations for BGP neighbors that share policies. Peer templates also allow the network operator to define very complex configuration patterns through the capability of a peer template to inherit a configuration from another peer template.

There are two types of peer templates:

- Peer session templates are used to group and apply the configuration of general session commands that are common to all address family and NLRI configuration modes.
- Peer policy templates are used to group and apply the configuration of commands that are applied within specific address families and NLRI configuration modes.

Peer templates improve the flexibility and enhance the capability of neighbor configuration. Peer templates also provide an alternative to peer group configuration and overcome some limitations of peer groups. BGP peer routers using peer templates also benefit from automatic update group configuration. With the configuration of the BGP peer templates and the support of the BGP dynamic update peer groups, the network operator no longer needs to configure peer groups in BGP and the network can benefit from improved configuration flexibility and faster convergence.

---

**Note**

A BGP neighbor cannot be configured to work with both peer groups and peer templates. A BGP neighbor can be configured to belong only to a peer group or to inherit policies from peer templates.

The following restrictions apply to the peer policy templates:

- A peer policy template can directly or indirectly inherit up to eight peer policy templates.
A BGP neighbor cannot be configured to work with both peer groups and peer templates. A BGP neighbor can be configured to belong only to a peer group or to inherit policies only from peer templates.

Inheritance in Peer Templates

The inheritance capability is a key component of peer template operation. Inheritance in a peer template is similar to node and tree structures commonly found in general computing, for example, file and directory trees. A peer template can directly or indirectly inherit the configuration from another peer template. The directly inherited peer template represents the tree in the structure. The indirectly inherited peer template represents a node in the tree. Because each node also supports inheritance, branches can be created that apply the configurations of all indirectly inherited peer templates within a chain back to the directly inherited peer template or the source of the tree.

This structure eliminates the need to repeat configuration statements that are commonly reapplied to groups of neighbors because common configuration statements can be applied once and then indirectly inherited by peer templates that are applied to neighbor groups with common configurations. Configuration statements that are duplicated separately within a node and a tree are filtered out at the source of the tree by the directly inherited template. A directly inherited template will overwrite any indirectly inherited statements that are duplicated in the directly inherited template.

Inheritance expands the scalability and flexibility of neighbor configuration by allowing you to chain together peer templates configurations to create simple configurations that inherit common configuration statements or complex configurations that apply very specific configuration statements along with common inherited configurations. Specific details about configuring inheritance in peer session templates and peer policy templates are provided in the following sections.

When BGP neighbors use inherited peer templates it can be difficult to determine which policies are associated with a specific template. The detail keyword was added to the `show ip bgp template peer-policy` command to display the detailed configuration of local and inherited policies associated with a specific template.

Peer Session Templates

Peer session templates are used to group and apply the configuration of general session commands to groups of neighbors that share session configuration elements. General session commands that are common for neighbors that are configured in different address families can be configured within the same peer session template. Peer session templates are created and configured in peer session configuration mode. Only general session commands can be configured in a peer session template. The following general session commands are supported by peer session templates:

- `description`
- `disable-connected-check`
- `ebgp-multihop`
- `exit peer-session`
- `inherit peer-session`
- `local-as`
- `password`
- `remote-as`
• shutdown
• timers
• translate-update
• update-source
• version

General session commands can be configured once in a peer session template and then applied to many neighbors through the direct application of a peer session template or through indirect inheritance from a peer session template. The configuration of peer session templates simplifies the configuration of general session commands that are commonly applied to all neighbors within an autonomous system.

Peer session templates support direct and indirect inheritance. A peer can be configured with only one peer session template at a time, and that peer session template can contain only one indirectly inherited peer session template.

Note
If you attempt to configure more than one inherit statement with a single peer session template, an error message will be displayed.

This behavior allows a BGP neighbor to directly inherit only one session template and indirectly inherit up to seven additional peer session templates. This allows you to apply up to a maximum of eight peer session configurations to a neighbor: the configuration from the directly inherited peer session template and the configurations from up to seven indirectly inherited peer session templates. Inherited peer session configurations are evaluated first and applied starting with the last node in the branch and ending with the directly applied peer session template configuration at the source of the tree. The directly applied peer session template will have priority over inherited peer session template configurations. Any configuration statements that are duplicated in inherited peer session templates will be overwritten by the directly applied peer session template. So, if a general session command is reapplied with a different value, the subsequent value will have priority and overwrite the previous value that was configured in the indirectly inherited template. The following examples illustrate the use of this feature.

In the following example, the general session command `remote-as 1` is applied in the peer session template named `SESSION-TEMPLATE-ONE`:

```plaintext
template peer-session SESSION-TEMPLATE-ONE
  remote-as 1
  exit peer-session
```

Peer session templates support only general session commands. BGP policy configuration commands that are configured only for a specific address family or NLRI configuration mode are configured with peer policy templates.

**Peer Policy Templates**

Peer policy templates are used to group and apply the configuration of commands that are applied within specific address families and NLRI configuration mode. Peer policy templates are created and configured in peer policy configuration mode. BGP policy commands that are configured for specific address families are configured in a peer policy template. The following BGP policy commands are supported by peer policy templates:
Peer policy templates are used to configure BGP policy commands that are configured for neighbors that belong to specific address families. Like peer session templates, peer policy templates are configured once and then applied to many neighbors through the direct application of a peer policy template or through inheritance from peer policy templates. The configuration of peer policy templates simplifies the configuration of BGP policy commands that are applied to all neighbors within an autonomous system.

Like a peer session template, a peer policy template supports inheritance. However, there are minor differences. A directly applied peer policy template can directly or indirectly inherit configurations from up to seven peer policy templates. So, a total of eight peer policy templates can be applied to a neighbor or neighbor group. Like route maps, inherited peer policy templates are configured with sequence numbers. Also like a route map, an inherited peer policy template is evaluated starting with the `inherit peer-policy` statement with the lowest sequence number and ending with the highest sequence number. However, there is a difference; a peer policy template will not collapse like a route map. Every sequence is evaluated, and if a BGP policy command is reapplied with a different value, it will overwrite any previous value from a lower sequence number.
The directly applied peer policy template and the inherit peer-policy statement with the highest sequence number will always have priority and be applied last. Commands that are reapplied in subsequent peer templates will always overwrite the previous values. This behavior is designed to allow you to apply common policy configurations to large neighbor groups and specific policy configurations only to certain neighbors and neighbor groups without duplicating individual policy configuration commands.

Peer policy templates support only policy configuration commands. BGP policy configuration commands that are configured only for specific address families are configured with peer policy templates.

The configuration of peer policy templates simplifies and improves the flexibility of BGP configuration. A specific policy can be configured once and referenced many times. Because a peer policy supports up to eight levels of inheritance, very specific and very complex BGP policies can also be created.

**BGP IPv6 Neighbor Activation Under the IPv4 Address Family**

Prior to Cisco IOS Release 12.2(33)SRE4, by default, both IPv6 and IPv4 capability is exchanged with a BGP peer that has an IPv6 address. When an IPv6 peer is configured, that neighbor is automatically activated under the IPv4 unicast address family.

Beginning with Cisco IOS Release 12.2(33)SRE4, when a new IPv6 neighbor is being configured, it is no longer automatically activated under the IPv4 address family. You can manually activate the IPv6 neighbor under the IPv4 address family if, for example, you have a dual stack environment and want to send IPv6 and IPv4 prefixes.

If you do not want an existing IPv6 peer to be activated under the IPv4 address family, you can manually deactivate the peer with the no neighbor activate command. Until then, existing configurations that activate an IPv6 neighbor under the IPv4 unicast address family will continue to try to establish a session.

**How to Configure a Basic BGP Network**

Configuring a basic BGP network consists of a few required tasks and many optional tasks. A BGP routing process must be configured and BGP peers must be configured, preferably using the address family configuration model. If the BGP peers are part of a VPN network, the BGP peers must be configured using the IPv4 VRF address family task. The other tasks in the following list are optional:

**Configuring a BGP Routing Process**

Perform this task to configure a BGP routing process. You must perform the required steps at least once to enable BGP. The optional steps here allow you to configure additional features in your BGP network. Several of the features, such as logging neighbor resets and immediate reset of a peer when its link goes down, are enabled by default but are presented here to enhance your understanding of how your BGP network operates.

A device that runs Cisco software can be configured to run only one BGP routing process and to be a member of only one BGP autonomous system. However, a BGP routing process and autonomous system can support multiple concurrent BGP address family and subaddress family configurations.

The configuration in this task is done at Router A in the figure below and would need to be repeated with appropriate changes to the IP addresses (for example, at Router B) to fully achieve a BGP process between...
the two devices. No address family is configured here for the BGP routing process, so routing information for the IPv4 unicast address family is advertised by default.

Figure 11: BGP Topology with Two Autonomous Systems

SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. network network-number [mask network-mask] [route-map route-map-name]
5. bgp router-id ip-address
6. timers bgp keepalive holdtime
7. bgp fast-external-fallover
8. bgp log-neighbor-changes
9. end
10. show ip bgp [network] [network-mask]

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td>Step</td>
<td>Command or Action</td>
</tr>
<tr>
<td>------</td>
<td>-------------------</td>
</tr>
</tbody>
</table>
| **Step 3** | router bgp *autonomous-system-number* | Configures a BGP routing process, and enters router configuration mode for the specified routing process.  
  - Use the *autonomous-system-number* argument to specify an integer, from 0 and 65534, that identifies the device to other BGP speakers. |
| **Example:** | Device(config)# router bgp 40000 | |
| **Step 4** | network *network-number* [mask *network-mask*] [route-map *route-map-name*] | (Optional) Specifies a network as local to this autonomous system and adds it to the BGP routing table.  
  - For exterior protocols, the *network* command controls which networks are advertised. Interior protocols use the *network* command to determine where to send updates. |
| **Example:** | Device(config-router)# network 10.1.1.0 mask 255.255.255.0 | |
| **Step 5** | bgp router-id *ip-address* | (Optional) Configures a fixed 32-bit router ID as the identifier of the local device running BGP.  
  - Use the *ip-address* argument to specify a unique router ID within the network.  
  **Note** Configuring a router ID using the bgp router-id command resets all active BGP peering sessions. |
| **Example:** | Device(config-router)# bgp router-id 10.1.1.99 | |
| **Step 6** | timers bgp *keepalive* *holdtime* | (Optional) Sets BGP network timers.  
  - Use the *keepalive* argument to specify the frequency, in seconds, with which the software sends keepalive messages to its BGP peer. By default, the keepalive timer is set to 60 seconds.  
  - Use the *holdtime* argument to specify the interval, in seconds, after which the software, having not received a keepalive message, declares a BGP peer dead. By default, the holdtime timer is set to 180 seconds. |
| **Example:** | Device(config-router)# timers bgp 70 120 | |
| **Step 7** | bgp fast-external-fallover | (Optional) Enables the automatic resetting of BGP sessions.  
  - By default, the BGP sessions of any directly adjacent external peers are reset if the link used to reach them goes down. |
| **Example:** | Device(config-router)# bgp fast-external-fallover | |
| **Step 8** | bgp log-neighbor-changes | (Optional) Enables logging of BGP neighbor status changes (up or down) and neighbor resets.  
  - Use this command for troubleshooting network connectivity problems and measuring network stability. Unexpected neighbor resets might indicate high error rates or high packet loss in the network and should be investigated. |
| **Example:** | Device(config-router)# bgp log-neighbor-changes | |
### Purpose

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 9</strong></td>
<td>Exits router configuration mode and enters privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-router)# end</td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td>(Optional) Displays the entries in the BGP routing table.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device# show ip bgp</td>
</tr>
</tbody>
</table>

### Examples

The following sample output from the `show ip bgp` command shows the BGP routing table for Router A in the figure above after this task has been configured on Router A. You can see an entry for the network 10.1.1.0 that is local to this autonomous system.

```
BGP table version is 12, local router ID is 10.1.1.99
Status codes: s suppress, d damped, h history, * valid, > best, i - internal, r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete
Network   Next Hop   Metric  LocPrf  Weight  Path
*> 10.1.1.0/24  0.0.0.0   0      32768   i
```

### Troubleshooting Tips

Use the `ping` command to check basic network connectivity between the BGP routers.

### Configuring a BGP Peer

Perform this task to configure BGP between two IPv4 routers (peers). The address family configured here is the default IPv4 unicast address family and the configuration is done at Router A in the figure above. Remember to perform this task for any neighbor routers that are to be BGP peers.

**Before you begin**

Before you perform this task, perform the “Configuring a BGP Routing Process” task shown in the prior section.

**Note**

By default, neighbors that are defined using the `neighbor remote-as` command in router configuration mode exchange only IPv4 unicast address prefixes. To exchange other address prefix types, such as IPv6 prefixes, neighbors must also be activated using the `neighbor activate` command in address family configuration mode for the other prefix types, such as IPv6 prefixes.
### SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router bgp autonomous-system-number**
4. **neighbor ip-address remote-as autonomous-system-number**
5. **address-family ipv4 [unicast | multicast | vrf vrf-name]**
6. **neighbor ip-address activate**
7. **end**
8. **show ip bgp [network] [network-mask]**
9. **show ip bgp neighbors [neighbor-address]**

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Router&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
</tbody>
</table>

| **Step 2** configure terminal | Enters global configuration mode. |
| **Example:** Router# configure terminal | |

| **Step 3** router bgp autonomous-system-number | Enters router configuration mode for the specified routing process. |
| **Example:** Router(config)# router bgp 40000 | |

| **Step 4** neighbor ip-address remote-as autonomous-system-number | Adds the IP address of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local router. |
| **Example:** Router(config-router)# neighbor 192.168.1.1 remote-as 45000 | |

<p>| <strong>Step 5</strong> address-family ipv4 [unicast | multicast | vrf vrf-name] | Specifies the IPv4 address family and enters address family configuration mode. |
| <strong>Example:</strong> Router(config-router)# address-family ipv4 unicast | • The <strong>unicast</strong> keyword specifies the IPv4 unicast address family. By default, the router is placed in configuration mode for the IPv4 unicast address family if the <strong>unicast</strong> keyword is not specified with the <strong>address-family ipv4</strong> command. |
| | • The <strong>multicast</strong> keyword specifies IPv4 multicast address prefixes. |</p>
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>• The vrf keyword and vrf-name argument specify the name of the virtual routing and forwarding (VRF) instance to associate with subsequent IPv4 address family configuration mode commands.</td>
<td></td>
</tr>
<tr>
<td>Step 6 <strong>neighbor</strong> ip-address <strong>activate</strong></td>
<td>Enables the neighbor to exchange prefixes for the IPv4 unicast address family with the local router.</td>
</tr>
<tr>
<td>Example: <strong>Router(config-router-af)# neighbor 192.168.1.1 activate</strong></td>
<td></td>
</tr>
<tr>
<td>Step 7 <strong>end</strong></td>
<td>Exits address family configuration mode and enters privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: <strong>Router(config-router-af)# end</strong></td>
<td></td>
</tr>
<tr>
<td>Step 8 <strong>show ip bgp [network] [network-mask]</strong></td>
<td>(Optional) Displays the entries in the BGP routing table.</td>
</tr>
<tr>
<td>Note Only the syntax applicable to this task is used in this example. For more details, see the Cisco IOS IP Routing: BGP Command Reference.</td>
<td></td>
</tr>
<tr>
<td>Example: <strong>Router# show ip bgp</strong></td>
<td></td>
</tr>
<tr>
<td>Step 9 <strong>show ip bgp neighbors [neighbor-address]</strong></td>
<td>(Optional) Displays information about the TCP and BGP connections to neighbors.</td>
</tr>
<tr>
<td>Note Only the syntax applicable to this task is used in this example. For more details, see the Cisco IOS IP Routing: BGP Command Reference.</td>
<td></td>
</tr>
<tr>
<td>Example: <strong>Router(config-router-af)# show ip bgp neighbors 192.168.2.2</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Examples**

The following sample output from the **show ip bgp** command shows the BGP routing table for Router A in the figure above after this task has been configured on Router A and Router B. You can now see an entry for the network 172.17.1.0 in autonomous system 45000.

```
BGP table version is 13, local router ID is 10.1.1.99
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal, r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

Network      Next Hop     Metric  LocPrf  Weight  Path
* 10.1.1.0/24  0.0.0.0    0       0       0       i
* 172.17.1.0/24  192.168.1.1  0        0       0      45000 i
```

The following sample output from the **show ip bgp neighbors** command shows information about the TCP and BGP connections to the BGP neighbor 192.168.1.1 of Router A in the figure above after this task has been configured on Router A:

```
BGP neighbor is 192.168.1.1, remote AS 45000, external link
BGP version 4, remote router ID 172.17.1.99
BGP state = Established, up for 00:06:55
```
Configuring a Basic BGP Network

Last read 00:00:15, last write 00:00:15, hold time is 120, keepalive intervals
Configured hold time is 120, keepalive interval is 70 seconds, Minimum holdtimes
Neighbor capabilities:
Route refresh: advertised and received (old & new)
Address family IPv4 Unicast: advertised and received
Message statistics:
InQ depth is 0
OutQ depth is 0

<table>
<thead>
<tr>
<th></th>
<th>Sent</th>
<th>Rcvd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opens</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Notifications</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Updates</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Keepalives</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Route Refresh</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>16</td>
</tr>
</tbody>
</table>

Default minimum time between advertisement runs is 30 seconds
For address family: IPv4 Unicast
BGP table version 13, neighbor version 13/0
Output queue size : 0
Index 1, Offset 0, Mask 0x2
1 update-group member

Prefix activity:

<table>
<thead>
<tr>
<th></th>
<th>Sent</th>
<th>Rcvd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prefixes Current:</td>
<td>1</td>
<td>1 (Consumes 52 bytes)</td>
</tr>
<tr>
<td>Prefixes Total:</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Implicit Withdraw:</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Explicit Withdraw:</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Used as bestpath:</td>
<td>n/a</td>
<td>1</td>
</tr>
<tr>
<td>Used as multipath:</td>
<td>n/a</td>
<td>0</td>
</tr>
</tbody>
</table>

Local Policy Denied Prefixes:-------- --------
AS_PATH loop: n/a 1
Bestpath from this peer:1 n/a
Total: 1

Number of NLRIIs in the update sent: max 0, min 0
Connections established 1; dropped 0

Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Connection is ECN Disabled
Local host: 192.168.1.2, Local port: 179
Foreign host: 192.168.1.1, Foreign port: 37725
Enqueued packets for retransmit: 0, input: 0 mis-ordered: 0 (0 bytes)
Event Timers (current time is 0x12F4F2C):

<table>
<thead>
<tr>
<th>Timer</th>
<th>Starts</th>
<th>Wakeups</th>
<th>Next</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retrans</td>
<td>14</td>
<td>0</td>
<td>0x0</td>
</tr>
<tr>
<td>TimeWait</td>
<td>0</td>
<td>0</td>
<td>0x0</td>
</tr>
<tr>
<td>AckHold</td>
<td>13</td>
<td>8</td>
<td>0x0</td>
</tr>
<tr>
<td>SendWnd</td>
<td>0</td>
<td>0</td>
<td>0x0</td>
</tr>
<tr>
<td>KeepAlive</td>
<td>0</td>
<td>0</td>
<td>0x0</td>
</tr>
<tr>
<td>GiveUp</td>
<td>0</td>
<td>0</td>
<td>0x0</td>
</tr>
<tr>
<td>PmtuAger</td>
<td>0</td>
<td>0</td>
<td>0x0</td>
</tr>
<tr>
<td>DeadWait</td>
<td>0</td>
<td>0</td>
<td>0x0</td>
</tr>
</tbody>
</table>

iss: 165379618  snduna: 165379963  sndxnt: 165379963  sndwnd: 16040
irs: 3127821601  rcvnxnt: 3127821993  rcvwnd: 15993  delrcvwnd: 391
SRTT: 254 ms, RTTO: 619 ms, RTV: 365 ms, KRTT: 0 ms
minRTT: 12 ms, maxRTT: 300 ms, ACK hold: 200 ms
Flags: passive open, nagle, gen tcbs
IP Precedence value: 6
Datagrams (max data segment is 1460 bytes):
Rcved: 20 (out of order: 0), with data: 15, total data bytes: 391
Sent: 22 (retransmit: 0, fastretransmit: 0, partialack: 0, Second Congestion: 04
Troubleshooting Tips

Use the **ping** command to verify basic network connectivity between the BGP routers.

What to Do Next

If you have BGP peers in a VPN, proceed to the Configuring a BGP Peer for the IPv4 VRF Address Family, on page 98. If you do not have BGP peers in a VPN, proceed to the Customizing a BGP Peer, on page 37.

Configuring a BGP Routing Process and Peers Using 4-Byte Autonomous System Numbers

Perform this task to configure a Border Gateway Protocol (BGP) routing process and BGP peers when the BGP peers are located in an autonomous system (AS) that uses 4-byte AS numbers. The address family configured here is the default IPv4 unicast address family, and the configuration is done at Router B in the figure above (in the “Cisco Implementation of 4-Byte Autonomous System Numbers” section). The 4-byte AS numbers in this task are formatted in the default asplain (decimal value) format; for example, Router B is in AS number 65538 in the figure above. Remember to perform this task for any neighbor routers that are to be BGP peers.

Before you begin

By default, neighbors that are defined using the `neighbor remote-as` command in router configuration mode exchange only IPv4 unicast address prefixes. To exchange other address prefix types, such as IPv6 prefixes, neighbors must also be activated using the `neighbor activate` command in address family configuration mode for the other prefix types.

SUMMARY STEPS

1.   enable
2.   configure terminal
3.   router bgp autonomous-system-number
4.   neighbor ip-address remote-as autonomous-system-number
5.   Repeat Step 4 to define other BGP neighbors, as required.
6.   address-family ipv4 [unicast | multicast | vrf vrf-name]
7.   neighbor ip-address activate
8.   Repeat Step 7 to activate other BGP neighbors, as required.
9.   network network-number [mask network-mask] [route-map route-map-name]
10.  end
11.  show ip bgp [network] [network-mask]
12.  show ip bgp summary

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Example:</strong> Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# router bgp 65538</td>
<td>• In this example, the 4-byte AS number, 65538, is defined in asplain notation.</td>
</tr>
<tr>
<td><strong>Step 4</strong> neighbor ip-address remote-as autonomous-system-number</td>
<td>Adds the IP address of the neighbor in the specified AS to the IPv4 multiprotocol BGP neighbor table of the local device.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router)# neighbor 192.168.1.2 remote-as 65536</td>
<td>• In this example, the 4-byte AS number, 65536, is defined in asplain notation.</td>
</tr>
<tr>
<td><strong>Step 5</strong> Repeat Step 4 to define other BGP neighbors, as required.</td>
<td>--</td>
</tr>
<tr>
<td><strong>Step 6</strong> address-family ipv4 [unicast</td>
<td>multicast</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router)# address-family ipv4 unicast</td>
<td>• The <strong>unicast</strong> keyword specifies the IPv4 unicast address family. By default, the device is placed in configuration mode for the IPv4 unicast address family if the <strong>unicast</strong> keyword is not specified with the <strong>address-family ipv4</strong> command.</td>
</tr>
<tr>
<td></td>
<td>• The <strong>multicast</strong> keyword specifies IPv4 multicast address prefixes.</td>
</tr>
<tr>
<td></td>
<td>• The <strong>vrf</strong> keyword and <strong>vrf-name</strong> argument specify the name of the virtual routing and forwarding (VRF) instance to associate with subsequent IPv4 address family configuration mode commands.</td>
</tr>
<tr>
<td><strong>Step 7</strong> neighbor ip-address activate</td>
<td>Enables the neighbor to exchange prefixes for the IPv4 unicast address family with the local device.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router-af)# neighbor 192.168.1.2 activate</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong> Repeat Step 7 to activate other BGP neighbors, as required.</td>
<td>--</td>
</tr>
<tr>
<td><strong>Step 9</strong> network network-number [mask network-mask] [route-map route-map-name]</td>
<td>(Optional) Specifies a network as local to this AS and adds it to the BGP routing table.</td>
</tr>
</tbody>
</table>
### Configuring a Basic BGP Network

**Command or Action**

- **Example:**
  ```
  Device(config-router-af)# network 172.17.1.0 mask 255.255.255.0
  ```
  - For exterior protocols the `network` command controls which networks are advertised. Interior protocols use the `network` command to determine where to send updates.

- **Step 10**
  ```
  Device(config-router-af)# end
  ```
  - Exits address family configuration mode and returns to privileged EXEC mode.

- **Step 11**
  ```
  Device# show ip bgp 10.1.1.0
  ```
  - (Optional) Displays the entries in the BGP routing table.

  **Note**
  Only the syntax applicable to this task is used in this example. For more details, see the *Cisco IOS IP Routing: BGP Command Reference*.

- **Step 12**
  ```
  Device# show ip bgp summary
  ```
  - (Optional) Displays the status of all BGP connections.

### Examples

The following output from the `show ip bgp` command at Router B shows the BGP routing table entry for network 10.1.1.0 learned from the BGP neighbor at 192.168.1.2 in Router A in the figure above with its 4-byte AS number of 65536 displayed in the default asplain format.

```
RouterB# show ip bgp 10.1.1.0
BGP routing table entry for 10.1.1.0/24, version 2
Paths: (1 available, best #1)
  Advertised to update-groups:
    2
      65536
        192.168.1.2 from 192.168.1.2 (10.1.1.99)
        Origin IGP, metric 0, localpref 100, valid, external, best
```

The following output from the `show ip bgp summary` command shows the 4-byte AS number 65536 for the BGP neighbor 192.168.1.2 of Router A in the figure above after this task has been configured on Router B:

```
RouterB# show ip bgp summary
BGP router identifier 172.17.1.99, local AS number 65538
BGP table version is 3, main routing table version 3
  2 network entries using 234 bytes of memory
  2 path entries using 104 bytes of memory
3/2 BGP path/bestpath attribute entries using 444 bytes of memory
  1 BGP AS-PATH entries using 24 bytes of memory
  0 BGP route-map cache entries using 0 bytes of memory
  0 BGP filter-list cache entries using 0 bytes of memory
  BGP using 806 total bytes of memory
```
Troubleshooting Tips

Use the **ping** command to verify basic network connectivity between the BGP routers.

**Modifying the Default Output and Regular Expression Match Format for 4-Byte Autonomous System Numbers**

Perform this task to modify the default output format for 4-byte autonomous system (AS) numbers from a plain format to a dot notation format. The **show ip bgp summary** command is used to display the changes in output format for the 4-byte AS numbers.

**SUMMARY STEPS**

1. **enable**
2. **show ip bgp summary**
3. **configure terminal**
4. **router bgp autonomous-system-number**
5. **bgp asnotation dot**
6. **end**
7. **clear ip bgp** *
8. **show ip bgp summary**
9. **show ip bgp regexp **regexp**
10. **configure terminal**
11. **router bgp autonomous-system-number**
12. **no bgp asnotation dot**
13. **end**
14. **clear ip bgp** *

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> show ip bgp summary</td>
<td>Displays the status of all Border Gateway Protocol (BGP) connections.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device# show ip bgp summary</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Device# configure terminal</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
</tbody>
</table>

**Step 4**

- **router bgp  autonomous-system-number**
- **Example:**
  - Device(config)# router bgp 65538

  Enters router configuration mode for the specified routing process.
  - In this example, the 4-byte AS number, 65538, is defined in asplain notation.

**Step 5**

- **bgp asnotation dot**
- **Example:**
  - Device(config-router)# bgp asnotation dot

  Changes the default output format of BGP 4-byte AS numbers from as plain (decimal values) to dot notation.
  
  **Note**: 4-byte AS numbers can be configured using either asplain format or asdot format. This command affects only the output displayed for `show` commands or the matching of regular expressions.

**Step 6**

- **end**
- **Example:**
  - Device(config-router)# end

  Exits address family configuration mode and returns to privileged EXEC mode.

**Step 7**

- **clear ip bgp ***
- **Example:**
  - Device# clear ip bgp *

  Clears and resets all current BGP sessions.
  - In this example, a hard reset is performed to ensure that the 4-byte AS number format change is reflected in all BGP sessions.
  
  **Note**: Only the syntax applicable to this task is used in this example. For more details, see the *Cisco IOS IP Routing: BGP Command Reference*.

**Step 8**

- **show ip bgp summary**
- **Example:**
  - Device# show ip bgp summary

  Displays the status of all BGP connections.

**Step 9**

- **show ip bgp regexp  regexp**
- **Example:**
  - Device# show ip bgp regexp ^1\.[0$

  Displays routes that match the AS path regular expression.
  - In this example, a regular expression to match a 4-byte AS path is configured using asdot format.

**Step 10**

- **configure terminal**
- **Example:**
  - Device# configure terminal

  Enters global configuration mode.

**Step 11**

- **router bgp  autonomous-system-number**
- **Example:**

  Enters router configuration mode for the specified routing process.
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device(config)# router bgp 65538</td>
<td>• In this example, the 4-byte AS number, 65538, is defined in asplain notation.</td>
</tr>
<tr>
<td><strong>Step 12</strong> no bgp asnotation dot</td>
<td>Reset the default output format of BGP 4-byte AS numbers back to asplain (decimal values).</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><strong>Note</strong> 4-byte AS numbers can be configured using either asplain format or asdot format. This command affects only the output displayed for <code>show</code> commands or the matching of regular expressions.</td>
</tr>
<tr>
<td>Device(config-router)# no bgp asnotation dot</td>
<td></td>
</tr>
<tr>
<td><strong>Step 13</strong> end</td>
<td>Exits router configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config-router)# end</td>
<td></td>
</tr>
<tr>
<td><strong>Step 14</strong> clear ip bgp *</td>
<td>Clears and resets all current BGP sessions.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>• In this example, a hard reset is performed to ensure that the 4-byte AS number format change is reflected in all BGP sessions.</td>
</tr>
<tr>
<td>Device# clear ip bgp *</td>
<td><strong>Note</strong> Only the syntax applicable to this task is used in this example. For more details, see the <em>Cisco IOS IP Routing: BGP Command Reference</em>.</td>
</tr>
</tbody>
</table>

**Examples**

The following output from the `show ip bgp summary` command shows the default asplain format of the 4-byte AS numbers. Note the asplain format of the 4-byte AS numbers, 65536 and 65550.

```
Router# show ip bgp summary

BGP router identifier 172.17.1.99, local AS number 65538
BGP table version is 1, main routing table version 1
Neighbor       V  AS MsgRcvd  MsgSent  TblVer InQ OutQ Up/Down  Statd
192.168.1.2    4   65536     7       7       1   0   0     0:03:04  0
192.168.3.2    4   65550     4       4       1   0   0     0:00:15  0
```

After the `bgp asnotation dot` command is configured (followed by the `clear ip bgp *` command to perform a hard reset of all current BGP sessions), the output is converted to asdot notation format as shown in the following output from the `show ip bgp summary` command. Note the asdot format of the 4-byte AS numbers, 1.0 and 1.14 (these are the asdot conversions of the 65536 and 65550 AS numbers).

```
Router# show ip bgp summary

BGP router identifier 172.17.1.99, local AS number 1.2
BGP table version is 1, main routing table version 1
```
After the `bgp asnotation dot` command is configured (followed by the `clear ip bgp *` command to perform a hard reset of all current BGP sessions), the regular expression match format for 4-byte AS paths is changed to asdot notation format. Although a 4-byte AS number can be configured in a regular expression using either asplain format or asdot format, only 4-byte AS numbers configured using the current default format are matched. In the first example below, the `show ip bgp regexp` command is configured with a 4-byte AS number in asplain format. The match fails because the default format is currently asdot format and there is no output. In the second example using asdot format, the match passes and the information about the 4-byte AS path is shown using the asdot notation.

**Note**
The asdot notation uses a period, which is a special character in Cisco regular expressions. To remove the special meaning, use a backslash before the period.

```plaintext
Router# show ip bgp regexp ^65536$
Router# show ip bgp regexp ^1\.0$
```

**Configuring a BGP Peer for the IPv4 VRF Address Family**

Perform this optional task to configure BGP between two IPv4 routers (peers) that must exchange IPv4 VRF information because they exist in a VPN. The address family configured here is the IPv4 VRF address family and the configuration is done at Router B in the figure below with the neighbor 192.168.3.2 at Router E in autonomous system 50000. Remember to perform this task for any neighbor routers that are to be BGP IPv4 VRF address family peers.

This task does not show the complete configuration required for VPN routing. For some complete example configurations and an example configuration showing how to create a VRF with a route-target that uses a 4-byte autonomous system number, see .
SUMMARY STEPS

1. enable
2. configure terminal
3. ip vrf vrf-name
4. rd route-distinguisher
5. route-target {import | export | both} route-target-ext-community
6. exit
7. router bgp autonomous-system-number
8. address-family ipv4 [unicast | multicast | vrf vrf-name]
9. neighbor ip-address remote-as autonomous-system-number
10. neighbor {ip-address | peer-group-name} maximum-prefix maximum [threshold] [restart restart-interval] [warning-only]
11. neighbor ip-address activate
12. end

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>- Enter your password if prompted.</td>
</tr>
<tr>
<td>Router&gt; enable</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router# configure terminal</td>
</tr>
<tr>
<td><strong>Step 3</strong> ip vrf vrf-name</td>
<td>Configures a VRF routing table and enters VRF configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config)# ip vrf vpn1</td>
</tr>
<tr>
<td></td>
<td>• Use the vrf-name argument to specify a name to be assigned to the VRF.</td>
</tr>
<tr>
<td><strong>Step 4</strong> rd route-distinguisher</td>
<td>Creates routing and forwarding tables and specifies the</td>
</tr>
<tr>
<td>Example:</td>
<td>default route distinguisher for a VPN.</td>
</tr>
<tr>
<td></td>
<td>Router(config-vrf)# rd 45000:5</td>
</tr>
<tr>
<td></td>
<td>• Use the route-distinguisher argument to add an 8-byte value to an</td>
</tr>
<tr>
<td></td>
<td>IPv4 prefix to create a unique VPN IPv4 prefix.</td>
</tr>
<tr>
<td><strong>Step 5</strong> route-target {import</td>
<td>export</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config-vrf)# route-target both 45000:100</td>
</tr>
<tr>
<td></td>
<td>• Use the import keyword to import routing information from the target</td>
</tr>
<tr>
<td></td>
<td>VPN extended community.</td>
</tr>
<tr>
<td></td>
<td>• Use the export keyword to export routing information to the target</td>
</tr>
<tr>
<td></td>
<td>VPN extended community.</td>
</tr>
<tr>
<td></td>
<td>• Use the both keyword to import both import and export routing</td>
</tr>
<tr>
<td></td>
<td>information to the target VPN extended community.</td>
</tr>
<tr>
<td></td>
<td>• Use the route-target-ext-community argument to add the route target</td>
</tr>
<tr>
<td></td>
<td>extended community attributes to the VRF's list of import, export, or</td>
</tr>
<tr>
<td></td>
<td>both (import and export) route target extended communities.</td>
</tr>
<tr>
<td><strong>Step 6</strong> exit</td>
<td>Exits VRF configuration mode and enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config-vrf)# exit</td>
</tr>
<tr>
<td><strong>Step 7</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode for the specified routing</td>
</tr>
<tr>
<td>Example:</td>
<td>process.</td>
</tr>
<tr>
<td></td>
<td>Router(config)# router bgp 45000</td>
</tr>
<tr>
<td><strong>Step 8</strong> address-family ipv4 [unicast</td>
<td>multicast</td>
</tr>
<tr>
<td>Example:</td>
<td>configuration mode.</td>
</tr>
<tr>
<td></td>
<td>• Use the unicast keyword to specify the IPv4 unicast address family.</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
</tbody>
</table>
| Router(config-router)# address-family ipv4 vrf vpn1 | configuration mode for the IPv4 unicast address family if the **unicast** keyword is not specified with the **address-family ipv4** command.  
• Use the **multicast** keyword to specify IPv4 multicast address prefixes.  
• Use the **vrf** keyword and **vrf-name** argument to specify the name of the VRF instance to associate with subsequent IPv4 address family configuration mode commands. |

**Step 9**  
**neighbor ip-address remote-as autonomous-system-number**  
**Example:**  
```
Router(config-router-af)# neighbor 192.168.3.2 remote-as 45000
```

Adds the IP address of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local router.

**Step 10**  
**neighbor [ip-address | peer-group-name] maximum-prefix maximum [threshold] [restart restart-interval] [warning-only]**  
**Example:**  
```
Router(config-router-af)# neighbor 192.168.3.2 maximum-prefix 10000 warning-only
```

Controls how many prefixes can be received from a neighbor.  
• Use the **maximum** argument to specify the maximum number of prefixes allowed from the specified neighbor. The number of prefixes that can be configured is limited only by the available system resources on a router.  
• Use the **threshold** argument to specify an integer representing a percentage of the maximum prefix limit at which the router starts to generate a warning message.  
• Use the **warning-only** keyword to allow the router to generate a log message when the maximum prefix limit is exceeded, instead of terminating the peering session.

**Step 11**  
**neighbor ip-address activate**  
**Example:**  
```
Router(config-router-af)# neighbor 192.168.3.2 activate
```

Enables the neighbor to exchange prefixes for the IPv4 VRF address family with the local router.

**Step 12**  
**end**  
**Example:**  
```
Router(config-router-af)# end
```

Exits address family configuration mode and enters privileged EXEC mode.
Troubleshooting Tips

Use the `ping` command to verify basic network connectivity between the BGP routers, and use the `show ip vrf` command to verify that the VRF instance has been created.

Customizing a BGP Peer

Perform this task to customize your BGP peers. Although many of the steps in this task are optional, this task demonstrates how the neighbor and address family configuration command relationships work. Using the example of the IPv4 multicast address family, neighbor address family-independent commands are configured before the IPv4 multicast address family is configured. Commands that are address family-dependent are then configured and the `exit address-family` command is shown. An optional step shows how to disable a neighbor.

The configuration in this task is done at Router B in the figure below and would need to be repeated with appropriate changes to the IP addresses, for example, at Router E to fully configure a BGP process between the two devices.

![Figure 13: BGP Peer Topology](image)

By default, neighbors that are defined using the `neighbor remote-as` command in router configuration mode exchange only IPv4 unicast address prefixes. To exchange other address prefix types, such as IPv6 prefixes, neighbors must also be activated using the `neighbor activate` command in address family configuration mode for the other prefix types, such as IPv6 prefixes.

**SUMMARY STEPS**

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. no bgp default ipv4-unicast
5. `neighbor {ip-address | peer-group-name} remote-as autonomous-system-number`
6. `neighbor {ip-address | peer-group-name} description text`
7. `address-family ipv4 [unicast | multicast | vrf vrf-name]`
8. `network network-number [mask network-mask] [route-map route-map-name]`
9. `neighbor {ip-address | peer-group-name} activate`
10. `neighbor {ip-address | peer-group-name} advertisement-interval seconds`
11. `neighbor {ip-address | peer-group-name} default-originate [route-map map-name]`
12. `exit-address-family`
13. `neighbor {ip-address | peer-group-name} shutdown`
14. `end`
15. `show ip bgp ipv4 multicast [command]`
16. `show ip bgp neighbors [neighbor-address] [received-routes | routes | advertised-routes | paths regexp | dampened-routes | received prefix-filter]`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td></td>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>router bgp autonomous-system-number</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config)# router bgp 45000</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>no bgp default ipv4-unicast</td>
<td>Disables the IPv4 unicast address family for the BGP routing process.</td>
</tr>
<tr>
<td></td>
<td>Note:</td>
<td>Routing information for the IPv4 unicast address family is advertised by default for each BGP routing session configured with the <code>neighbor remote-as</code> router configuration command unless you configure the <code>no bgp default ipv4-unicast</code> router configuration command before configuring the <code>neighbor remote-as</code> command. Existing neighbor configurations are not affected.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config-router)# no bgp default ipv4-unicast</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>neighbor {ip-address</td>
<td>peer-group-name} remote-as autonomous-system-number</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
</tbody>
</table>
### Command or Action

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| Device(config-router)# neighbor 192.168.3.2 remote-as 50000 | **Step 6** neighbor {ip-address | peer-group-name} description text  
**Example:** Device(config-router)# neighbor 192.168.3.2 description finance |
| Step 7 address-family ipv4 [unicast | multicast | vrf vrf-name] | Specifies the IPv4 address family and enters address family configuration mode.  
- The **unicast** keyword specifies the IPv4 unicast address family. By default, the device is placed in configuration mode for the IPv4 unicast address family if the **unicast** keyword is not specified with the **address-family ipv4** command.  
- The **multicast** keyword specifies IPv4 multicast address prefixes.  
- The **vrf** keyword and **vrf-name** argument specify the name of the VRF instance to associate with subsequent IPv4 address family configuration mode commands.  
**Example:** Device(config-router)# address-family ipv4 multicast |
| Step 8 network network-number [mask network-mask] [route-map route-map-name] | **Step 8** network network-number [mask network-mask] [route-map route-map-name]  
**Example:** Device(config-router-af)# network 172.17.1.0 mask 255.255.255.0 |
| Step 9 neighbor {ip-address | peer-group-name} activate | Enables the exchange of information with a BGP neighbor.  
**Example:** Device(config-router-af)# neighbor 192.168.3.2 activate |
| Step 10 neighbor {ip-address | peer-group-name} advertisement-interval seconds | (Optional) Sets the minimum interval between the sending of BGP routing updates.  
**Example:** Device(config-router-af)# neighbor 192.168.3.2 advertisement-interval 25 |
<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| 11   | `neighbor {ip-address | peer-group-name}
  default-originate [route-map map-name]` | (Optional) Permits a BGP speaker--the local device--to send the default route 0.0.0.0 to a peer for use as a default route. |
|      | Example:         |         |
|      | `Device(config-router-af)# neighbor 192.168.3.2
default-originate` |         |
| 12   | `exit-address-family` | Exits address family configuration mode and enters router configuration mode. |
|      | Example:         |         |
|      | `Device(config-router-af)# exit-address-family` |         |
| 13   | `neighbor {ip-address | peer-group-name} shutdown` | (Optional) Disables a BGP peer or peer group. |
|      | Note: If you perform this step you will not be able to run either of the subsequent `show` command steps because you have disabled the neighbor. |
|      | Example:         |         |
|      | `Device(config-router)# neighbor 192.168.3.2
shutdown` |         |
| 14   | `end` | Exits router configuration mode and enters privileged EXEC mode. |
|      | Example:         |         |
|      | `Device(config-router)# end` |         |
| 15   | `show ip bgp ipv4 multicast [command]` | (Optional) Displays IPv4 multicast database-related information. |
|      | Example:         |         |
|      | `Device# show ip bgp ipv4 multicast` |         |
| 16   | `show ip bgp neighbors [neighbor-address]
[received-routes | routes | advertised-routes | paths
regexp | dampened-routes | received prefix-filter]` | (Optional) Displays information about the TCP and BGP connections to neighbors. |
|      | Example:         |         |
|      | `Device# show ip bgp neighbors 192.168.3.2` |         |

**Examples**

The following sample output from the `show ip bgp ipv4 multicast` command shows BGP IPv4 multicast information for Router B in the figure above after this task has been configured on Router B and Router E. Note that the networks local to each device that were configured under IPv4 multicast address family appear in the output table.

```
BGP table version is 3, local router ID is 172.17.1.99
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
r RIB-failure, S Stale
```

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The following partial sample output from the `show ip bgp neighbors` command for neighbor 192.168.3.2 shows general BGP information and specific BGP IPv4 multicast address family information about the neighbor. The command was entered on Router B in the figure above after this task had been configured on Router B and Router E.

BGP neighbor is 192.168.3.2, remote AS 50000, external link
Description: finance
BGP version 4, remote router ID 10.2.2.99
BGP state = Established, up for 01:48:27
Last read 00:00:26, last write 00:00:26, hold time is 120, keepalive intervals
Configured hold time is 120,keepalive interval is 70 seconds, Minimum holdtime
Neighbor capabilities:
  Route refresh: advertised and received (old & new)
  Address family IPv4 Unicast: advertised
  Address family IPv4 Multicast: advertised and received

For address family: IPv4 Multicast
BGP table version 3, neighbor version 3/0
Output queue size : 0
Index 1, Offset 0, Mask 0x2
1 update-group member
  Uses NEXT_HOP attribute for MBGP NLRIs

Prefix activity: Sent Rcvd
  Prefixes Current: 1 1 (Consumes 48 bytes)
  Prefixes Total: 1 1
  Implicit Withdraw: 0 0
  Explicit Withdraw: 0 0
  Used as bestpath: n/a 1
  Used as multipath: n/a 0

Outbound Inbound
  Local Policy Denied Prefixes: n/a
  Bestpath from this peer: 1 n/a
  Total: 1 0

Number of NLRIs in the update sent: max 0, min 0
Minimum time between advertisement runs is 25 seconds
Connections established 8; dropped 7
Last reset 01:48:54, due to User reset
Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Local host: 192.168.3.1, Local port: 13172
Foreign host: 192.168.3.2, Foreign port: 179

Removing BGP Configuration Commands Using a Redistribution

BGP CLI configuration can become quite complex even in smaller BGP networks. If you need to remove any CLI configuration, you must consider all the implications of removing the CLI. Analyze the current running configuration to determine the current BGP neighbor relationships, any address family considerations, and even other routing protocols that are configured. Many BGP CLI commands affect other parts of the CLI configuration.

Perform this task to remove all the BGP configuration commands used in a redistribution of BGP routes into EIGRP. A route map can be used to match and set parameters or to filter the redistributed routes to ensure
that routing loops are not created when these routes are subsequently advertised by EIGRP. When removing BGP configuration commands you must remember to remove or disable all the related commands. In this example, if the `route-map` command is omitted, then the redistribution will still occur and possibly with unexpected results as the route map filtering has been removed. Omitting just the `redistribute` command would mean that the route map is not applied, but it would leave unused commands in the running configuration.

For more details on BGP CLI removal, see the “BGP CLI Removal Considerations” concept in the “Cisco BGP Overview” module.

To view the redistribution configuration before and after the CLI removal, see the “Examples: Removing BGP Configuration Commands Using a Redistribution Example” section.

**SUMMARY STEPS**

1. enable
2. configure terminal
3. no route-map map-name
4. router eigrp autonomous-system-number
5. no redistribute protocol [as-number]
6. end
7. show running-config

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| Step 1 | enable | Enables privileged EXEC mode.  
• Enter your password if prompted. |
| Example: | Device> enable |
| Step 2 | configure terminal | Enters global configuration mode. |
| Example: | Device# configure terminal |
| Step 3 | no route-map map-name | Removes a route map from the running configuration.  
• In this example, a route map named bgp-to-eigrp is removed from the configuration. |
| Example: | Device(config)# no route-map bgp-to-eigrp |
| Step 4 | router eigrp autonomous-system-number | Enters router configuration mode for the specified routing process. |
| Example: | Device(config)# router eigrp 100 |
| Step 5 | no redistribute protocol [as-number] | Disables the redistribution of routes from one routing domain into another routing domain.  
• In this example, the configuration of the redistribution of BGP routes into the EIGRP routing process is removed from the running configuration. |
<p>| Example: | Device(config-router)# no redistribute bgp 45000 |</p>
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>end</td>
<td>Exits router configuration mode and enters privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>(Optional) Displays the current running configuration on the router.</td>
</tr>
<tr>
<td>Example: Device(config-router)# end</td>
<td></td>
</tr>
<tr>
<td>Step 6</td>
<td></td>
</tr>
<tr>
<td>Step 7</td>
<td></td>
</tr>
</tbody>
</table>

### Monitoring and Maintaining Basic BGP

The tasks in this section are concerned with the resetting and display of information about basic BGP processes and peer relationships. Once you have defined two routers to be BGP neighbors, they will form a BGP connection and exchange routing information. If you subsequently change a BGP filter, weight, distance, version, or timer, or make a similar configuration change, you may have to reset BGP connections for the configuration change to take effect.

### Configuring Inbound Soft Reconfiguration When Route Refresh Capability Is Missing

Perform this task to configure inbound soft reconfiguration using the `bgp soft-reconfig-backup` command for BGP peers that do not support the route refresh capability. BGP peers that support the route refresh capability are unaffected by the configuration of this command. Note that the memory requirements for storing the inbound update information can become quite large.

### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `bgp log-neighbor-changes`
5. `bgp soft-reconfig-backup`
6. `neighbor {ip-address | peer-group-name} remote-as autonomous-system-number`
7. `neighbor {ip-address | peer-group-name} soft-reconfiguration [inbound]`
8. `neighbor {ip-address | peer-group-name} route-map map-name {in | out}`
9. Repeat Steps 6 through 8 for every peer that is to be configured with inbound soft reconfiguration.
10. `exit`
11. `route-map map-name [permit | deny] [sequence-number]`
12. `set ip next-hop ip-address`
13. `end`
14. `show ip bgp neighbors [neighbor-address]`
15. `show ip bgp [network] [network-mask]`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example: Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td>Example: Device(config)# router bgp 45000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> bgp log-neighbor-changes</td>
<td>Enables logging of BGP neighbor resets.</td>
</tr>
<tr>
<td>Example: Device(config-router)# bgp log-neighbor-changes</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> bgp soft-reconfig-backup</td>
<td>Configures a BGP speaker to perform inbound soft reconfiguration for peers that do not support the route refresh capability.</td>
</tr>
<tr>
<td>Example: Device(config-router)# bgp soft-reconfig-backup</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> neighbor {ip-address</td>
<td>peer-group-name} remote-as autonomous-system-number</td>
</tr>
<tr>
<td>Example: Device(config-router)# neighbor 192.168.1.2 remote-as 40000</td>
<td></td>
</tr>
</tbody>
</table>

*This command is used to configure BGP to perform inbound soft reconfiguration for peers that do not support the route refresh capability. The configuration of this command allows you to configure BGP to store updates (soft reconfiguration) only as necessary. Peers that support the route refresh capability are unaffected by the configuration of this command.*
### Configuring Inbound Soft Reconfiguration When Route Refresh Capability Is Missing

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 7** neighbor {ip-address | peer-group-name} soft-reconfiguration [inbound] | Configures the Cisco software to start storing updates.  
- All the updates received from this neighbor will be stored unmodified, regardless of the inbound policy. When inbound soft reconfiguration is done later, the stored information will be used to generate a new set of inbound updates. |
| **Example:** Device(config-router)# neighbor 192.168.1.2 soft-reconfiguration inbound | |

| Step 8 | neighbor {ip-address | peer-group-name} route-map map-name {in | out} | Applies a route map to incoming or outgoing routes.  
- In this example, the route map named LOCAL will be applied to incoming routes. |
| **Example:** Device(config-router)# neighbor 192.168.1.2 route-map LOCAL in | |

| Step 9 | Repeat Steps 6 through 8 for every peer that is to be configured with inbound soft reconfiguration. |

| Step 10 | exit | Exits router configuration mode and enters global configuration mode. |
| **Example:** Device(config-router)# exit | |

| Step 11 | route-map map-name [permit | deny] [sequence-number] | Configures a route map and enters route-map configuration mode.  
- In this example, a route map named LOCAL is created. |
| **Example:** Device(config)# route-map LOCAL permit 10 | |

| Step 12 | set ip next-hop ip-address | Specifies where output packets that pass a match clause of a route map for policy routing.  
- In this example, the ip address is set to 192.168.1.144. |
| **Example:** Device(config-route-map)# set ip next-hop 192.168.1.144 | |

| Step 13 | end | Exits route-map configuration mode and enters privileged EXEC mode. |
| **Example:** Device(config-route-map)# end | |

| Step 14 | show ip bgp neighbors [neighbor-address] | (Optional) Displays information about the TCP and BGP connections to neighbors. |
| **Note** Only the syntax applicable to this task is used in this example. For more details, see the Cisco IOS IP Routing: BGP Command Reference. |
| **Example:** Device# show ip bgp neighbors 192.168.1.2 | |

| Step 15 | show ip bgp [network] [network-mask] | (Optional) Displays the entries in the BGP routing table. |
| **Example:** | |
### Resetting and Displaying Basic BGP Information

Perform this task to reset and display information about basic BGP processes and peer relationships.

#### SUMMARY STEPS

1. `enable`
2. `clear ip bgp {* | autonomous-system-number | neighbor-address} [soft [in | out]]`
3. `show ip bgp [network-address] [network-mask] [longer-prefixes] [prefix-list prefix-list-name | route-map route-map-name] [shorter prefixes mask-length]`
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> clear ip bgp {*</td>
<td>autonomous-system-number</td>
</tr>
<tr>
<td>Example:</td>
<td>• In the example provided, all BGP neighbor sessions are cleared and reset.</td>
</tr>
<tr>
<td>Device# clear ip bgp *</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> show ip bgp [network-address] [network-mask] [longer-prefixes] [prefix-list prefix-list-name</td>
<td>route-map route-map-name] [shorter prefixes mask-length]</td>
</tr>
<tr>
<td>Example:</td>
<td>• In the example provided, the BGP routing table information for the 10.1.1.0 network is displayed.</td>
</tr>
<tr>
<td>Device# show ip bgp 10.1.1.0 255.255.255.0</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> show ip bgp neighbors [neighbor-address] [received-routes</td>
<td>routes</td>
</tr>
<tr>
<td>Example:</td>
<td>• In the example provided, the routes advertised from the device to BGP neighbor 192.168.3.2 on another device are displayed.</td>
</tr>
<tr>
<td>Device# show ip bgp neighbors 192.168.3.2 advertised-routes</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> show ip bgp paths</td>
<td>Displays information about all the BGP paths in the database.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device# show ip bgp paths</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> show ip bgp summary</td>
<td>Displays information about the status of all BGP connections.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device# show ip bgp summary</td>
<td></td>
</tr>
</tbody>
</table>
Aggregating Route Prefixes Using BGP

BGP peers exchange information about local networks, but this can quickly lead to large BGP routing tables. CIDR enables the creation of aggregate routes (or supernets) to minimize the size of routing tables. Smaller BGP routing tables can reduce the convergence time of the network and improve network performance. Aggregated routes can be configured and advertised using BGP. Some aggregations advertise only summary routes and other methods of aggregating routes allow more specific routes to be forwarded. Aggregation applies only to routes that exist in the BGP routing table. An aggregated route is forwarded if at least one more specific route of the aggregation exists in the BGP routing table. Perform one of the following tasks to aggregate routes within BGP:

Redistributing a Static Aggregate Route into BGP

Use this task to redistribute a static aggregate route into BGP. A static aggregate route is configured and then redistributed into the BGP routing table. The static route must be configured to point to interface null 0 and the prefix should be a superset of known BGP routes. When a device receives a BGP packet, it will use the more specific BGP routes. If the route is not found in the BGP routing table, then the packet will be forwarded to null 0 and discarded.

SUMMARY STEPS

1. enable
2. configure terminal
3. ip route prefix mask {ip-address | interface-type interface-number [ip-address]} [distance] [name] [permanent | track number] [tag tag]
4. router bgp autonomous-system-number
5. redistribute static
6. end

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td>Step 2 configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td>Step 3 ip route prefix mask {ip-address</td>
<td>interface-type interface-number [ip-address]} [distance] [name] [permanent</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config)# ip route 172.0.0.0 255.0.0.0 null 0</td>
<td></td>
</tr>
</tbody>
</table>
### Configuring Conditional Aggregate Routes Using BGP

Use this task to create an aggregate route entry in the BGP routing table when at least one specific route falls into the specified range. The aggregate route is advertised as originating from your autonomous system. For more information, see the “BGP Route Aggregation Generating AS_SET Information” section.

### SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. aggregate-address address mask [as-set]
5. end

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td>Step 2 configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example: Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td>Step 3 router bgp autonomous-system-number</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td>Example: Device(config)# router bgp 45000</td>
<td></td>
</tr>
</tbody>
</table>
### Purpose

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 4 aggregate-address address mask [as-set]</td>
<td>Creates an aggregate entry in a BGP routing table.</td>
</tr>
</tbody>
</table>
| Example: Device(config-router)# aggregate-address 172.0.0.0 255.0.0.0 as-set | • A specified route must exist in the BGP table.  
• Use the **aggregate-address** command with no keywords to create an aggregate entry if any more-specific BGP routes are available that fall in the specified range.  
• Use the **as-set** keyword to specify that the path advertised for this route is an AS_SET. Do not use the **as-set** keyword when aggregating many paths because this route is withdrawn and updated every time the reachability information for the aggregated route changes. |
| Note Only partial syntax is used in this example. For more details, see the *Cisco IOS IP Routing: BGP Command Reference*. |
| Step 5 end | Exits router configuration mode and enters privileged EXEC mode. |
| Example: Device(config-router)# end |

### Suppressing and Unsuppressing the Advertisement of Aggregated Routes Using BGP

Use this task to create an aggregate route, suppress the advertisement of routes using BGP, and subsequently unsuppress the advertisement of routes. Routes that are suppressed are not advertised to any neighbors, but it is possible to unsuppress routes that were previously suppressed to specific neighbors.

### SUMMARY STEPS

1. enable  
2. configure terminal  
3. router bgp autonomous-system-number  
4. neighbor ip-address remote-as autonomous-system-number  
5. Do one of the following:  
   - aggregate-address address mask [summary-only]  
   - aggregate-address address mask [suppress-map map-name]  
6. neighbor {ip-address | peer-group-name} unsuppress-map map-name  
7. end

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
</tbody>
</table>
### Command or Action

<table>
<thead>
<tr>
<th>Step 2</th>
<th><strong>Example:</strong></th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Device&gt; enable</strong></td>
<td>• Enters global configuration mode.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 3</th>
<th><strong>Example:</strong></th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Device# configure terminal</strong></td>
<td></td>
<td>Enters global configuration mode.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 4</th>
<th><strong>Example:</strong></th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Device(config)# router bgp 45000</strong></td>
<td></td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 5</th>
<th><strong>Example:</strong></th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Device(config-router)# neighbor 192.168.1.2 remote-as 40000</strong></td>
<td></td>
<td>Adds the IP address of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local device.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 6</th>
<th><strong>Example:</strong></th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Device(config-router)# aggregate-address 172.0.0.0 255.0.0.0 summary-only</strong></td>
<td>• Use the optional <strong>summary-only</strong> keyword to create the aggregate route (for example, 10.<em>.</em>.*) and also suppresses advertisements of more-specific routes to all neighbors.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 7</th>
<th><strong>Example:</strong></th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Device(config-router)# neighbor 192.168.1.2 unsuppress-map map1</strong></td>
<td>(Optional) Selectively advertises routes previously suppressed by the <strong>aggregate-address</strong> command.</td>
<td></td>
</tr>
</tbody>
</table>

#### Note
Only partial syntax is used in this example. For more details, see the *Cisco IOS IP Routing: BGP Command Reference*.
### Suppressing Inactive Route Advertisement Using BGP

Perform this task to suppress the advertisement of inactive routes by BGP. In Cisco IOS Release 12.2(25)S, 12.2(33)SXH, and 15.0(1)M, the `bgp suppress-inactive` command was introduced to configure BGP to not advertise inactive routes to any BGP peer. A BGP routing process can advertise routes that are not installed in the RIB to BGP peers by default. A route that is not installed into the RIB is an inactive route. Inactive route advertisement can occur, for example, when routes are advertised through common route aggregation.

Inactive route advertisements can be suppressed to provide more consistent data forwarding. This feature can be configured on a per IPv4 address family basis. For example, when specifying the maximum number of routes that can be configured in a VRF with the `maximum routes` global configuration command, you also suppress inactive route advertisement to prevent inactive routes from being accepted into the VRF after route limit has been exceeded.

### Before you begin

This task assumes that BGP is enabled and that peering has been established.

---

**Note**

Inactive route suppression can be configured only under the IPv4 address family or under a default IPv4 general session.

### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `router bgp as-number`
4. `address-family {ipv4 [ndt | multicast | unicast [vrf vrf-name] | vrf vrf-name] | vpnv4 [unicast]}`
5. `bgp suppress-inactive`
6. `end`
7. `show ip bgp rib-failure`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1**
- `enable`  
  Example:  
  `Router> enable` | Enables privileged EXEC mode.  
  - Enter your password if prompted. |
| **Step 2**
- `configure terminal`  
  Example: | Enters global configuration mode. |
### Command or Action

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Command or Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enters router configuration mode and creates a BGP routing process.</td>
<td><strong>Step 3</strong> <code>router bgp as-number</code> &lt;br&gt; Example: &lt;br&gt; <code>Router(config)# router bgp 45000</code></td>
</tr>
</tbody>
</table>
| Enter address family configuration mode to configure BGP peers to accept address family specific configurations.  
  - The example creates an IPv4 unicast address family session. | **Step 4** `address-family {ipv4 [mdt | multicast | unicast [vrf vrf-name] | vrf vrf-name] | vpnv4 [unicast]}` <br> Example: <br> `Router(config-router)# address-family ipv4 unicast` |
| Suppresses BGP advertising of inactive routes.  
  - BGP advertises inactive routes by default.  
  - Entering the `no` form of this command reenables the advertisement of inactive routes. | **Step 5** `bgp suppress-inactive` <br> Example: <br> `Router(config-router-af)# bgp suppress-inactive` |
| Exits address family configuration mode and enters privileged EXEC mode. | **Step 6** `end` <br> Example: <br> `Router(config-router-af)# end` |
| (Optional) Displays BGP routes that are not installed in the RIB. | **Step 7** `show ip bgp rib-failure` <br> Example: <br> `Router# show ip bgp rib-failure` |

### Examples

The following example shows output from the `show ip bgp rib-failure` command displaying routes that are not installed in the RIB. The output shows that the displayed routes were not installed because a route or routes with a better administrative distance already exist in the RIB.

```
Router# show ip bgp rib-failure

<table>
<thead>
<tr>
<th>Network</th>
<th>Next Hop</th>
<th>RIB-failure</th>
<th>RIB-NH Matches</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1.15.0/24</td>
<td>10.1.35.5</td>
<td>Higher admin distance</td>
<td>n/a</td>
</tr>
<tr>
<td>10.1.16.0/24</td>
<td>10.1.15.1</td>
<td>Higher admin distance</td>
<td>n/a</td>
</tr>
</tbody>
</table>
```

### Conditionally Advertising BGP Routes

Perform this task to conditionally advertise selected BGP routes. The routes or prefixes that will be conditionally advertised are defined in two route maps: an advertise map and either an exist map or nonexist map. The route map associated with the exist map or nonexist map specifies the prefix that the BGP speaker will track. The
route map associated with the advertise map specifies the prefix that will be advertised to the specified neighbor when the condition is met.

- If a prefix is found to be present in the exist map by the BGP speaker, the prefix specified by the advertise map is advertised.
- If a prefix is found not to be present in the nonexist map by the BGP speaker, the prefix specified by the advertise map is advertised.

If the condition is not met, the route is withdrawn and conditional advertisement does not occur. All routes that may be dynamically advertised or not advertised must exist in the BGP routing table in order for conditional advertisement to occur. These routes are referenced from an access list or an IP prefix list.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `neighbor {ip-address | peer-group-name} remote-as autonomous-system-number`
5. `neighbor ip-address advertise-map map-name {exist-map map-name | non-exist-map map-name}`
6. `exit`
7. `route-map map-tag [permit | deny] [sequence-number]`
8. `match ip address {access-list-number [access-list-number... | access-list-name... | access-list-name] | prefix-list prefix-list-name [prefix-list-name...]}`
9. `exit`
10. `route-map map-tag [permit | deny] [sequence-number]`
11. `match ip address {access-list-number [access-list-number... | access-list-name... | access-list-name] | prefix-list prefix-list-name [prefix-list-name...]}`
12. `exit`
13. `access-list access-list-number {deny | permit} source [source-wildcard] [log]`
14. `access-list access-list-number {deny | permit} source [source-wildcard] [log]`
15. `exit`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><code>enable</code></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><code>Example:</code></td>
<td></td>
</tr>
<tr>
<td><code>Device&gt; enable</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><code>configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><code>Example:</code></td>
<td></td>
</tr>
<tr>
<td><code>Device# configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td><code>router bgp autonomous-system-number</code></td>
<td></td>
</tr>
<tr>
<td><code>Example:</code></td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Device(config)# router bgp 45000</td>
<td>Adds the IP address of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local device.</td>
</tr>
<tr>
<td><strong>Step 4</strong> neighbor {ip-address</td>
<td>peer-group-name} remote-as autonomous-system-number</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router)# neighbor 192.168.1.2 remote-as 40000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> neighbor ip-address advertise-map map-name {exist-map map-name</td>
<td>non-exist-map map-name}</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router)# neighbor 192.168.1.2 advertise-map map1 exist-map map2</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> exit</td>
<td>Exits router configuration mode and enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router)# exit</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong> route-map map-tag [permit</td>
<td>deny] [sequence-number]</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# route-map map1 permit 10</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong> match ip address {access-list-number [access-list-number...</td>
<td>access-list-name [access-list-number...</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-route-map)# match ip address 1</td>
<td></td>
</tr>
<tr>
<td><strong>Step 9</strong> exit</td>
<td>Exits route map configuration mode and enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-route-map)# exit</td>
<td></td>
</tr>
<tr>
<td><strong>Step 10</strong> route-map map-tag [permit</td>
<td>deny] [sequence-number]</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# route-map map2 permit 10</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router)# match ip address 1</td>
<td></td>
</tr>
</tbody>
</table>
### Command or Action

| Step 11 | match ip address {access-list-number [access-list-number... | access-list-name...] | access-list-name [access-list-number... | access-list-name] | prefix-list prefix-list-name [prefix-list-name...]}  
|---------|-------------------------------------------------------------------------|
| **Example:** | Device(config-route-map)# match ip address 2  
| **Purpose:** | Configures the route map to match a prefix that is permitted by a standard access list, an extended access list, or a prefix list.  
  - In this example, the route map is configured to match a prefix permitted by access list 2.  
| Step 12 | exit  
| **Example:** | Device(config-route-map)# exit  
| **Purpose:** | Exits route map configuration mode and enters global configuration mode.  
| Step 13 | access-list access-list-number {deny | permit} source [source-wildcard] [log]  
| **Example:** | Device(config)# access-list 1 permit 172.17.0.0  
| **Purpose:** | Configures a standard access list.  
  - In this example, access list 1 permits advertising of the 172.17.0.0 prefix, depending on other conditions set by the neighbor advertise-map command.  
| Step 14 | access-list access-list-number {deny | permit} source [source-wildcard] [log]  
| **Example:** | Device(config)# access-list 2 permit 192.168.50.0  
| **Purpose:** | Configures a standard access list.  
  - In this example, access list 2 permits the 192.168.50.0 to be the prefix of the exist-map.  
| Step 15 | exit  
| **Example:** | Device(config)# exit  
| **Purpose:** | Exits global configuration mode and returns to privileged EXEC mode.  

### Originating BGP Routes

Route aggregation is useful to minimize the size of the BGP table, but there are situations when you want to add more specific prefixes to the BGP table. Route aggregation can hide more specific routes. Using the `network` command as shown in the “Configuring a BGP Routing Process” section originates routes, and the following optional tasks originate BGP routes for the BGP table for different situations.

### Advertising a Default Route Using BGP

Perform this task to advertise a default route to BGP peers. The default route is locally originated. A default route can be useful to simplify configuration or to prevent the device from using too many system resources. If the device is peered with an Internet service provider (ISP), the ISP will carry full routing tables, so configuring a default route into the ISP network saves resources at the local device.

### SUMMARY STEPS

1. `enable`
2. configure terminal
3. ip prefix-list list-name [seq seq-value] {deny network / length | permit network / length} [ge ge-value] [le le-value]
4. route-map map-tag [permit | deny] [sequence-number]
5. match ip address {access-list-number [access-list-number... | access-list-name...] | access-list-name [access-list-number... | access-list-name... | prefix-list prefix-list-name [prefix-list-name...]}
6. exit
7. router bgp autonomous-system-number
8. neighbor {ip-address | peer-group-name} default-originate [route-map map-name]
9. end

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** enable | Enables privileged EXEC mode.  
  Example:  
  Device> enable |
| **Step 2** configure terminal | Enters global configuration mode.  
  Example:  
  Device# configure terminal |
| **Step 3** ip prefix-list list-name [seq seq-value] {deny network / length | permit network / length} [ge ge-value] [le le-value] | Configures an IP prefix list.  
  Example:  
  Device(config)# ip prefix-list DEFAULT permit 10.1.1.0/24 |
| **Step 4** route-map map-tag [permit | deny] [sequence-number] | Configures a route map and enters route map configuration mode.  
  Example:  
  Device(config)# route-map ROUTE |
| **Step 5** match ip address {access-list-number [access-list-number... | access-list-name...] | access-list-name [access-list-number... | access-list-name...] | prefix-list prefix-list-name [prefix-list-name...]} | Configures the route map to match a prefix that is permitted by a standard access list, an extended access list, or a prefix list.  
  Example:  
  Device(config-route-map)# match ip address prefix-list DEFAULT |
| **Step 6** exit | Exits route map configuration mode and enters global configuration mode.  
  Example:  
  Device(config)# exit |
**Command or Action**

<table>
<thead>
<tr>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device(config-route-map)# exit</td>
</tr>
</tbody>
</table>

**Step 7**

**Purpose:** Enters router configuration mode for the specified routing process.

**Command or Action**

<table>
<thead>
<tr>
<th>router bgp autonomous-system-number</th>
</tr>
</thead>
</table>

**Example:**

Device(config)# router bgp 40000

**Step 8**

**Purpose:** (Optional) Permits a BGP speaker--the local device--to send the default route 0.0.0.0 to a peer for use as a default route.

**Command or Action**

| neighbor {ip-address|peer-group-name} default-originate [route-map map-name] |

**Example:**

Device(config-router)# neighbor 192.168.3.2 default-originate

**Step 9**

**Purpose:** Exits router configuration mode and enters privileged EXEC mode.

**Command or Action**

| end |

**Example:**

Device(config-router)# end

**Troubleshooting Tips**

Use the `show ip route` command on the receiving BGP peer (not on the local router) to verify that the default route has been set. In the output, verify that a line similar to the following showing the default route 0.0.0.0 is present:

```
B* 0.0.0.0/0 [20/0] via 192.168.1.2, 00:03:10
```

**Conditionally Injecting BGP Routes**

Use this task to inject more specific prefixes into a BGP routing table over less specific prefixes that were selected through normal route aggregation. These more specific prefixes can be used to provide a finer granularity of traffic engineering or administrative control than is possible with aggregated routes. For more information, see the “Conditional BGP Route Injection” section.

**Before you begin**

This task assumes that the IGP is already configured for the BGP peers.

**SUMMARY STEPS**

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. bgp inject-map inject-map-name exist-map exist-map-name [copy-attributes]
5. exit
6. route-map map-tag [permit | deny] [sequence-number]
7. match ip address {access-list-number [access-list-number... | access-list-name...] | access-list-name [access-list-number... | access-list-name] | prefix-list prefix-list-name [prefix-list-name...]}

---

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8. match ip route-source \{access-list-number | access-list-name\} [access-list-number...]
   access-list-name...\]

9. exit

10. route-map map-tag [permit | deny] [sequence-number]

11. set ip address \{access-list-number [access-list-number... | access-list-name...]
    access-list-name [prefix-list prefix-list-name [prefix-list-name...]]\}

12. set community \{community-number [additive] [well-known-community] | none\}

13. exit

14. ip prefix-list list-name [seq seq-value] \{deny network length | permit network length [ge ge-value]
    [le le-value]\]

15. Repeat Step 14 for every prefix list to be created.

16. exit

17. show ip bgp injected-paths

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Router&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example: Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td>Example: Router(config)# router bgp 40000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> bgp inject-map inject-map-name exist-map exist-map-name [copy-attributes]</td>
<td>Specifies the inject map and the exist map for conditional route injection.</td>
</tr>
<tr>
<td>Example: Router(config-router)# bgp inject-map ORIGINATE exist-map LEARNED_PATH</td>
<td>• Use the copy-attributes keyword to specify that the injected route inherit the attributes of the aggregate route.</td>
</tr>
<tr>
<td><strong>Step 5</strong> exit</td>
<td>Exits router configuration mode and enters global configuration mode.</td>
</tr>
<tr>
<td>Example: Router(config-router)# exit</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> route-map map-tag [permit</td>
<td>deny] [sequence-number]</td>
</tr>
<tr>
<td>Example: Router(config)# route-map LEARNED_PATH permit 10</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>------------------</td>
<td>---------</td>
</tr>
</tbody>
</table>
| **Step 7** | **match ip address** `{access-list-number \[access-list-number... \| access-list-name...\]|access-list-name [access-list-number... \| access-list-name]|prefix-list prefix-list-name [prefix-list-list-name...]}`<br><br>Example: <br>Router(config-route-map)# match ip address prefix-list SOURCE | Specifies the aggregate route to which a more specific route will be injected.  
- In this example, the prefix list named SOURCE is used to redistribute the source of the route. |
| **Step 8** | **match ip route-source** `{access-list-number \| access-list-name} [access-list-number...]|access-list-name...`<br><br>Example: <br>Router(config-route-map)# match ip route-source prefix-list ROUTE_SOURCE | Specifies the match conditions for redistributing the source of the route.  
- In this example, the prefix list named ROUTE_SOURCE is used to redistribute the source of the route. |
| **Step 9** | `exit`<br><br>Example: <br>Router(config-route-map)# exit | Exits route map configuration mode and enters global configuration mode. |
| **Step 10** | `route-map map-tag [permit | deny] [sequence-number]`<br><br>Example: <br>Router(config)# route-map ORIGINATE permit 10 | Configures a route map and enters route map configuration mode. |
| **Step 11** | `set ip address` `{access-list-number \| access-list-name ... | access-list-name | prefix-list prefix-list-name [prefix-list-list-name...]}`<br><br>Example: <br>Router(config-route-map)# set ip address prefix-list ORIGINATED_ROUTES | Specifies the routes to be injected.  
- In this example, the prefix list named originated_routes is used to redistribute the source of the route. |
| **Step 12** | `set community` `{community-number \[additive]\ | well-known-community] | none}`<br><br>Example: <br>Router(config-route-map)# set community 14616:555 additive | Sets the BGP community attribute of the injected route. |
### Command or Action

| Step 13 | exit |
| Example: | Router(config-route-map)# exit |

**Purpose**
Exits route map configuration mode and enters global configuration mode.

| Step 14 | ip prefix-list  list-name  [seq seq-value]  [deny networklength]  [permit networklength]  [ge ge-value]  [le le-value] |
| Example: | Router(config)# ip prefix-list SOURCE permit 10.1.1.0/24 |

**Purpose**
Configures a prefix list.
- In this example, the prefix list named SOURCE is configured to permit routes from network 10.1.1.0/24.

| Step 15 | Repeat Step 14 for every prefix list to be created. |
| Step 16 | exit |
| Example: | Router(config)# exit |

**Purpose**
Exits global configuration mode and returns to privileged EXEC mode.

| Step 17 | show ip bgp injected-paths |
| Example: | Router# show ip bgp injected-paths |

**Purpose**
(Optional) Displays information about injected paths.

### Examples
The following sample output is similar to the output that will be displayed when the `show ip bgp injected-paths` command is entered:

```
Router# show ip bgp injected-paths
BGP table version is 11, local router ID is 10.0.0.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal
Origin codes: i - IGP, e - EGP, ? - incomplete
Network Next Hop Metric LocPrf Weight Path
*> 172.16.0.0 10.0.0.2 0 ?
*> 172.17.0.0/16 10.0.0.2 0 ?
```

### Troubleshooting Tips
BGP conditional route injection is based on the injection of a more specific prefix into the BGP routing table when a less specific prefix is present. If conditional route injection is not working properly, verify the following:

- If conditional route injection is configured but does not occur, verify the existence of the aggregate prefix in the BGP routing table. The existence (or not) of the tracked prefix in the BGP routing table can be verified with the `show ip bgp` command.
• If the aggregate prefix exists but conditional route injection does not occur, verify that the aggregate prefix is being received from the correct neighbor and the prefix list identifying that neighbor is a /32 match.

• Verify the injection (or not) of the more specific prefix using the show ip bgp injected-paths command.

• Verify that the prefix that is being injected is not outside of the scope of the aggregate prefix.

• Ensure that the inject route map is configured with the set ip address command and not the match ip address command.

### Originating BGP Routes Using Backdoor Routes

Use this task to indicate to border devices which networks are reachable using a backdoor route. A backdoor network is treated the same as a local network, except that it is not advertised. For more information, see the BGP Backdoor Routes section.

**Before you begin**

This task assumes that the IGP (EIGRP, in this example) is already configured for the BGP peers. The configuration is done at Router B in the in the “BGP Backdoor Routes” section, and the BGP peer is Router D.

### SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. neighbor ip-address remote-as autonomous-system-number
5. network ip-address backdoor
6. end

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example: Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td>Example: Device(config)# router bgp 45000</td>
<td></td>
</tr>
</tbody>
</table>
## Configuring a BGP Peer Group

This task explains how to configure a BGP peer group. Often, in a BGP speaker, many neighbors are configured with the same update policies (that is, the same outbound route maps, distribute lists, filter lists, update source, and so on). Neighbors with the same update policies can be grouped into peer groups to simplify configuration and, more importantly, to make updating more efficient. When you have many peers, this approach is highly recommended.

The three steps to configure a BGP peer group, described in the following task, are as follows:

- Creating the peer group
- Assigning options to the peer group
- Making neighbors members of the peer group

You can disable a BGP peer or peer group without removing all the configuration information using the `neighbor shutdown` router configuration command.

### Note

By default, neighbors that are defined using the `neighbor remote-as` command in router configuration mode exchange only IPv4 unicast address prefixes. To exchange other address prefix types, such as IPv6 prefixes, neighbors must also be activated using the `neighbor activate` command in address family configuration mode for the other prefix types.

### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `neighbor peer-group-name peer-group`

5. `neighbor ip-address remote-as autonomous-system-number`

6. `neighbor ip-address peer-group peer-group-name`

7. `address-family ipv4 [unicast | multicast | vrf vrf-name]`

8. `neighbor peer-group-name activate`

9. `neighbor ip-address peer-group peer-group-name`

10. `end`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> <code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> <code>configure terminal</code></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> <code>router bgp autonomous-system-number</code></td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# router bgp 40000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> <code>neighbor peer-group-name peer-group</code></td>
<td>Creates a BGP peer group.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router)# neighbor fingroup peer-group</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> <code>neighbor ip-address remote-as autonomous-system-number</code></td>
<td>Adds the IP address of the neighbor in the specified autonomous system to the multiprotocol BGP neighbor table of the local device.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router)# neighbor 192.168.1.1 remote-as 45000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> <code>neighbor ip-address peer-group peer-group-name</code></td>
<td>Assigns the IP address of a BGP neighbor to a peer group.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router)# neighbor 192.168.1.1 peer-group fingroup</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong> `address-family ipv4 [unicast</td>
<td>multicast</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
</tbody>
</table>
### Purpose

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| `Device(config-router)# address-family ipv4 multicast` | - The **unicast** keyword specifies the IPv4 unicast address family. This is the default.  
  - The **multicast** keyword specifies that IPv4 multicast address prefixes will be exchanged.  
  - The `vrf` keyword and `vrf-name` argument specify that IPv4 VRF instance information will be exchanged. |

#### Step 8

**neighbor peer-group-name activate**

**Example:**

```bash
Device(config-router-af)# neighbor fingroup activate
```

- Enables the neighbor to exchange prefixes for the IPv4 address family with the local device.
  - By default, neighbors that are defined using the `neighbor remote-as` command in router configuration mode exchange only unicast address prefixes. To allow BGP to exchange other address prefix types, such as multicast that is configured in this example, neighbors must also be activated using the `neighbor activate` command.

#### Step 9

**neighbor ip-address peer-group peer-group-name**

**Example:**

```bash
Device(config-router-af)# neighbor 192.168.1.1 peer-group fingroup
```

- Assigns the IP address of a BGP neighbor to a peer group.

#### Step 10

**end**

**Example:**

```bash
Device(config-router-af)# end
```

- Exits address family configuration mode and returns to privileged EXEC mode.

---

### Configuring Peer Session Templates

The following tasks create and configure a peer session template:

#### Configuring a Basic Peer Session Template

Perform this task to create a basic peer session template with general BGP routing session commands that can be applied to many neighbors using one of the next two tasks.

**Note**

The commands in Step 5 and 6 are optional and could be replaced with any supported general session commands.
The following restrictions apply to the peer session templates:

- A peer session template can directly inherit only one session template, and each inherited session template can also contain one indirectly inherited session template. So, a neighbor or neighbor group can be configured with only one directly applied peer session template and seven additional indirectly inherited peer session templates.
- A BGP neighbor cannot be configured to work with both peer groups and peer templates. A BGP neighbor can be configured to belong only to a peer group or to inherit policies only from peer templates.

### SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. template peer-session session-template-name
5. remote-as autonomous-system-number
6. timers keepalive-interval hold-time
7. end
8. show ip bgp template peer-session [session-template-name]

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Router&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Step 2</td>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td>router bgp autonomous-system-number</td>
<td>Enters router configuration mode and creates a BGP routing process.</td>
</tr>
<tr>
<td>Example:</td>
<td>Router(config)# router bgp 101</td>
<td></td>
</tr>
<tr>
<td>Step 4</td>
<td>template peer-session session-template-name</td>
<td>Enters session-template configuration mode and creates a peer session template.</td>
</tr>
<tr>
<td>Example:</td>
<td>Router(config-router)# template peer-session INTERNAL-BGP</td>
<td></td>
</tr>
<tr>
<td>Step 5</td>
<td>remote-as autonomous-system-number</td>
<td>(Optional) Configures peering with a remote neighbor in the specified autonomous system.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Command or Action

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Command or Action</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Router(config-router-stmp)# remote-as 202</td>
</tr>
<tr>
<td>Note</td>
<td>Any supported general session command can be used here. For a list of the supported commands, see the “Restrictions” section.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 6</th>
<th>timers keepalive-interval hold-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example</td>
<td>Router(config-router-stmp)# timers 30 300</td>
</tr>
<tr>
<td>Note</td>
<td>(Optional) Configures BGP keepalive and hold timers.</td>
</tr>
<tr>
<td></td>
<td>• The hold time must be at least twice the keepalive time.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 7</th>
<th>end</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example</td>
<td>Router(config-router)# end</td>
</tr>
<tr>
<td>Note</td>
<td>Exits session-template configuration mode and returns to privileged EXEC mode.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 8</th>
<th>show ip bgp template peer-session [session-template-name]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example</td>
<td>Router# show ip bgp template peer-session</td>
</tr>
<tr>
<td>Note</td>
<td>Displays locally configured peer session templates.</td>
</tr>
<tr>
<td></td>
<td>• The output can be filtered to display a single peer policy template with the session-template-name argument. This command also supports all standard output modifiers.</td>
</tr>
</tbody>
</table>

### What to Do Next

After the peer session template is created, the configuration of the peer session template can be inherited or applied by another peer session template with the `inherit peer-session` or `neighbor inherit peer-session` command.

#### Configuring Peer Session Template Inheritance with the inherit peer-session Command

This task configures peer session template inheritance with the `inherit peer-session` command. It creates and configures a peer session template and allows it to inherit a configuration from another peer session template.

#### Note

The commands in Steps 5 and 6 are optional and could be replaced with any supported general session commands.

### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `template peer-session session-template-name`
5. `description text-string`
6. `update-source interface-type interface-number`
7. `inherit peer-session session-template-name`
8. end
9. `show ip bgp template peer-session [session-template-name]`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>Router&gt; enable</code></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>Router# configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode and creates a BGP routing process.</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>Router(config)# router bgp 101</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> template peer-session session-template-name</td>
<td>Enter session-template configuration mode and creates a peer session template.</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>Router(config-router)# template peer-session CORE1</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> description text-string</td>
<td>(Optional) Configures a description.</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>Router(config-router-stmp)# description CORE-123</code></td>
<td>• The text string can be up to 80 characters.</td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td>Any supported general session command can be used here. For a list of the supported commands, see the “Restrictions” section.</td>
</tr>
<tr>
<td><strong>Step 6</strong> update-source interface-type interface-number</td>
<td>(Optional) Configures a router to select a specific source or interface to receive routing table updates.</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>Router(config-router-stmp)# update-source loopback 1</code></td>
<td>• The example uses a loopback interface. The advantage to this configuration is that the loopback interface is not as susceptible to the effects of a flapping interface.</td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td>Any supported general session command can be used here. For a list of the supported commands, see the “Restrictions” section.</td>
</tr>
<tr>
<td><strong>Step 7</strong> inherit peer-session session-template-name</td>
<td>Configures this peer session template to inherit the configuration of another peer session template.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>• The example configures this peer session template to inherit the configuration from INTERNAL-BGP. This</td>
</tr>
</tbody>
</table>
Configuring Peer Session Template Inheritance with the neighbor inherit peer-session Command

This task configures a router to send a peer session template to a neighbor to inherit the configuration from the specified peer session template with the neighbor inherit peer-session command. Use the following steps to send a peer session template configuration to a neighbor to inherit.

SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. neighbor ip-address remote-as autonomous-system-number
5. neighbor ip-address inherit peer-session session-template-name
6. end
7. show ip bgp template peer-session [session-template-name]

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
</tbody>
</table>

Example:

Router> enable

What to Do Next

After the peer session template is created, the configuration of the peer session template can be inherited or applied by another peer session template with the inherit peer-session or neighbor inherit peer-session command.
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example: Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode and creates a BGP routing process.</td>
</tr>
<tr>
<td>Example: Router(config)# router bgp 101</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> neighbor ip-address remote-as autonomous-system-number</td>
<td>Configures a peering session with the specified neighbor.</td>
</tr>
<tr>
<td>Example: Router(config-router)# neighbor 172.16.0.1 remote-as 202</td>
<td>• The explicit remote-as statement is required for the neighbor inherit statement in Step 5 to work. If a peering is not configured, the specified neighbor in Step 5 will not accept the session template.</td>
</tr>
<tr>
<td><strong>Step 5</strong> neighbor ip-address inherit peer-session session-template-name</td>
<td>Sends a peer session template to a neighbor so that the neighbor can inherit the configuration.</td>
</tr>
<tr>
<td>Example: Router(config-router)# neighbor 172.16.0.1 inherit peer-session CORE1</td>
<td>• The example configures a router to send the peer session template named CORE1 to the 172.16.0.1 neighbor to inherit. This template can be applied to a neighbor, and if another peer session template is indirectly inherited in CORE1, the indirectly inherited configuration will also be applied. No additional peer session templates can be directly applied. However, the directly inherited template can also inherit up to seven additional indirectly inherited peer session templates.</td>
</tr>
<tr>
<td><strong>Step 6</strong> end</td>
<td>Exits router configuration mode and enters privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Router(config-router)# end</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong> show ip bgp template peer-session [session-template-name]</td>
<td>Displays locally configured peer session templates.</td>
</tr>
<tr>
<td>Example: Router# show ip bgp template peer-session</td>
<td>• The output can be filtered to display a single peer policy template with the optional session-template-name argument. This command also supports all standard output modifiers.</td>
</tr>
</tbody>
</table>

**What to Do Next**

To create a peer policy template, go to the Configuring Peer Policy Templates, on page 136.
Configuring Peer Policy Templates

Configuring Basic Peer Policy Templates

Perform this task to create a basic peer policy template with BGP policy configuration commands that can be applied to many neighbors using one of the next two tasks.

Note

The commands in Steps 5 through 7 are optional and could be replaced with any supported BGP policy configuration commands.

Note

The following restrictions apply to the peer policy templates:

- A peer policy template can directly or indirectly inherit up to eight peer policy templates.
- A BGP neighbor cannot be configured to work with both peer groups and peer templates. A BGP neighbor can be configured to belong only to a peer group or to inherit policies only from peer templates.

SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. template peer-policy policy-template-name
5. maximum-prefix prefix-limit [threshold] [restart restart-interval | warning-only]
6. weight weight-value
7. prefix-list prefix-list-name {in | out}
8. end

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>enable</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Device&gt; enable</td>
</tr>
<tr>
<td></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Device# configure terminal</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Enters router configuration mode and creates a BGP routing process.</td>
</tr>
<tr>
<td>router bgp autonomous-system-number</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td><code>Device(config)# router bgp 45000</code></td>
<td>Enters policy-template configuration mode and creates a peer policy template.</td>
</tr>
</tbody>
</table>
| **Step 4** | **template peer-policy** *policy-template-name*  
**Example:**  
`Device(config-router)# template peer-policy GLOBAL` | |
| **Step 5** | **maximum-prefix** *prefix-limit* [threshold] [restart restart-interval] [warning-only]  
**Example:**  
`Device(config-router-ptmp)# maximum-prefix 10000` | (Optional) Configures the maximum number of prefixes that a neighbor will accept from this peer. | Any supported BGP policy configuration command can be used here. For a list of the supported commands, see the “Peer Policy Templates” section. |
| **Step 6** | **weight** *weight-value*  
**Example:**  
`Device(config-router-ptmp)# weight 300` | (Optional) Sets the default weight for routes that are sent from this neighbor. | Any supported BGP policy configuration command can be used here. For a list of the supported commands, see the “Peer Policy Templates” section. |
| **Step 7** | **prefix-list** *prefix-list-name* {in | out}  
**Example:**  
`Device(config-router-ptmp)# prefix-list NO-MARKETING in` | (Optional) Filters prefixes that are received by the router or sent from the router.  
• The prefix list in the example filters inbound internal addresses. | Any supported BGP policy configuration command can be used here. For a list of the supported commands, see the “Peer Policy Templates” section. |
| **Step 8** | **end**  
**Example:**  
`Device(config-router-ptmp)# end` | Exits policy-template configuration mode and returns to privileged EXEC mode. | |

**What to Do Next**

After the peer policy template is created, the configuration of the peer policy template can be inherited or applied by another peer policy template. For details about peer policy inheritance, see the “Configuring Peer Policy Template Inheritance with the inherit peer-policy Command” section or the “Configuring Peer Policy Template Inheritance with the neighbor inherit peer-policy Command” section.
Configuring Peer Policy Template Inheritance with the `inherit peer-policy` Command

This task configures peer policy template inheritance using the `inherit peer-policy` command. It creates and configure a peer policy template and allows it to inherit a configuration from another peer policy template.

When BGP neighbors use inherited peer templates, it can be difficult to determine which policies are associated with a specific template. In Cisco IOS Release 12.0(25)S, 12.4(11)T, 12.2(33)SRB, 12.2(33)SB, and later releases, the `detail` keyword was added to the `show ip bgp template peer-policy` command to display the detailed configuration of local and inherited policies associated with a specific template.

### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `template peer-policy policy-template-name`
5. `route-map map-name {in out}`
6. `inherit peer-policy policy-template-name sequence-number`
7. `end`
8. `show ip bgp template peer-policy [policy-template-name[detail]]`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td><code>enable</code>  &lt;br&gt; <strong>Example:</strong>  &lt;br&gt; Router&gt; enable</td>
<td>Enables privileged EXEC mode.  &lt;br&gt; - Enter your password if prompted.</td>
</tr>
<tr>
<td>Step 2</td>
<td><code>configure terminal</code>  &lt;br&gt; <strong>Example:</strong>  &lt;br&gt; Router# configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Step 3</td>
<td><code>router bgp autonomous-system-number</code>  &lt;br&gt; <strong>Example:</strong>  &lt;br&gt; Router(config)# router bgp 45000</td>
<td>Enters router configuration mode and creates a BGP routing process.</td>
</tr>
<tr>
<td>Step 4</td>
<td><code>template peer-policy policy-template-name</code>  &lt;br&gt; <strong>Example:</strong>  &lt;br&gt; Router(config-router)# template peer-policy NETWORK1</td>
<td>Enter policy-template configuration mode and creates a peer policy template.</td>
</tr>
<tr>
<td>Step 5</td>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>--------</td>
<td>------------------</td>
<td>---------</td>
</tr>
<tr>
<td></td>
<td>route-map map-name {in</td>
<td>out}</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config-router-ptmp)# route-map ROUTE in</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 6</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>inherit peer-policy policy-template-name sequence-number</td>
<td>Configures the peer policy template to inherit the configuration of another peer policy template.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config-router-ptmp)# inherit peer-policy GLOBAL 10</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 7</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>end</td>
<td>Exits policy-template configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config-router-ptmp)# end</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 8</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>show ip bgp template peer-policy [policy-template-name[detail]]</td>
<td>Displays locally configured peer policy templates.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router# show ip bgp template peer-policy NETWORK1 detail</td>
<td></td>
</tr>
</tbody>
</table>

**Note** Any supported BGP policy configuration command can be used here. For a list of the supported commands, see the Peer Policy Templates, on page 83.

**Note** The sequence-number argument sets the order in which the peer policy template is evaluated. Like a route map sequence number, the lowest sequence number is evaluated first.

**Note** The example configures this peer policy template to inherit the configuration from GLOBAL. If the template created in these steps is applied to a neighbor, the configuration GLOBAL will also be inherited and applied indirectly. Up to six additional peer policy templates can be indirectly inherited from GLOBAL for a total of eight directly applied and indirectly inherited peer policy templates.

**Note** This template in the example will be evaluated first if no other templates are configured with a lower sequence number.

**Note** The output can be filtered to display a single peer policy template with the policy-template-name argument. This command also supports all standard output modifiers.

**Note** Use the detail keyword to display detailed policy information.

**Note** The detail keyword is supported only in Cisco IOS Release 12.0(25)S, 12.4(11)T, 12.2(33)SRB, 12.2(33)SB, and later releases.
Examples

The following sample output of the `show ip bgp template peer-policy` command with the `detail` keyword displays details of the policy named NETWORK1. The output in this example shows that the GLOBAL template was inherited. Details of route map and prefix list configurations are also displayed.

```
Router# show ip bgp template peer-policy NETWORK1 detail
Template:NETWORK1, index:2.
Local policies:0x1, Inherited polices:0x80840
This template inherits:
  GLOBAL, index:i, seq_no:10, flags:0x1
Locally configured policies:
  route-map ROUTE in
Inherited policies:
  prefix-list NO-MARKETING in
  weight 300
  maximum-prefix 10000
Template:NETWORK1 <detail>
Locally configured policies:
  route-map ROUTE in
  route-map ROUTE, permit, sequence 10
Match clauses:
  ip address prefix-lists: DEFAULT
ip prefix-list DEFAULT: 1 entries
  seq 5 permit 10.1.1.0/24
Set clauses:
  Policy routing matches: 0 packets, 0 bytes
Inherited policies:
  prefix-list NO-MARKETING in
ip prefix-list NO-MARKETING: 1 entries
  seq 5 deny 10.2.2.0/24
```

Configuring Peer Policy Template Inheritance with the `neighbor inherit peer-policy` Command

This task configures a router to send a peer policy template to a neighbor to inherit using the `neighbor inherit peer-policy` command. Perform the following steps to send a peer policy template configuration to a neighbor to inherit.

When BGP neighbors use multiple levels of peer templates, it can be difficult to determine which policies are applied to the neighbor. In Cisco IOS Release 12.0(25)S, 12.4(11)T, 12.2(33)SRB, 12.2(33)SB, and later releases, the `policy` and `detail` keywords were added to the `show ip bgp neighbors` command to display the inherited policies and policies configured directly on the specified neighbor.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `neighbor ip-address remote-as autonomous-system-number`
5. `address-family ipv4 [multicast | unicast | vrf vrf-name]`
6. `neighbor ip-address inherit peer-policy policy-template-name`
7. `end`
8. `show ip bgp neighbors [ip-address[policy [detail]]]`
## DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td><strong>enable</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Router&gt; enable</td>
<td>Enables privileged EXEC mode.&lt;br&gt;• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td><strong>configure terminal</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Router# configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td><strong>router bgp autonomous-system-number</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Router(config)# router bgp 45000</td>
<td>Enters router configuration mode and creates a BGP routing process.</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td><strong>neighbor ip-address remote-as autonomous-system-number</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Router(config-router)# neighbor 192.168.1.2 remote-as 40000</td>
<td>Configures a peering session with the specified neighbor.&lt;br&gt;• The explicit <code>remote-as</code> statement is required for the <code>neighbor inherit</code> statement in Step 6 to work. If a peering is not configured, the specified neighbor in Step 6 will not accept the session template.</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>**address-family ipv4 [multicast</td>
<td>unicast</td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td><strong>neighbor ip-address inherit peer-policy policy-template-name</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Router(config-router-af)# neighbor 192.168.1.2 inherit peer-policy GLOBAL</td>
<td>Sends a peer policy template to a neighbor so that the neighbor can inherit the configuration.&lt;br&gt;• The example configures a router to send the peer policy template named GLOBAL to the 192.168.1.2 neighbor to inherit. This template can be applied to a neighbor, and if another peer policy template is indirectly inherited from GLOBAL, the indirectly inherited configuration will also be applied. Up to seven additional peer policy templates can be indirectly inherited from GLOBAL.</td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td><strong>end</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Router(config-router-af)# end</td>
<td>Exits address family configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td><strong>show ip bgp neighbors [ip-address[policy [detail]]]</strong>&lt;br&gt;<strong>Example:</strong></td>
<td>Displays locally configured peer policy templates.</td>
</tr>
</tbody>
</table>
### Purpose

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| Router# show ip bgp neighbors 192.168.1.2 policy | - The output can be filtered to display a single peer policy template with the `policy-template-name` argument. This command also supports all standard output modifiers.  
- Use the `policy` keyword to display the policies applied to this neighbor per address family.  
- Use the `detail` keyword to display detailed policy information.  
- The `policy` and `detail` keywords are supported only in Cisco IOS Release 12.0(25)S, 12.4(11)T, 12.2(33)SRB, 12.2(33)SB, and later releases. |

#### Note

Only the syntax required for this task is shown. For more details, see the *Cisco IOS IP Routing: BGP Command Reference*.

### Examples

The following sample output shows the policies applied to the neighbor at 192.168.1.2. The output displays both inherited policies and policies configured on the neighbor device. Inherited policies are policies that the neighbor inherits from a peer-group or a peer-policy template.

```
Router# show ip bgp neighbors 192.168.1.2 policy
Neighbor: 192.168.1.2, Address-Family: IPv4 Unicast
Locally configured policies:
  - route-map ROUTE in
Inherited polices:
  - prefix-list NO-MARKETING in
  - route-map ROUTE in
  - weight 300
  - maximum-prefix 10000
```

### Monitoring and Maintaining BGP Dynamic Update Groups

Use this task to clear and display information about the processing of dynamic BGP update groups. The performance of BGP update message generation is improved with the use of BGP update groups. With the configuration of the BGP peer templates and the support of the dynamic BGP update groups, the network operator no longer needs to configure peer groups in BGP and can benefit from improved configuration flexibility and system performance. For information about using BGP peer templates, see the “Configuring Peer Session Templates” and “Configuring Peer Policy Templates” sections.

### SUMMARY STEPS

1. `enable`
2. `clear ip bgp update-group [index-group | ip-address]`
3. `show ip bgp replication [index-group | ip-address]`
4. `show ip bgp update-group [index-group | ip-address] [summary]`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
</tr>
<tr>
<td><code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><em>Example:</em></td>
<td></td>
</tr>
<tr>
<td><code>Device&gt; enable</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Clears BGP update group membership and recalculate BGP update groups.</td>
</tr>
<tr>
<td>`clear ip bgp update-group [index-group</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ip-address]</td>
</tr>
<tr>
<td><em>Example:</em></td>
<td></td>
</tr>
<tr>
<td><code>Device# clear ip bgp update-group 192.168.2.2</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Displays update replication statistics for BGP update groups.</td>
</tr>
<tr>
<td>`show ip bgp replication [index-group</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ip-address]</td>
</tr>
<tr>
<td><em>Example:</em></td>
<td></td>
</tr>
<tr>
<td><code>Device# show ip bgp replication</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>Displays information about BGP update groups.</td>
</tr>
<tr>
<td>`show ip bgp update-group [index-group</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ip-address]</td>
</tr>
<tr>
<td><code>[summary]</code></td>
<td></td>
</tr>
<tr>
<td><em>Example:</em></td>
<td></td>
</tr>
<tr>
<td><code>Device# show ip bgp update-group</code></td>
<td></td>
</tr>
</tbody>
</table>

**Troubleshooting Tips**

Use the `debug ip bgp groups` command to display information about the processing of BGP update groups. Information can be displayed for all update groups, an individual update group, or a specific BGP neighbor. The output of this command can be very verbose. This command should not be deployed in a production network unless you are troubleshooting a problem.

**Configuration Examples for a Basic BGP Network**

**Example: Configuring a BGP Process and Customizing Peers**

The following example shows the configuration for Router B in the above (in the “Customizing a BGP Peer” section) with a BGP process configured with two neighbor peers (at Router A and at Router E) in separate autonomous systems. IPv4 unicast routes are exchanged with both peers and IPv4 multicast routes are exchanged with the BGP peer at Router E.

**Router B**

```
router bgp 45000
bgp router-id 172.17.1.99
```
Examples: Configuring a BGP Routing Process and Peers Using 4-Byte Autonomous System Numbers

Asplain Format

The following example shows the configuration for Router A, Router B, and Router E in the figure below with a Border Gateway Protocol (BGP) process configured between three neighbor peers (at Router A, at Router B, and at Router E) in separate 4-byte autonomous systems configured using asplain notation. IPv4 unicast routes are exchanged with all peers.

Figure 14: BGP Peers Using 4-Byte Autonomous System Numbers in Asplain Format

Router A

router bgp 65536
bgp router-id 10.1.1.99
no bgp default ipv4-unicast
gbg fast-external-fallover
bgp log-neighbor-changes
timers bgp 70 120
neighbor 192.168.1.1 remote-as 65538
!
address-family ipv4
neighbor 192.168.1.1 activate
no auto-summary
no synchronization
network 10.1.1.0 mask 255.255.255.0
exit-address-family

Router B

router bgp 65538
bgp router-id 172.17.1.99
no bgp default ipv4-unicast
bgp fast-external-fallover
bgp log-neighbor-changes
timers bgp 70 120
neighbor 192.168.1.2 remote-as 65536
neighbor 192.168.3.2 remote-as 65550
neighbor 192.168.3.2 description finance
!
address-family ipv4
neighbor 192.168.1.2 activate
neighbor 192.168.3.2 activate
no auto-summary
no synchronization
network 172.17.1.0 mask 255.255.255.0
exit-address-family

Router E

router bgp 65550
bgp router-id 10.2.2.99
no bgp default ipv4-unicast
bgp fast-external-fallover
bgp log-neighbor-changes
timers bgp 70 120
neighbor 192.168.3.1 remote-as 65538
!
address-family ipv4
neighbor 192.168.3.1 activate
no auto-summary
no synchronization
network 10.2.2.0 mask 255.255.255.0
exit-address-family

Asdot Format

The following example shows how to create the configuration for Router A, Router B, and Router E in the figure below with a BGP process configured between three neighbor peers (at Router A, at Router B, and at Router E) in separate 4-byte autonomous systems configured using the default asdot format. IPv4 unicast routes are exchanged with all peers.
Figure 15: BGP Peers Using 4-Byte Autonomous System Numbers in Asdot Format

Router A

router bgp 1.0
bgp router-id 10.1.1.99
no bgp default ipv4-unicast
bgp fast-external-fallover
bgp log-neighbor-changes
timers bgp 70 120
neighbor 192.168.1.1 remote-as 1.2
! address-family ipv4
  neighbor 192.168.1.1 activate
  no auto-summary
  no synchronization
  network 10.1.1.0 mask 255.255.255.0
  exit-address-family

Router B

router bgp 1.2
bgp router-id 172.17.1.99
no bgp default ipv4-unicast
bgp fast-external-fallover
bgp log-neighbor-changes
timers bgp 70 120
neighbor 192.168.1.2 remote-as 1.0
neighbor 192.168.3.2 remote-as 1.14
neighbor 192.168.3.2 description finance
! address-family ipv4
  neighbor 192.168.1.2 activate
  neighbor 192.168.3.2 activate
  no auto-summary
  no synchronization
  network 172.17.1.0 mask 255.255.255.0
  exit-address-family

Router E

router bgp 1.14
bgp router-id 10.2.2.99
no bgp default ipv4-unicast
bgp fast-external-fallover
bgp log-neighbor-changes
timers bgp 70 120
neighbor 192.168.3.1 remote-as 1.2
!
address-family ipv4
neighbor 192.168.3.1 activate
no auto-summary
no synchronization
network 10.2.2.0 mask 255.255.255.0
exit-address-family

Examples: Configuring a VRF and Setting an Extended Community Using a BGP 4-Byte Autonomous System Number

Asplain Default Format in Cisco IOS Release 12.0(32)SY8, 12.0(33)S3, 12.2(33)SRE, 12.2(33)SXI1, and Later Releases

The following example is available in Cisco IOS Release 12.0(32)SY8, 12.0(33)S3, 12.2(33)SRE, 12.2(33)XNE, 12.2(33)SXI1, and later releases and shows how to create a VRF with a route target that uses a 4-byte autonomous system number, 65537, and how to set the route target to extended community value 65537:100 for routes that are permitted by the route map:

ip vrf vpn_red
rd 64500:100
route-target both 65537:100
exit
route-map red_map permit 10
set extcommunity rt 65537:100
end

After the configuration is completed, use the show route-map command to verify that the extended community is set to the route target that contains the 4-byte autonomous system number of 65537:

RouterB# show route-map red_map
route-map red_map, permit, sequence 10
Match clauses:
Set clauses:
    extended community RT:65537:100
Policy routing matches: 0 packets, 0 bytes

4-Byte Autonomous System Number RD Support

The following example shows how to create a VRF with a route distinguisher that contains a 4-byte AS number 65536, and a route target that contains a 4-byte autonomous system number, 65537:

ip vrf vpn_red
rd 65536:100
route-target both 65537:100
exit

After the configuration is completed, use the show vrf command to verify that the 4-byte AS number route distinguisher is set to 65536:100:
Example: NLRI to AFI Configuration

The following example upgrades an existing router configuration file in the NLRI format to the AFI format and set the router CLI to use only commands in the AFI format:

```
router bgp 60000
  bgp upgrade-cli
```

The `show running-config` command can be used in privileged EXEC mode to verify that an existing router configuration file has been upgraded from the NLRI format to the AFI format. The following sections provide
sample output from a router configuration file in the NLRI format, and the same router configuration file after it has been upgraded to the AFI format with the `bgp upgrade-cli` command in router configuration mode.

---

**Note**

After a router has been upgraded from the AFI format to the NLRI format with the `bgp upgrade-cli` command, NLRI commands will no longer be accessible or configurable.

---

**Router Configuration File in NLRI Format Before Upgrading**

The following sample output is from the `show running-config` command in privileged EXEC mode. The sample output shows a router configuration file, in the NLRI format, prior to upgrading to the AFI format with the `bgp upgrade-cli` command. The sample output is filtered to show only the affected portion of the router configuration.

```bash
Router# show running-config | begin bgp

router bgp 101
  no synchronization
  bgp log-neighbor-changes
  neighbor 10.1.1.1 remote-as 505 nlri unicast multicast
  no auto-summary
  !
  ip default-gateway 10.4.9.1
  ip classless
  !
  route-map REDISTRIBUTE-MULTICAST permit 10
    match ip address prefix-list MULTICAST-PREFIXES
    set nlri multicast
    !
  route-map MULTICAST-PREFIXES permit 10
  !
  route-map REDISTRIBUTE-UNICAST permit 20
    match ip address prefix-list UNICAST-PREFIXES
    set nlri unicast
  !
  !
  line con 0
  line aux 0
  line vty 0 4
    password PASSWORD
    login
  !
end
```

**Router Configuration File in AFI Format After Upgrading**

The following sample output shows the router configuration file after it has been upgraded to the AFI format. The sample output is filtered to show only the affected portion of the router configuration file.

```bash
Router# show running-config | begin bgp

router bgp 101
  no synchronization
  bgp log-neighbor-changes
  neighbor 10.1.1.1 remote-as 505
  no auto-summary
```
Examples: Removing BGP Configuration Commands Using a Redistribution Example

The following examples show first the CLI configuration to enable the redistribution of BGP routes into EIGRP using a route map and then the CLI configuration to remove the redistribution and route map. Some BGP configuration commands can affect other CLI commands and this example demonstrates how the removal of one command affects another command.

In the first configuration example, a route map is configured to match and set autonomous system numbers. BGP neighbors in three different autonomous systems are configured and activated. An EIGRP routing process is started, and the redistribution of BGP routes into EIGRP using the route map is configured.

**CLI to Enable BGP Route Redistribution Into EIGRP**

```
route-map bgp-to-eigrp permit 10
match tag 50000
set tag 65000
exit
router bgp 45000
bgp log-neighbor-changes
address-family ipv4
```
neighbor 172.16.1.2 remote-as 45000
neighbor 172.21.1.2 remote-as 45000
neighbor 192.168.1.2 remote-as 40000
neighbor 192.168.3.2 remote-as 50000
neighbor 172.16.1.2 activate
neighbor 172.21.1.2 activate
neighbor 192.168.1.2 activate
neighbor 192.168.3.2 activate
network 172.17.1.0 mask 255.255.255.0
exit-address-family
exit
router eigrp 100
redistribute bgp 45000 metric 10000 100 255 1 1500 route-map bgp-to-eigrp
no auto-summary
exit

In the second configuration example, both the route-map command and the redistribute command are disabled. If only the route-map command is removed, it does not automatically disable the redistribution. The redistribution will now occur without any matching or filtering. To remove the redistribution configuration, the redistribute command must also be disabled.

**CLI to Remove BGP Route Redistribution Into EIGRP**

```
configure terminal
no route-map bgp-to-eigrp
router eigrp 100
    no redistribute bgp 45000
end
```

**Examples: BGP Soft Reset**

The following examples show two ways to reset the connection for BGP peer 192.168.1.1.

**Example: Dynamic Inbound Soft Reset**

The following example shows the command used to initiate a dynamic soft reconfiguration in the BGP peer 192.168.1.1. This command requires that the peer support the route refresh capability.

```
clear ip bgp 192.168.1.1 soft in
```

**Example: Inbound Soft Reset Using Stored Information**

The following example shows how to enable inbound soft reconfiguration for the neighbor 192.168.1.1. All the updates received from this neighbor will be stored unmodified, regardless of the inbound policy. When inbound soft reconfiguration is performed later, the stored information will be used to generate a new set of inbound updates.

```
router bgp 100
neighbor 192.168.1.1 remote-as 200
neighbor 192.168.1.1 soft-reconfiguration inbound
```

The following example clears the session with the neighbor 192.168.1.1:

```
clear ip bgp 192.168.1.1 soft in
```
Example: Resetting BGP Peers Using 4-Byte Autonomous System Numbers

The following examples show how to clear BGP peers belonging to an autonomous system that uses 4-byte autonomous system numbers. The initial state of the BGP routing table is shown using the `show ip bgp` command, and peers in 4-byte autonomous systems 65536 and 65550 are displayed.

RouterB# show ip bgp

BGP table version is 4, local router ID is 172.17.1.99
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal, r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

<table>
<thead>
<tr>
<th>Network</th>
<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>*&gt; 10.1.1.0/24</td>
<td>192.168.1.2</td>
<td>0</td>
<td>0</td>
<td>65536</td>
<td>i</td>
</tr>
<tr>
<td>*&gt; 10.2.2.0/24</td>
<td>192.168.3.2</td>
<td>0</td>
<td>0</td>
<td>65550</td>
<td>i</td>
</tr>
<tr>
<td>*&gt; 172.17.1.0/24</td>
<td>0.0.0.0</td>
<td>0</td>
<td>32768</td>
<td>i</td>
<td></td>
</tr>
</tbody>
</table>

The `clear ip bgp 65550` command is entered to remove all BGP peers in the 4-byte autonomous system 65550. The ADJCHANGE message shows that the BGP peer at 192.168.3.2 is being reset.

RouterB# clear ip bgp 65550
RouterB#
* Nov 30 23:25:27.043: %BGP-5-ADJCHANGE: neighbor 192.168.3.2 Down User reset

The `show ip bgp` command is entered again, and only the peer in 4-byte autonomous systems 65536 is now displayed.

RouterB# show ip bgp

BGP table version is 5, local router ID is 172.17.1.99
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal, r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

<table>
<thead>
<tr>
<th>Network</th>
<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>*&gt; 10.1.1.0/24</td>
<td>192.168.1.2</td>
<td>0</td>
<td>0</td>
<td>65536</td>
<td>i</td>
</tr>
<tr>
<td>*&gt; 172.17.1.0/24</td>
<td>0.0.0.0</td>
<td>0</td>
<td>32768</td>
<td>i</td>
<td></td>
</tr>
</tbody>
</table>

Almost immediately, the next ADJCHANGE message shows that the BGP peer at 192.168.3.2 (in the 4-byte autonomous system 65550) is now back up.

RouterB# *
* Nov 30 23:25:55.995: %BGP-5-ADJCHANGE: neighbor 192.168.3.2 Up

Example: Resetting and Displaying Basic BGP Information

The following example shows how to reset and display basic BGP information.

The `clear ip bgp *` command clears and resets all the BGP neighbor sessions. In Cisco IOS Release 12.2(25)S and later releases, the syntax is `clear ip bgp all`. Specific neighbors or all peers in an autonomous system can be cleared by using the `neighbor-address` and `autonomous-system-number` arguments. If no argument is specified, this command will clear and reset all BGP neighbor sessions.
The `clear ip bgp *` command also clears all the internal BGP structures which makes it useful as a troubleshooting tool.

**Note**

Router# `clear ip bgp *`

The `show ip bgp` command is used to display all the entries in the BGP routing table. The following example displays BGP routing table information for the 10.1.1.0 network:

Router# `show ip bgp 10.1.1.0 255.255.255.0`

BGP routing table entry for 10.1.1.0/24, version 2
Paths: (1 available, best #1, table Default-IP-Routing-Table)
  Advertised to update-groups:
    1
    40000
  192.168.1.2 from 192.168.1.2 (10.1.1.99)
    Origin IGP, metric 0, localpref 100, valid, external, best

The `show ip bgp neighbors` command is used to display information about the TCP and BGP connections to neighbors. The following example displays the routes that were advertised from Router B in the figure above (in the “Configuring a BGP Peer for the IPv4 VRF Address Family” section) to its BGP neighbor 192.168.3.2 on Router E:

Router# `show ip bgp neighbors 192.168.3.2 advertised-routes`

BGP table version is 3, local router ID is 172.17.1.99
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal, r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

<table>
<thead>
<tr>
<th>Network</th>
<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>* 10.1.1.0/24</td>
<td>192.168.1.2</td>
<td>0</td>
<td>0</td>
<td>40000</td>
<td>i</td>
</tr>
<tr>
<td>* 172.17.1.0/24</td>
<td>0.0.0.0</td>
<td>0</td>
<td>32768</td>
<td>i</td>
<td></td>
</tr>
</tbody>
</table>

Total number of prefixes 2

The `show ip bgp paths` command is used to display all the BGP paths in the database. The following example displays BGP path information for Router B in the figure above (in the “Customizing a BGP Peer” section):

Router# `show ip bgp paths`

<table>
<thead>
<tr>
<th>Address</th>
<th>Hash</th>
<th>Refcount</th>
<th>Metric</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x2FB5DB0</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>i</td>
</tr>
<tr>
<td>0x2FB5C90</td>
<td>1</td>
<td>4</td>
<td>0</td>
<td>i</td>
</tr>
<tr>
<td>0x2FB5C00</td>
<td>1361</td>
<td>2</td>
<td>0</td>
<td>50000</td>
</tr>
<tr>
<td>0x2FB5D20</td>
<td>2625</td>
<td>2</td>
<td>0</td>
<td>40000</td>
</tr>
</tbody>
</table>

The `show ip bgp summary` command is used to display the status of all BGP connections. The following example displays BGP routing table information for Router B in the figure above (in the “Customizing a BGP Peer” section):

Router# `show ip bgp summary`

BGP router identifier 172.17.1.99, local AS number 45000
BGP table version is 3, main routing table version 3
2 network entries using 234 bytes of memory
2 path entries using 104 bytes of memory
4/2 BGP path/bestpath attribute entries using 496 bytes of memory
Examples: Aggregating Prefixes Using BGP

The following examples show how you can use aggregate routes in BGP either by redistributing an aggregate route into BGP or by using the BGP conditional aggregation routing feature.

In the following example, the **redistribute static** router configuration command is used to redistribute aggregate route 10.0.0.0:

```
ip route 10.0.0.0 255.0.0.0 null 0
router bgp 100
  redistribute static
```

The following configuration shows how to create an aggregate entry in the BGP routing table when at least one specific route falls into the specified range. The aggregate route will be advertised as coming from your autonomous system and has the atomic aggregate attribute set to show that information might be missing. (By default, atomic aggregate is set unless you use the **as-set** keyword in the **aggregate-address** router configuration command.)

```
router bgp 100
  aggregate-address 10.0.0.0 255.0.0.0
```

The following example shows how to create an aggregate entry using the same rules as in the previous example, but the path advertised for this route will be an AS_SET consisting of all elements contained in all paths that are being summarized:

```
router bgp 100
  aggregate-address 10.0.0.0 255.0.0.0 as-set
```

The following example shows how to create the aggregate route for 10.0.0.0 and also suppress advertisements of more specific routes to all neighbors:

```
router bgp 100
  aggregate-address 10.0.0.0 255.0.0.0 summary-only
```

The following example configures BGP to not advertise inactive routes:

```
Device(config)# router bgp 50000
Device(config-router)# address-family ipv4 unicast
Device(config-router-af)# bgp suppress-inactive
Device(config-router-af)# end
```

The following example configures a maximum route limit in the VRF named RED and configures BGP to not advertise inactive routes through the VRF named RED:

```
Device(config)# ip vrf RED
Device(config-vrf)# rd 50000:10
Device(config-vrf)# maximum routes 1000 10
```
Device(config-vrf)# exit
Device(config)# router bgp 50000
Device(config-router)# address-family ipv4 vrf RED
Device(config-router-af)# bgp suppress-inactive
Device(config-router-af)# end

Example: Configuring a BGP Peer Group

The following example shows how to use an address family to configure a peer group so that all members of the peer group are both unicast- and multicast-capable:

```
router bgp 45000
neighbor 192.168.1.2 remote-as 40000
neighbor 192.168.3.2 remote-as 50000
address-family ipv4 unicast
  neighbor mygroup peer-group
  neighbor 192.168.1.2 peer-group mygroup
  neighbor 192.168.3.2 peer-group mygroup
router bgp 45000
neighbor 192.168.1.2 remote-as 40000
neighbor 192.168.3.2 remote-as 50000
address-family ipv4 multicast
  neighbor mygroup peer-group
  neighbor 192.168.1.2 peer-group mygroup
  neighbor 192.168.3.2 peer-group mygroup
  neighbor 192.168.1.2 activate
  neighbor 192.168.3.2 activate
```

Example: Configuring Peer Session Templates

The following example creates a peer session template named INTERNAL-BGP in session-template configuration mode:

```
router bgp 45000
  template peer-session INTERNAL-BGP
    remote-as 50000
    timers 30 300
  exit-peer-session
```

The following example creates a peer session template named CORE1. This example inherits the configuration of the peer session template named INTERNAL-BGP.

```
router bgp 45000
  template peer-session CORE1
    description CORE-123
    update-source loopback 1
    inherit peer-session INTERNAL-BGP
  exit-peer-session
```

The following example configures the 192.168.3.2 neighbor to inherit the CORE1 peer session template. The 192.168.3.2 neighbor will also indirectly inherit the configuration from the peer session template named INTERNAL-BGP. The explicit remote-as statement is required for the neighbor inherit statement to work. If a peering is not configured, the specified neighbor will not accept the session template.

```
router bgp 45000
```

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Examples: Configuring Peer Policy Templates

The following example creates a peer policy template named GLOBAL and enters policy-template configuration mode:

```
router bgp 45000
template peer-policy GLOBAL
  weight 1000
  maximum-prefix 5000
  prefix-list NO_SALES in
  exit-peer-policy
```

The following example creates a peer policy template named PRIMARY-IN and enters policy-template configuration mode:

```
router bgp 45000
template peer-policy PRIMARY-IN
  prefix-list ALLOW-PRIMARY-A in
  route-map SET-LOCAL in
  weight 2345
  default-originate
  exit-peer-policy
```

The following example creates a peer policy template named CUSTOMER-A. This peer policy template is configured to inherit the configuration from the peer policy templates named PRIMARY-IN and GLOBAL.

```
router bgp 45000
template peer-policy CUSTOMER-A
  route-map SET-COMMUNITY in
  filter-list 20 in
  inherit peer-policy PRIMARY-IN 20
  inherit peer-policy GLOBAL 10
  exit-peer-policy
```

The following example configures the 192.168.2.2 neighbor in address family mode to inherit the peer policy template named CUSTOMER-A. Assuming this example is a continuation of the example above, because the peer policy template named CUSTOMER-A above inherited the configuration from the templates named PRIMARY-IN and GLOBAL, the 192.168.2.2 neighbor will also indirectly inherit the peer policy templates named PRIMARY-IN and GLOBAL.

```
router bgp 45000
  neighbor 192.168.2.2 remote-as 50000
  address-family ipv4 unicast
    neighbor 192.168.2.2 inherit peer-policy CUSTOMER-A
  end
```

Examples: Monitoring and Maintaining BGP Dynamic Update Peer-Groups

No configuration is required to enable the BGP dynamic update of peer groups and the algorithm runs automatically. The following examples show how BGP update group information can be cleared or displayed.
clear ip bgp update-group Example

The following example clears the membership of neighbor 10.0.0.1 from an update group:

Router# clear ip bgp update-group 10.0.0.1

debug ip bgp groups Example

The following example output from the debug ip bgp groups command shows the recalculation of update groups after the clear ip bgp groups command was issued:

Router# debug ip bgp groups

5w4d: %BGP-5-ADJCHANGE: neighbor 10.4.9.5 Down User reset
5w4d: BGP-DYN(0): Comparing neighbor 10.4.9.5 flags 0x0 cap 0x0 and updgrp 2 f10
5w4d: BGP-DYN(0): Update-group 2 flags 0x0 cap 0x0 policies same as 10.4.9.5 f10
5w4d: %BGP-5-ADJCHANGE: neighbor 10.4.9.8 Down User reset
5w4d: BGP-DYN(0): Comparing neighbor 10.4.9.8 flags 0x0 cap 0x0 and updgrp 2 f10
5w4d: BGP-DYN(0): Update-group 2 flags 0x0 cap 0x0 policies same as 10.4.9.8 f10
5w4d: %BGP-5-ADJCHANGE: neighbor 10.4.9.21 Down User reset
5w4d: BGP-DYN(0): Comparing neighbor 10.4.9.21 flags 0x0 cap 0x0 and updgrp 1 f0
5w4d: BGP-DYN(0): Update-group 1 flags 0x0 cap 0x0 policies same as 10.4.9.21 f0
5w4d: %BGP-5-ADJCHANGE: neighbor 10.4.9.5 Up
5w4d: %BGP-5-ADJCHANGE: neighbor 10.4.9.21 Up
5w4d: %BGP-5-ADJCHANGE: neighbor 10.4.9.8 Up

show ip bgp replication Example

The following sample output from the show ip bgp replication command shows update group replication information for all for neighbors:

Router# show ip bgp replication

BGP Total Messages Formatted/Enqueued : 0/0
Index Type Members Leader MsgFmt MsgRepl Csize Qsize
1 internal 1 10.4.9.21 0 0 0 0
2 internal 2 10.4.9.5 0 0 0 0

show ip bgp update-group Example

The following sample output from the show ip bgp update-group command shows update group information for all neighbors:

Router# show ip bgp update-group

BGP version 4 update-group 1, internal, Address Family: IPv4 Unicast
  BGP Update version : 0, messages 0/0
  Route map for outgoing advertisements is COST1
  Update messages formatted 0, replicated 0
  Number of NLRIIs in the update sent: max 0, min 0
  Minimum time between advertisement runs is 5 seconds
  Has 1 member: 10.4.9.21
BGP version 4 update-group 2, internal, Address Family: IPv4 Unicast
  BGP Update version : 0, messages 0/0
  Update messages formatted 0, replicated 0
  Number of NLRIIs in the update sent: max 0, min 0
  Minimum time between advertisement runs is 5 seconds
Where to Go Next

- If you want to connect to an external service provider, see the “Connecting to a Service Provider Using External BGP” module.
- To configure BGP neighbor session options, proceed to the “Configuring BGP Neighbor Session Options” module.
- If you want to configure some iBGP features, see the “Configuring Internal BGP Features” module.

Additional References

Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
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</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
<tr>
<td>IPv6 commands: complete command syntax, command mode, defaults, usage guidelines, and examples</td>
<td>Cisco IOS IPv6 Command Reference</td>
</tr>
<tr>
<td>Overview of Cisco BGP conceptual information with links to all the individual BGP modules</td>
<td>“Cisco BGP Overview” module in the IP Routing: BGP Configuration Guide</td>
</tr>
<tr>
<td>Multiprotocol Label Switching (MPLS) and BGP configuration example using the IPv4 VRF address family</td>
<td>“MPLS VPN Inter-AS with ASBRs Exchanging IPv4 Routes and MPLS Labels” module in the MPLS: Layer 3 VPNs: Inter-AS and CSC Configuration Guide</td>
</tr>
</tbody>
</table>

Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Title</th>
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<tbody>
<tr>
<td>MDT SAFI</td>
<td>MDT SAFI</td>
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MIBs

<table>
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<tr>
<th>MIB</th>
<th>MIBs Link</th>
</tr>
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<tbody>
<tr>
<td>CISCO-BGP4-MIB</td>
<td>To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
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</table>
RFCs

<table>
<thead>
<tr>
<th>RFC</th>
<th>Title</th>
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<tbody>
<tr>
<td>RFC 1772</td>
<td>Application of the Border Gateway Protocol in the Internet</td>
</tr>
<tr>
<td>RFC 1773</td>
<td>Experience with the BGP Protocol</td>
</tr>
<tr>
<td>RFC 1774</td>
<td>BGP-4 Protocol Analysis</td>
</tr>
<tr>
<td>RFC 1930</td>
<td>Guidelines for Creation, Selection, and Registration of an Autonomous System (AS)</td>
</tr>
<tr>
<td>RFC 2519</td>
<td>A Framework for Inter-Domain Route Aggregation</td>
</tr>
<tr>
<td>RFC 2858</td>
<td>Multiprotocol Extensions for BGP-4</td>
</tr>
<tr>
<td>RFC 2918</td>
<td>Route Refresh Capability for BGP-4</td>
</tr>
<tr>
<td>RFC 3392</td>
<td>Capabilities Advertisement with BGP-4</td>
</tr>
<tr>
<td>RFC 4271</td>
<td>A Border Gateway Protocol 4 (BGP-4)</td>
</tr>
<tr>
<td>RFC 4893</td>
<td>BGP Support for Four-octet AS Number Space</td>
</tr>
<tr>
<td>RFC 5396</td>
<td>Textual Representation of Autonomous system (AS) Numbers</td>
</tr>
<tr>
<td>RFC 5398</td>
<td>Autonomous System (AS) Number Reservation for Documentation Use</td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

Feature Information for Configuring a Basic BGP Network

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.
Table 13: Feature Information for Configuring a Basic BGP Network

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Configuration Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP Conditional Route Injection</td>
<td>12.0(22)S, 12.2(4)T, 12.2(14)S, 15.0(1)S, Cisco IOS XE 3.1.0SG</td>
<td>The BGP Conditional Route Injection feature allows you to inject more specific prefixes into a BGP routing table over less specific prefixes that were selected through normal route aggregation. These more specific prefixes can be used to provide a finer granularity of traffic engineering or administrative control than is possible with aggregated routes.</td>
</tr>
<tr>
<td>BGP Configuration Using Peer Templates</td>
<td>12.0(24)S, 12.2(18)S, 12.2(27)SBC, 12.3(4)T, 15.0(1)S, Cisco IOS XE 3.1.0SG</td>
<td>The BGP Configuration Using Peer Templates feature introduces a new mechanism that groups distinct neighbor configurations for BGP neighbors that share policies. This type of policy configuration has been traditionally configured with BGP peer groups. However, peer groups have certain limitations because peer group configuration is bound to update grouping and specific session characteristics. Configuration templates provide an alternative to peer group configuration and overcome some of the limitations of peer groups.</td>
</tr>
<tr>
<td>BGP Dynamic Update Peer Groups</td>
<td>12.0(24)S, 12.2(18)S, 12.2(27)SBC, 12.3(4)T, 15.0(1)S, Cisco IOS XE 3.1.0SG</td>
<td>The BGP Dynamic Update Peer Groups feature introduces a new algorithm that dynamically calculates and optimizes update groups of neighbors that share the same outbound policies and can share the same update messages. In previous versions of Cisco IOS software, BGP update messages were grouped based on peer-group configurations. This method of grouping updates limited outbound policies and specific-session configurations. The BGP Dynamic Update Peer Group feature separates update group replication from peer group configuration, which improves convergence time and flexibility of neighbor configuration.</td>
</tr>
<tr>
<td>BGP Hybrid CLI</td>
<td>12.0(22)S, 12.2(15)T, 15.0(1)S</td>
<td>The BGP Hybrid CLI feature simplifies the migration of BGP networks and existing configurations from the NLRI format to the AFI format. This new functionality allows the network operator to configure commands in the AFI format and save these command configurations to existing NLRI formatted configurations. The feature provides the network operator with the capability to take advantage of new features and provides support for migration from the NLRI format to the AFI format.</td>
</tr>
<tr>
<td>Suppress BGP Advertisement for Inactive Routes</td>
<td>12.2(25)S, 12.2(33)SXH, 15.0(1)M, 15.0(1)S</td>
<td>The Suppress BGP Advertisements for Inactive Routes feature allows you to configure the suppression of advertisements for routes that are not installed in the Routing Information Base (RIB). Configuring this feature allows Border Gateway Protocol (BGP) updates to be more consistent with data used for traffic forwarding.</td>
</tr>
</tbody>
</table>
BGP 4 Soft Configuration

BGP4 soft configuration allows BGP4 policies to be configured and activated without clearing the BGP session, hence without invalidating the forwarding cache.

- Finding Feature Information, on page 161
- Information About BGP 4 Soft Configuration, on page 161
- How to Configure BGP 4 Soft Configuration, on page 162
- Configuration Examples for BGP 4 Soft Configuration, on page 165
- Additional References, on page 166
- Feature Information for BGP 4 Soft Configuration, on page 166

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About BGP 4 Soft Configuration

BGP Session Reset

Whenever the routing policy changes due to a configuration change, BGP peering sessions must be reset by using the clear ip bgp command. Cisco software supports the following three mechanisms to reset BGP peering sessions:

- Hard reset—A hard reset tears down the specified peering sessions including the TCP connection and deletes routes coming from the specified peer.

- Soft reset—A soft reset uses stored prefix information to reconfigure and activate BGP routing tables without tearing down existing peering sessions. Soft reconfiguration uses stored update information, at the cost of additional memory for storing the updates, to allow you to apply new BGP policy without disrupting the network. Soft reconfiguration can be configured for inbound or outbound sessions.
Dynamic inbound soft reset—The route refresh capability, as defined in RFC 2918, allows the local device to reset inbound routing tables dynamically by exchanging route refresh requests to supporting peers. The route refresh capability does not store update information locally for nondisruptive policy changes. It instead relies on dynamic exchange with supporting peers. Route refresh must first be advertised through BGP capability negotiation between peers. All BGP devices must support the route refresh capability. To determine if a BGP device supports this capability, use the `show ip bgp neighbors` command. The following message is displayed in the output when the device supports the route refresh capability:

Received route refresh capability from peer.

The `bgp soft-reconfig-backup` command was introduced to configure BGP to perform inbound soft reconfiguration for peers that do not support the route refresh capability. The configuration of this command allows you to configure BGP to store updates (soft reconfiguration) only as necessary. Peers that support the route refresh capability are unaffected by the configuration of this command.

How to Configure BGP 4 Soft Configuration

Configuring Inbound Soft Reconfiguration When Route Refresh Capability Is Missing

Perform this task to configure inbound soft reconfiguration using the `bgp soft-reconfig-backup` command for BGP peers that do not support the route refresh capability. BGP peers that support the route refresh capability are unaffected by the configuration of this command. Note that the memory requirements for storing the inbound update information can become quite large.

SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `bgp log-neighbor-changes`
5. `bgp soft-reconfig-backup`
6. `neighbor {ip-address | peer-group-name} remote-as autonomous-system-number`
7. `neighbor {ip-address | peer-group-name} soft-reconfiguration [inbound]`
8. `neighbor {ip-address | peer-group-name} route-map map-name {in | out}`
9. Repeat Steps 6 through 8 for every peer that is to be configured with inbound soft reconfiguration.
10. `exit`
11. `route-map map-name [permit | deny] [sequence-number]`
12. `set ip next-hop ip-address`
13. `end`
14. `show ip bgp neighbors [neighbor-address]`
15. `show ip bgp [network] [network-mask]`
## DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** | enable | Enables privileged EXEC mode.  
  *Example:*  
  ```bash
  Device> enable
  ``` |
| **Step 2** | configure terminal | Enters global configuration mode.  
  *Example:*  
  ```bash
  Device# configure terminal
  ``` |
| **Step 3** | router bgp autonomous-system-number | Enters router configuration mode for the specified routing process.  
  *Example:*  
  ```bash
  Device(config)# router bgp 45000
  ``` |
| **Step 4** | bgp log-neighbor-changes | Enables logging of BGP neighbor resets.  
  *Example:*  
  ```bash
  Device(config-router)# bgp log-neighbor-changes
  ``` |
| **Step 5** | bgp soft-reconfig-backup | Configures a BGP speaker to perform inbound soft reconfiguration for peers that do not support the route refresh capability.  
  *Example:*  
  ```bash
  Device(config-router)# bgp soft-reconfig-backup
  ```  
  *Note:* This command is used to configure BGP to perform inbound soft reconfiguration for peers that do not support the route refresh capability. The configuration of this command allows you to configure BGP to store updates (soft reconfiguration) only as necessary. Peers that support the route refresh capability are unaffected by the configuration of this command. |
| **Step 6** | neighbor {ip-address | peer-group-name} remote-as autonomous-system-number | Adds the IP address of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local device.  
  *Example:*  
  ```bash
  Device(config-router)# neighbor 192.168.1.2 remote-as 40000
  ``` |
| **Step 7** | neighbor {ip-address | peer-group-name} soft-reconfiguration [inbound] | Configures the Cisco software to start storing updates.  
  *Example:*  
  ```bash
  Device(config-router)# neighbor 192.168.1.2 soft-reconfiguration inbound
  ```  
  *Note:* All the updates received from this neighbor will be stored unmodified, regardless of the inbound policy. When inbound soft reconfiguration is done later, the stored information will be used to generate a new set of inbound updates. |
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 8** \(\text{neighbor \{ip-address | peer-group-name\} route-map map-name \{in | out\}}\) | Applies a route map to incoming or outgoing routes.  
- In this example, the route map named LOCAL will be applied to incoming routes. |
| **Example:** \(\text{Device(config-router)}\# \text{neighbor 192.168.1.2 route-map LOCAL in}\) | |
| **Step 9** route-map map-name \{permit | deny\} \{sequence-number\} | Configures a route map and enters route-map configuration mode.  
- In this example, a route map named LOCAL is created. |
| **Example:** \(\text{Device(config)}\# \text{route-map LOCAL permit 10}\) | |
| **Step 10** exit | Exits router configuration mode and enters global configuration mode. |
| **Example:** \(\text{Device(config-router)}\# \text{exit}\) | |
| **Step 11** set ip next-hop ip-address | Specifies where output packets that pass a match clause of a route map for policy routing.  
- In this example, the ip address is set to 192.168.1.144. |
| **Example:** \(\text{Device(config-route-map)}\# \text{set ip next-hop 192.168.1.144}\) | |
| **Step 12** end | Exits route-map configuration mode and enters privileged EXEC mode. |
| **Example:** \(\text{Device(config-route-map)}\# \text{end}\) | |
| **Step 13** show ip bgp neighbors \[neighbor-address\] | (Optional) Displays information about the TCP and BGP connections to neighbors.  
**Note** Only the syntax applicable to this task is used in this example. For more details, see the *Cisco IOS IP Routing: BGP Command Reference*. |
| **Example:** \(\text{Device}\# \text{show ip bgp neighbors 192.168.1.2}\) | |
| **Step 14** show ip bgp \[network\] \[network-mask\] | (Optional) Displays the entries in the BGP routing table.  
**Note** Only the syntax applicable to this task is used in this example. For more details, see the *Cisco IOS IP Routing: BGP Command Reference*. |
| **Example:** \(\text{Device}\# \text{show ip bgp}\) | |
Examples

The following partial output from the `show ip bgp neighbors` command shows information about the TCP and BGP connections to the BGP neighbor 192.168.2.1. This peer supports route refresh.

```
BGP neighbor is 192.168.1.2, remote AS 40000, external link
Neighbor capabilities:
  Route refresh: advertised and received(new)
```

The following partial output from the `show ip bgp neighbors` command shows information about the TCP and BGP connections to the BGP neighbor 192.168.3.2. This peer does not support route refresh so the soft-reconfig inbound paths for BGP peer 192.168.3.2 will be stored because there is no other way to update any inbound policy updates.

```
BGP neighbor is 192.168.3.2, remote AS 50000, external link
Neighbor capabilities:
  Route refresh: advertised
```

The following sample output from the `show ip bgp` command shows the entry for the network 172.17.1.0. Both BGP peers are advertising 172.17.1.0/24, but only the received-only path is stored for 192.168.3.2.

```
BGP routing table entry for 172.17.1.0/24, version 11
Paths: (3 available, best #3, table Default-IP-Routing-Table, RIB-failure(4))
Flag: 0x820
  Advertised to update-groups:
    1
    50000
    192.168.3.2 from 192.168.3.2 (172.17.1.0)
      Origin incomplete, metric 0, localpref 200, valid, external
    50000, (received-only)
    192.168.3.2 from 192.168.3.2 (172.17.1.0)
      Origin incomplete, metric 0, localpref 100, valid, external
    40000
    192.168.1.2 from 192.168.1.2 (172.16.1.0)
      Origin incomplete, metric 0, localpref 200, valid, external, best
```

Configuration Examples for BGP 4 Soft Configuration

Examples: BGP Soft Reset

The following examples show two ways to reset the connection for BGP peer 192.168.1.1.

Example: Dynamic Inbound Soft Reset

The following example shows the command used to initiate a dynamic soft reconfiguration in the BGP peer 192.168.1.1. This command requires that the peer support the route refresh capability.

```
clear ip bgp 192.168.1.1 soft in
```
Example: Inbound Soft Reset Using Stored Information

The following example shows how to enable inbound soft reconfiguration for the neighbor 192.168.1.1. All the updates received from this neighbor will be stored unmodified, regardless of the inbound policy. When inbound soft reconfiguration is performed later, the stored information will be used to generate a new set of inbound updates.

```cpp
router bgp 100
    neighbor 192.168.1.1 remote-as 200
    neighbor 192.168.1.1 soft-reconfiguration inbound
```

The following example clears the session with the neighbor 192.168.1.1:

```cpp
clear ip bgp 192.168.1.1 soft in
```

Additional References

### Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
</tbody>
</table>

### Standards and RFCs

<table>
<thead>
<tr>
<th>Standard/RFC</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFC 2918</td>
<td>Route Refresh Capability for BGP-4</td>
</tr>
</tbody>
</table>

### Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
</tr>
</tbody>
</table>

Feature Information for BGP 4 Soft Configuration

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.
Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

**Table 14: Feature Information for BGP 4 Soft Configuration**

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP 4 Soft Configuration</td>
<td>Cisco IOS XE Release 2.1</td>
<td>BGP 4 Soft Configuration allows BGP4 policies to be configured and activated without clearing the BGP session, hence without invalidating the forwarding cache. This feature was introduced on the Cisco ASR 1000 Series Routers.</td>
</tr>
</tbody>
</table>
CHAPTER 6

BGP Support for 4-byte ASN

The Cisco implementation of 4-byte autonomous system (AS) numbers uses asplain (65538, for example) as the default regular expression match and the output display format for AS numbers. However, you can configure 4-byte AS numbers in both the asplain format and the asdot format as described in RFC 5396. In addition, 4-byte ASN route distinguisher (RD) and route target (RT) BGP support for 4-byte autonomous numbers is added.

- Finding Feature Information, on page 169
- Information About BGP Support for 4-byte ASN, on page 169
- How to Configure BGP Support for 4-byte ASN, on page 172
- Configuration Examples for BGP Support for 4-byte ASN, on page 179
- Additional References for BGP Support for 4-byte ASN, on page 183
- Feature Information for BGP Support for 4-byte ASN, on page 184

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About BGP Support for 4-byte ASN

BGP Autonomous System Number Formats

Prior to January 2009, BGP autonomous system (AS) numbers that were allocated to companies were 2-octet numbers in the range from 1 to 65535 as described in RFC 4271, A Border Gateway Protocol 4 (BGP-4). Due to increased demand for AS numbers, the Internet Assigned Number Authority (IANA) started to allocate four-octet AS numbers in the range from 65536 to 4294967295. RFC 5396, Textual Representation of Autonomous System (AS) Numbers, documents three methods of representing AS numbers. Cisco has implemented the following two methods:
• Asplain—Decimal value notation where both 2-byte and 4-byte AS numbers are represented by their decimal value. For example, 65526 is a 2-byte AS number and 234567 is a 4-byte AS number.

• Asdot—Autonomous system dot notation where 2-byte AS numbers are represented by their decimal value and 4-byte AS numbers are represented by a dot notation. For example, 65526 is a 2-byte AS number and 1.169031 is a 4-byte AS number (this is dot notation for the 234567 decimal number).

For details about the third method of representing autonomous system numbers, see RFC 5396.

**Asdot Only Autonomous System Number Formatting**

In Cisco IOS XE Release 2.3, the 4-octet (4-byte) AS numbers are entered and displayed only in asdot notation, for example, 1.10 or 45000.64000. When using regular expressions to match 4-byte AS numbers the asdot format includes a period, which is a special character in regular expressions. A backslash must be entered before the period (for example, 1\.14) to ensure the regular expression match does not fail. The table below shows the format in which 2-byte and 4-byte AS numbers are configured, matched in regular expressions, and displayed in **show** command output in Cisco IOS images where only asdot formatting is available.

**Table 15: Asdot Only 4-Byte AS Number Format**

<table>
<thead>
<tr>
<th>Format</th>
<th>Configuration Format</th>
<th>Show Command Output and Regular Expression Match Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>asdot</td>
<td>2-byte: 1 to 65535 4-byte: 1.0 to 65535.65535</td>
<td>2-byte: 1 to 65535 4-byte: 1.0 to 65535.65535</td>
</tr>
</tbody>
</table>

**Asplain as Default AS Number Formatting**

In Cisco IOS XE Release 2.4 and later releases, the Cisco implementation of 4-byte AS numbers uses asplain as the default display format for AS numbers, but you can configure 4-byte AS numbers in both the asplain and asdot format. In addition, the default format for matching 4-byte AS numbers in regular expressions is asplain, so you must ensure that any regular expressions to match 4-byte AS numbers are written in the asplain format. If you want to change the default **show** command output to display 4-byte autonomous system numbers in the asdot format, use the **bgp asnotation dot** command under router configuration mode. When the asdot format is enabled as the default, any regular expressions to match 4-byte AS numbers must be written using the asdot format, or the regular expression match will fail. The tables below show that although you can configure 4-byte AS numbers in either asplain or asdot format, only one format is used to display **show** command output and control 4-byte AS number matching for regular expressions, and the default is asplain format. To display 4-byte AS numbers in **show** command output and to control matching for regular expressions in the asdot format, you must configure the **bgp asnotation dot** command. After enabling the **bgp asnotation dot** command, a hard reset must be initiated for all BGP sessions by entering the **clear ip bgp *** command.

**Note**

If you are upgrading to an image that supports 4-byte AS numbers, you can still use 2-byte AS numbers. The **show** command output and regular expression match are not changed and remain in asplain (decimal value) format for 2-byte AS numbers regardless of the format configured for 4-byte AS numbers.
### Table 16: Default Asplain 4-Byte AS Number Format

<table>
<thead>
<tr>
<th>Format</th>
<th>Configuration Format</th>
<th>Show Command Output and Regular Expression Match Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>asplain</td>
<td>2-byte: 1 to 65535 4-byte: 65536 to 4294967295</td>
<td>2-byte: 1 to 65535 4-byte: 65536 to 4294967295</td>
</tr>
<tr>
<td>asdot</td>
<td>2-byte: 1 to 65535 4-byte: 1.0 to 65535.65535</td>
<td>2-byte: 1 to 65535 4-byte: 65536 to 4294967295</td>
</tr>
</tbody>
</table>

### Table 17: Asdot 4-Byte AS Number Format

<table>
<thead>
<tr>
<th>Format</th>
<th>Configuration Format</th>
<th>Show Command Output and Regular Expression Match Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>asplain</td>
<td>2-byte: 1 to 65535 4-byte: 65536 to 4294967295</td>
<td>2-byte: 1 to 65535 4-byte: 1.0 to 65535.65535</td>
</tr>
<tr>
<td>asdot</td>
<td>2-byte: 1 to 65535 4-byte: 1.0 to 65535.65535</td>
<td>2-byte: 1 to 65535 4-byte: 1.0 to 65535.65535</td>
</tr>
</tbody>
</table>

### Reserved and Private AS Numbers

In Cisco IOS XE Release 2.3 and later releases, the Cisco implementation of BGP supports RFC 4893. RFC 4893 was developed to allow BGP to support a gradual transition from 2-byte AS numbers to 4-byte AS numbers. A new reserved (private) AS number, 23456, was created by RFC 4893 and this number cannot be configured as an AS number in the Cisco IOS CLI.

RFC 5398, *Autonomous System (AS) Number Reservation for Documentation Use*, describes new reserved AS numbers for documentation purposes. Use of the reserved numbers allow configuration examples to be accurately documented and avoids conflict with production networks if these configurations are literally copied. The reserved numbers are documented in the IANA AS number registry. Reserved 2-byte AS numbers are in the contiguous block, 64496 to 64511 and reserved 4-byte AS numbers are from 65536 to 65551 inclusive.

Private 2-byte AS numbers are still valid in the range from 64512 to 65534 with 65535 being reserved for special use. Private AS numbers can be used for internal routing domains but must be translated for traffic that is routed out to the Internet. BGP should not be configured to advertise private AS numbers to external networks. Cisco IOS software does not remove private AS numbers from routing updates by default. We recommend that ISPs filter private AS numbers.

---

**Note**

AS number assignment for public and private networks is governed by the IANA. For information about AS numbers, including reserved number assignment, or to apply to register an AS number, see the following URL: [http://www.iana.org/](http://www.iana.org/).

### Cisco Implementation of 4-Byte Autonomous System Numbers

In Cisco IOS XE Release 2.4 and later releases, the Cisco implementation of 4-byte autonomous system (AS) numbers uses asplain—65538, for example—as the default regular expression match and output display format for AS numbers, but you can configure 4-byte AS numbers in both the asplain format and the asdot format as described in RFC 5396. To change the default regular expression match and output display of 4-byte AS
numbers to asdot format, use the `bgp asnotation dot` command followed by the `clear ip bgp *` command to perform a hard reset of all current BGP sessions. For more details about 4-byte AS number formats, see the “BGP Autonomous System Number Formats” section.

In Cisco IOS XE Release 2.3, the Cisco implementation of 4-byte AS numbers uses asdot—1.2, for example—as the only configuration format, regular expression match, and output display, with no asplain support. For an example of BGP peers in two autonomous systems using 4-byte numbers, see the figure below. To view a configuration example of the configuration between three neighbor peers in separate 4-byte autonomous systems configured using asdot notation, see the “Example: Configuring a BGP Routing Process and Peers Using 4-Byte Autonomous System Numbers” section.

Cisco also supports RFC 4893, which was developed to allow BGP to support a gradual transition from 2-byte AS numbers to 4-byte AS numbers. To ensure a smooth transition, we recommend that all BGP speakers within an AS that is identified using a 4-byte AS number be upgraded to support 4-byte AS numbers.

---

**Note**

A new private AS number, 23456, was created by RFC 4893, and this number cannot be configured as an AS number in the Cisco IOS CLI.

**Figure 16: BGP Peers in Two Autonomous Systems Using 4-Byte Numbers**

---

**How to Configure BGP Support for 4-byte ASN**

**Configuring a BGP Routing Process and Peers Using 4-Byte Autonomous System Numbers**

Perform this task to configure a Border Gateway Protocol (BGP) routing process and BGP peers when the BGP peers are located in an autonomous system (AS) that uses 4-byte AS numbers. The address family configured here is the default IPv4 unicast address family, and the configuration is done at Router B in the figure above (in the “Cisco Implementation of 4-Byte Autonomous System Numbers” section). The 4-byte AS numbers in this task are formatted in the default asplain (decimal value) format; for example, Router B is in AS number 65538 in the figure above. Remember to perform this task for any neighbor routers that are to be BGP peers.
Before you begin

Note

By default, neighbors that are defined using the `neighbor remote-as` command in router configuration mode exchange only IPv4 unicast address prefixes. To exchange other address prefix types, such as IPv6 prefixes, neighbors must also be activated using the `neighbor activate` command in address family configuration mode for the other prefix types.

### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `neighbor ip-address remote-as autonomous-system-number`
5. Repeat Step 4 to define other BGP neighbors, as required.
6. `address-family ipv4 [unicast | multicast | vrf vrf-name]`
7. `neighbor ip-address activate`
8. Repeat Step 7 to activate other BGP neighbors, as required.
9. `network network-number [mask network-mask] [route-map route-map-name]`
10. `end`
11. `show ip bgp [network] [network-mask]`
12. `show ip bgp summary`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** | **enable**  
**Example:**  
Device> enable |
| Enables privileged EXEC mode.  
• Enter your password if prompted. |
| **Step 2** | **configure terminal**  
**Example:**  
Device# configure terminal |
| Enters global configuration mode. |
| **Step 3** | **router bgp autonomous-system-number**  
**Example:**  
Device(config)# router bgp 65538 |
| Enters router configuration mode for the specified routing process.  
• In this example, the 4-byte AS number, 65538, is defined in asplain notation. |
| **Step 4** | **neighbor ip-address remote-as autonomous-system-number**  
**Example:**  
Device(config)# neighbor 10.0.0.1 remote-as 65536 |
| Adds the IP address of the neighbor in the specified AS to the IPv4 multiprotocol BGP neighbor table of the local device.  
• In this example, the 4-byte AS number, 65536, is defined in asplain notation. |
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device(config-router)# neighbor 192.168.1.2 remote-as 65536</td>
<td>Step 5 Repeat Step 4 to define other BGP neighbors, as required. --</td>
</tr>
<tr>
<td><strong>Step 6</strong> address-family ipv4 [unicast</td>
<td>multicast</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router)# address-family ipv4 unicast</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong> neighbor ip-address activate</td>
<td>Enables the neighbor to exchange prefixes for the IPv4 unicast address family with the local device.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router-af)# neighbor 192.168.1.2 activate</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong> Repeat Step 7 to activate other BGP neighbors, as required. --</td>
<td></td>
</tr>
<tr>
<td><strong>Step 9</strong> network network-number [mask network-mask] [route-map route-map-name]</td>
<td>(Optional) Specifies a network as local to this AS and adds it to the BGP routing table.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router-af)# network 172.17.1.0 mask 255.255.255.0</td>
<td></td>
</tr>
<tr>
<td><strong>Step 10</strong> end</td>
<td>Exits address family configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router-af)# end</td>
<td></td>
</tr>
<tr>
<td><strong>Step 11</strong> show ip bgp [network] [network-mask]</td>
<td>(Optional) Displays the entries in the BGP routing table.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device# show ip bgp 10.1.1.0</td>
<td><strong>Note</strong> Only the syntax applicable to this task is used in this example. For more details, see the <em>Cisco IOS IP Routing: BGP Command Reference</em>.</td>
</tr>
</tbody>
</table>
**Examples**

The following output from the `show ip bgp` command at Router B shows the BGP routing table entry for network 10.1.1.0 learned from the BGP neighbor at 192.168.1.2 in Router A in the figure above with its 4-byte AS number of 65536 displayed in the default asplain format.

```
RouterB# show ip bgp 10.1.1.0
```

BGP routing table entry for 10.1.1.0/24, version 2
Paths: (1 available, best #1)
  Advertised to update-groups:
       2
          65536
          192.168.1.2 from 192.168.1.2 (10.1.1.99)
            Origin IGP, metric 0, localpref 100, valid, external, best

The following output from the `show ip bgp summary` command shows the 4-byte AS number 65536 for the BGP neighbor 192.168.1.2 of Router A in the figure above after this task has been configured on Router B:

```
RouterB# show ip bgp summary
```

BGP router identifier 172.17.1.99, local AS number 65538
BGP table version is 3, main routing table version 3
2 path entries using 104 bytes of memory
3/2 BGP path/bestpath attribute entries using 444 bytes of memory
1 BGP AS-PATH entries using 24 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 806 total bytes of memory
BGP activity 2/0 prefixes, 2/0 paths, scan interval 60 secs

<table>
<thead>
<tr>
<th>Neighbor</th>
<th>V</th>
<th>AS</th>
<th>MsgRcvd</th>
<th>MsgSent</th>
<th>TblVer</th>
<th>InQ</th>
<th>OutQ</th>
<th>Up/Down</th>
<th>Stated</th>
</tr>
</thead>
<tbody>
<tr>
<td>192.168.1.2</td>
<td>4</td>
<td>65536</td>
<td>6</td>
<td>6</td>
<td>3</td>
<td>0</td>
<td>00:01:33</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

**Troubleshooting Tips**

Use the `ping` command to verify basic network connectivity between the BGP devices.

**Modifying the Default Output and Regular Expression Match Format for 4-Byte Autonomous System Numbers**

Perform this task to modify the default output format for 4-byte autonomous system (AS) numbers from asplain format to asdot notation format. The `show ip bgp summary` command is used to display the changes in output format for the 4-byte AS numbers.
SUMMARY STEPS

1. enable
2. show ip bgp summary
3. configure terminal
4. router bgp autonomous-system-number
5. bgp asnotation dot
6. end
7. clear ip bgp *
8. show ip bgp summary
9. show ip bgp regexp \*regexp
10. configure terminal
11. router bgp autonomous-system-number
12. no bgp asnotation dot
13. end
14. clear ip bgp *

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> show ip bgp summary</td>
<td>Displays the status of all Border Gateway Protocol (BGP) connections.</td>
</tr>
<tr>
<td>Example: Device# show ip bgp summary</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example: Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td>Example: Device(config)# router bgp 65538</td>
<td>• In this example, the 4-byte AS number, 65538, is defined in asplain notation.</td>
</tr>
<tr>
<td><strong>Step 5</strong> bgp asnotation dot</td>
<td>Changes the default output format of BGP 4-byte AS numbers from asplain (decimal values) to dot notation.</td>
</tr>
<tr>
<td>Example: Device(config-router)# bgp asnotation dot</td>
<td>Note 4-byte AS numbers can be configured using either asplain format or asdot format. This command affects only the output displayed for show commands or the matching of regular expressions.</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>Exits address family configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td>end</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-router)# end</td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>Clears and resets all current BGP sessions.</td>
</tr>
<tr>
<td>clear ip bgp *</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td>Device# clear ip bgp *</td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td>Only the syntax applicable to this task is used in this example. For more details, see the <em>Cisco IOS IP Routing: BGP Command Reference</em>.</td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td>Displays the status of all BGP connections.</td>
</tr>
<tr>
<td>show ip bgp summary</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td>Device# show ip bgp summary</td>
</tr>
<tr>
<td><strong>Step 9</strong></td>
<td>Displays routes that match the AS path regular expression.</td>
</tr>
<tr>
<td>show ip bgp regexp regexp</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td>Device# show ip bgp regexp ^1.0$</td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>configure terminal</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td>Device# configure terminal</td>
</tr>
<tr>
<td><strong>Step 11</strong></td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td>router bgp autonomous-system-number</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config)# router bgp 65538</td>
</tr>
<tr>
<td><strong>Step 12</strong></td>
<td>Resets the default output format of BGP 4-byte AS numbers back to asplain (decimal values).</td>
</tr>
<tr>
<td>no bgp asnotation dot</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-router)# no bgp asnotation dot</td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td>4-byte AS numbers can be configured using either asplain format or asdot format. This command affects only the output displayed for show commands or the matching of regular expressions.</td>
</tr>
<tr>
<td><strong>Step 13</strong></td>
<td>Exits router configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td>end</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-router)# end</td>
</tr>
</tbody>
</table>
### Purpose

**Command or Action**

| Step 14 | clear ip bgp * |

**Example:**

Device# clear ip bgp *

**Purpose**

Clears and resets all current BGP sessions.

- In this example, a hard reset is performed to ensure that the 4-byte AS number format change is reflected in all BGP sessions.

**Note**

Only the syntax applicable to this task is used in this example. For more details, see the *Cisco IOS IP Routing: BGP Command Reference*.

### Examples

The following output from the `show ip bgp summary` command shows the default asplain format of the 4-byte AS numbers. Note the asplain format of the 4-byte AS numbers, 65536 and 65550.

```
Router# show ip bgp summary

BGP router identifier 172.17.1.99, local AS number 65538
BGP table version is 1, main routing table version 1
Neighbor   V  AS MagRcvd MsgSent TblVer InQ OutQ Up/Down Statd
192.168.1.2 4  65536  7  7  1  0  0 00:03:04  0
192.168.3.2 4  65550  4  4  1  0  0 00:00:15  0
```

After the `bgp asnotation dot` command is configured (followed by the `clear ip bgp *` command to perform a hard reset of all current BGP sessions), the output is converted to asdot notation format as shown in the following output from the `show ip bgp summary` command. Note the asdot format of the 4-byte AS numbers, 1.0 and 1.14 (these are the asdot conversions of the 65536 and 65550 AS numbers.

```
Router# show ip bgp summary

BGP router identifier 172.17.1.99, local AS number 1.2
BGP table version is 1, main routing table version 1
Neighbor   V  AS MagRcvd MsgSent TblVer InQ OutQ Up/Down Statd
192.168.1.2 4  1.0  9  9  1  0  0 00:04:13  0
192.168.3.2 4  1.14  6  6  1  0  0 00:01:24  0
```

After the `bgp asnotation dot` command is configured (followed by the `clear ip bgp *` command to perform a hard reset of all current BGP sessions), the regular expression match format for 4-byte AS paths is changed to asdot notation format. Although a 4-byte AS number can be configured in a regular expression using either asplain format or asdot format, only 4-byte AS numbers configured using the current default format are matched. In the first example below, the `show ip bgp regexp` command is configured with a 4-byte AS number in asplain format. The match fails because the default format is currently asdot format and there is no output. In the second example using asdot format, the match passes and the information about the 4-byte AS path is shown using the asdot notation.

```
```

**Note**

The asdot notation uses a period, which is a special character in Cisco regular expressions. To remove the special meaning, use a backslash before the period.
Router# show ip bgp regexp ^65536$

Router# show ip bgp regexp ^1\0$

BGP table version is 2, local router ID is 172.17.1.99
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

<table>
<thead>
<tr>
<th>Network</th>
<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>*&gt; 10.1.1.0/24</td>
<td>192.168.1.2</td>
<td>0</td>
<td></td>
<td>0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

**Configuration Examples for BGP Support for 4-byte ASN**

**Examples: Configuring a BGP Routing Process and Peers Using 4-Byte Autonomous System Numbers**

**Asplain Format**

The following example shows the configuration for Router A, Router B, and Router E in the figure below with a Border Gateway Protocol (BGP) process configured between three neighbor peers (at Router A, at Router B, and at Router E) in separate 4-byte autonomous systems configured using asplain notation. IPv4 unicast routes are exchanged with all peers.

*Figure 17: BGP Peers Using 4-Byte Autonomous System Numbers in Asplain Format*

**Router A**

```
router bgp 65536
 bgp router-id 10.1.1.99
 no bgp default ipv4-unicast
 bgp fast-external-fallover
 bgp log-neighbor-changes
timers bgp 70 120
neighbor 192.168.1.1 remote-as 65538
!
address-family ipv4
```
neighbor 192.168.1.1 activate
no auto-summary
no synchronization
network 10.1.1.0 mask 255.255.255.0
exit-address-family

Router B

router bgp 65538
bgp router-id 172.17.1.99
no bgp default ipv4-unicast
bgp fast-external-fallover
bgp log-neighbor-changes
timers bgp 70 120
neighbor 192.168.1.2 remote-as 65536
neighbor 192.168.3.2 remote-as 65550
neighbor 192.168.3.2 description finance
!
address-family ipv4
neighbor 192.168.1.2 activate
neighbor 192.168.3.2 activate
no auto-summary
no synchronization
network 172.17.1.0 mask 255.255.255.0
exit-address-family

Router E

router bgp 65550
bgp router-id 10.2.2.99
no bgp default ipv4-unicast
bgp fast-external-fallover
bgp log-neighbor-changes
timers bgp 70 120
neighbor 192.168.3.1 remote-as 65538
!
address-family ipv4
neighbor 192.168.3.1 activate
no auto-summary
no synchronization
network 10.2.2.0 mask 255.255.255.0
exit-address-family

Asdot Format

The following example shows how to create the configuration for Router A, Router B, and Router E in the figure below with a BGP process configured between three neighbor peers (at Router A, at Router B, and at Router E) in separate 4-byte autonomous systems configured using the default asdot format. IPv4 unicast routes are exchanged with all peers.
Figure 18: BGP Peers Using 4-Byte Autonomous System Numbers in Asdot Format

**Router A**

```
router bgp 1.0
bgp router-id 10.1.1.99
no bgp default ipv4-unicast
bgp fast-external-fallover
bgp log-neighbor-changes
timers bgp 70 120
neighbor 192.168.1.1 remote-as 1.2
!
address-family ipv4
neighbor 192.168.1.1 activate
no auto-summary
no synchronization
network 10.1.1.0 mask 255.255.255.0
exit-address-family
```

**Router B**

```
router bgp 1.2
bgp router-id 172.17.1.99
no bgp default ipv4-unicast
bgp fast-external-fallover
bgp log-neighbor-changes
timers bgp 70 120
neighbor 192.168.1.2 remote-as 1.0
neighbor 192.168.3.2 remote-as 1.14
neighbor 192.168.3.2 description finance
!
address-family ipv4
neighbor 192.168.1.2 activate
neighbor 192.168.3.2 activate
no auto-summary
no synchronization
network 172.17.1.0 mask 255.255.255.0
exit-address-family
```

**Router E**

```
router bgp 1.14
```

---

BGP Support for 4-byte ASN

Examples: Configuring a BGP Routing Process and Peers Using 4-Byte Autonomous System Numbers
Examples: Configuring a VRF and Setting an Extended Community Using a BGP 4-Byte Autonomous System Number

Asplain Default Format in Cisco IOS Release 12.0(32)SY8, 12.0(33)S3, 12.2(33)SRE, 12.2(33)SXI1, and Later Releases

The following example is available in Cisco IOS Release 12.0(32)SY8, 12.0(33)S3, 12.2(33)SRE, 12.2(33)XNE, 12.2(33)SXI1, and later releases and shows how to create a VRF with a route target that uses a 4-byte autonomous system number, 65537, and how to set the route target to extended community value 65537:100 for routes that are permitted by the route map:

```
ip vrf vpn_red
  rd 64500:100
  route-target both 65537:100
  exit
route-map red_map permit 10
  set extcommunity rt 65537:100
end
```

After the configuration is completed, use the `show route-map` command to verify that the extended community is set to the route target that contains the 4-byte autonomous system number of 65537:

```
RouterB# show route-map red_map
route-map red_map, permit, sequence 10
  Match clauses:
  Set clauses:
    extended community RT:65537:100
  Policy routing matches: 0 packets, 0 bytes
```

4-Byte Autonomous System Number RD Support

The following example shows how to create a VRF with a route distinguisher that contains a 4-byte AS number 65536, and a route target that contains a 4-byte autonomous system number, 65537:

```
ip vrf vpn_red
  rd 65536:100
  route-target both 65537:100
  exit
```

After the configuration is completed, use the `show vrf` command to verify that the 4-byte AS number route distinguisher is set to 65536:100:
RouterB# `show vrf vpn_red`
Current configuration : 36 bytes
vrf definition x
  rd 65536:100

**Asdot Default Format in Cisco IOS Release 12.0(32)S12, and 12.4(24)T**

The following example is available in Cisco IOS Release 12.0(32)S12, and 12.4(24)T and shows how to create a VRF with a route target that uses a 4-byte autonomous system number, 1.1, and how to set the route target to the extended community value 1.1:100 for routes that are permitted by the route map.

```
ip vrf vpn_red
rd 64500:100
route-target both 1.1:100
exit
route-map red_map permit 10
  set extcommunity rt 1.1:100
end
```

After the configuration is completed, use the `show route-map` command to verify that the extended community is set to the route target that contains the 4-byte autonomous system number of 1.1.

```
RouterB# `show route-map red_map`
route-map red_map, permit, sequence 10
  Match clauses:
  Set clauses:
    extended community RT:1.1:100
  Policy routing matches: 0 packets, 0 bytes
```

**Asdot Default Format for 4-Byte Autonomous System Number RD Support**

The following example works if you have configured asdot as the default display format using the `bgp asnotation dot` command:

```
ip vrf vpn_red
rd 1.0:100
route-target both 1.1:100
exit
```

**Additional References for BGP Support for 4-byte ASN**

**Related Documents**

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
</tbody>
</table>
Feature Information for BGP Support for 4-byte ASN

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.
## Table 18: Feature Information for BGP Support for 4-byte ASN

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP Support for 4-byte ASN</td>
<td>Cisco IOS XE Release 2.3</td>
<td>The BGP Support for 4-Byte ASN feature introduced support for 4-byte autonomous system numbers.</td>
</tr>
<tr>
<td></td>
<td>Cisco IOS XE Release 2.4</td>
<td>In Cisco IOS XE Release 2.4 and later releases, the Cisco implementation of 4-byte autonomous system numbers uses asplain as the default regular expression match and output display format for autonomous system numbers, but you can configure 4-byte autonomous system numbers in both the asplain format and the asdot format as described in RFC 5396. To change the default regular expression match and output display of 4-byte autonomous system numbers to asdot format, use the <code>bgp asnotation dot</code> command. The following commands were introduced or modified: <code>bgp asnotation dot</code>, <code>bgp confederation identifier</code>, <code>bgp confederation peers</code>, all <code>clear ip bgp</code> commands that configure an autonomous system number, <code>ip as-path access-list</code>, <code>ip extcommunity-list</code>, <code>match source-protocol</code>, <code>neighbor local-as</code>, <code>neighbor remote-as</code>, <code>redistribute (IP)</code>, <code>router bgp</code>, <code>route-target</code>, <code>set as-path</code>, <code>set extcommunity</code>, <code>set origin</code>, all <code>show ip bgp</code> commands that display an autonomous system number, and <code>show ip extcommunity-list</code>.</td>
</tr>
<tr>
<td></td>
<td>Cisco IOS XE Release 3.9S</td>
<td>The BGP Support for 4-Byte ASN RD and RT support for 4-byte autonomous system numbers was added.</td>
</tr>
<tr>
<td>BGP—4-Byte ASN RD and RT Support</td>
<td>Cisco IOS XE Release 3.13S</td>
<td></td>
</tr>
</tbody>
</table>
IPv6 Routing: Multiprotocol BGP Extensions for IPv6

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About IPv6 Routing: Multiprotocol BGP Extensions for IPv6

Multiprotocol BGP Extensions for IPv6

Multiprotocol BGP is the supported Exterior Gateway Protocol (EGP) for IPv6. Multiprotocol BGP extensions for IPv6 supports many of the same features and functionality as IPv4 BGP. IPv6 enhancements to multiprotocol BGP include support for an IPv6 address family and Network Layer Reachability Information (NLRI) and next hop (the next device in the path to the destination) attributes that use IPv6 addresses.
How to Implement Multiprotocol BGP for IPv6

Configuring an IPv6 BGP Routing Process and BGP Router ID

Perform this task to configure an IPv6 BGP routing process and an optional BGP router ID for a BGP-speaking device.

BGP uses a router ID to identify BGP-speaking peers. The BGP router ID is a 32-bit value that is often represented by an IPv4 address. By default, the router ID is set to the IPv4 address of a loopback interface on the device. If no loopback interface is configured on the device, then the software chooses the highest IPv4 address configured to a physical interface on the device to represent the BGP router ID.

When configuring BGP on a device that is enabled only for IPv6 (that is, the device does not have an IPv4 address), you must manually configure the BGP router ID for the device. The BGP router ID, which is represented as a 32-bit value using an IPv4 address syntax, must be unique to the BGP peers of the device.

SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp as-number
4. no bgp default ipv4-unicast
5. bgp router-id ip-address

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example: Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp as-number</td>
<td>Configures a BGP routing process, and enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td>Example: Device(config)# router bgp 65000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> no bgp default ipv4-unicast</td>
<td>Disables the IPv4 unicast address family for the BGP routing process specified in the previous step.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
</tbody>
</table>
### Configuring IPv6 Multiprotocol BGP Between Two Peers

By default, neighbors that are defined using the `neighbor remote-as` command in router configuration mode exchange only IPv4 unicast address prefixes. To exchange other address prefix types, such as IPv6 prefixes, neighbors must also be activated using the `neighbor activate` command in address family configuration mode for the other prefix types, as shown for IPv6 prefixes.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp as-number`
4. `neighbor {ip-address | ipv6-address [%] | peer-group-name} remote-as autonomous-system-number [alternate-as autonomous-system-number ...]`
5. `address-family ipv6 [unicast | multicast]`
6. `neighbor {ip-address | peer-group-name | ipv6-address %} activate`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><code>enable</code></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device&gt;</code> <code>enable</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><code>configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device&gt;</code> <code>configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td><code>router bgp as-number</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config)# router bgp 65000</code></td>
<td></td>
</tr>
</tbody>
</table>
Advertising IPv4 Routes Between IPv6 BGP Peers

If an IPv6 network is connecting two separate IPv4 networks, IPv6 can be used to advertise the IPv4 routes. Configure the peering using the IPv6 addresses within the IPv4 address family. Set the next hop with a static route or with an inbound route map because the advertised next hop will usually be unreachable. Advertising IPv4 routes between two IPv4 peers is also possible using the same model.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router bgp as-number**
4. **neighbor peer-group-name peer-group**
5. **neighbor {ip-address | ipv6-address [%] | peer-group-name} remote-as autonomous-system-number [alternate-as autonomous-system-number ...]**
6. **address-family ipv4 [mdt | multicast | tunnel | unicast [vrf vrf-name] | vrf vrf-name]**
7. **neighbor ipv6-address peer-group peer-group-name**
8. **neighbor {ip-address | peer-group-name | ipv6-address [%]} route-map map-name {in | out}**
9. **exit**
10. **exit**
11. **route-map map-tag [permit | deny] [sequence-number]**
12. **set ip next-hop ip-address [... ip-address] [peer-address]**

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** enable | Enables privileged EXEC mode.  
• Enter your password if prompted. |
| Example: Device> enable |
| **Step 2** configure terminal | Enters global configuration mode. |
| Example: Device# configure terminal |
| **Step 3** router bgp as-number | Enters router configuration mode for the specified routing process. |
| Example: Device(config)# router bgp 65000 |
| **Step 4** neighbor peer-group-name peer-group | Creates a multiprotocol BGP peer group. |
| Example: Device(config-router)# neighbor 6peers peer-group |
| **Step 5** neighbor {ip-address | ipv6-address[%] | peer-group-name} remote-as autonomous-system-number [alternate-as autonomous-system-number ...] | Adds the IPv6 address of the neighbor in the specified autonomous system to the IPv6 multiprotocol BGP neighbor table of the local device. |
| Example: Device(config-router)# neighbor 6peers remote-as 65002 |
| **Step 6** address-family ipv4 [mld | multicast | tunnel | unicast [vrf vrf-name] | vrf vrf-name] | Enters address family configuration mode to configure a routing session using standard IPv4 address prefixes. |
| Example: Device(config-router)# address-family ipv4 |
| **Step 7** neighbor ipv6-address peer-group peer-group-name | Assigns the IPv6 address of a BGP neighbor to a peer group. |
| Example: Device(config-router-af)# neighbor 2001:DB8:1234::2 peer-group 6peers |
| **Step 8** neighbor {ip-address | peer-group-name | ipv6-address [ %]} route-map map-name {in | out} | Applies a route map to incoming or outgoing routes.  
• Changes to the route map will not take effect for existing peers until the peering is reset or a soft reset is performed. Using the clear bgp ipv6 command |
### Clearing External BGP Peers

**SUMMARY STEPS**

1. `enable`
2. `clear bgp ipv6 {unicast | multicast} external [soft] [in | out]`
3. `clear bgp ipv6 {unicast | multicast} peer-group name`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><code>enable</code></td>
<td>- Enter your password if prompted.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td><code>Device&gt; enable</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Clears external IPv6 BGP peers.</td>
</tr>
<tr>
<td>`clear bgp ipv6 {unicast</td>
<td>multicast} external [soft] [in</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td><code>Device# clear bgp ipv6 unicast external soft in</code></td>
<td></td>
</tr>
</tbody>
</table>
### Purpose

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>clear bgp ipv6 {unicast</td>
<td>multicast} peer-group name</td>
</tr>
</tbody>
</table>

#### Example:

Device# clear bgp ipv6 unicast peer-group marketing

---

### Configuring BGP IPv6 Admin Distance

#### Before you begin

- 

#### SUMMARY STEPS

1. 

#### DETAILED STEPS

<table>
<thead>
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<tbody>
<tr>
<td>Step 1</td>
<td>Example:</td>
</tr>
</tbody>
</table>

#### Example

What to do next

- 

---

### Configuration Examples for Multiprotocol BGP for IPv6

#### Example: Configuring a BGP Process, BGP Router ID, and IPv6 Multiprotocol BGP Peer

The following example enables IPv6 globally, configures a BGP process, and establishes a BGP router ID. Also, the IPv6 multiprotocol BGP peer 2001:DB8:0:CC00::1 is configured and activated.

```conf
ipv6 unicast-routing
!
router bgp 65000
no bgp default ipv4-unicast
bgp router-id 192.168.99.70
neighbor 2001:DB8:0:CC00::1 remote-as 64600
address-family ipv6 unicast
   neighbor 2001:DB8:0:CC00::1 activate
```

---
Example: Configuring an IPv6 Multiprotocol BGP Peer Group

The following example configures the IPv6 multiprotocol BGP peer group named group1:

```
router bgp 65000
  no bgp default ipv4-unicast
  neighbor group1 peer-group
  neighbor 2001:DB8:0:CC00::1 remote-as 64600
  address-family ipv6 unicast
  neighbor group1 activate
  neighbor 2001:DB8:0:CC00::1 peer-group group1
```

Example: Advertising Routes into IPv6 Multiprotocol BGP

The following example injects the IPv6 network 2001:DB8::/24 into the IPv6 unicast database of the local device. (BGP checks that a route for the network exists in the IPv6 unicast database of the local device before advertising the network.)

```
router bgp 65000
  no bgp default ipv4-unicast
  address-family ipv6 unicast
    network 2001:DB8::/24
```

Example: Configuring a Route Map for IPv6 Multiprotocol BGP Prefixes

The following example configures the route map named rtp to permit IPv6 unicast routes from network 2001:DB8::/24 if they match the prefix list named cisco:

```
router bgp 64900
  no bgp default ipv4-unicast
  neighbor 2001:DB8:0:CC00::1 remote-as 64700
  address-family ipv6 unicast
    neighbor 2001:DB8:0:CC00::1 activate
    neighbor 2001:DB8:0:CC00::1 route-map rtp in
    ipv6 prefix-list cisco seq 10 permit 2001:DB8::/24
    route-map rtp permit 10
      match ipv6 address prefix-list cisco
```

Example: Redistributing Prefixes into IPv6 Multiprotocol BGP

The following example redistributes RIP routes into the IPv6 unicast database of the local device:

```
router bgp 64900
  no bgp default ipv4-unicast
  address-family ipv6 unicast
    redistribute rip
```

Example: Advertising IPv4 Routes Between IPv6 Peers

The following example advertises IPv4 routes between IPv6 peers when the IPv6 network is connecting two separate IPv4 networks. Peering is configured using IPv6 addresses in the IPv4 address family configuration:
mode. The inbound route map named rmap sets the next hop because the advertised next hop is likely to be unreachable.

```
router bgp 65000
!
neighbor 6peers peer-group
neighbor 2001:DB8:1234::2 remote-as 65002
address-family ipv4
neighbor 6peers activate
neighbor 2001:DB8:1234::2 soft-reconfiguration inbound
neighbor 2001:DB8:1234::2 peer-group 6peers
neighbor 2001:DB8:1234::2 route-map rmap in
!
route-map rmap permit 10
set ip next-hop 10.21.8.10
```

### Additional References

#### Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
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<tbody>
<tr>
<td>IPv6 addressing and connectivity</td>
<td>IPv6 Configuration Guide</td>
</tr>
<tr>
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<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>IPv6 commands</td>
<td>Cisco IOS IPv6 Command Reference</td>
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<tr>
<td>Cisco IOS IPv6 features</td>
<td>Cisco IOS IPv6 Feature Mapping</td>
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#### Standards and RFCs

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<th>Title</th>
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#### MIBs

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<th>MIBs Link</th>
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<td>To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
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### Technical Assistance

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<th>Description</th>
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<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
<tr>
<td>download documentation, software, and tools. Use these resources to install</td>
<td></td>
</tr>
<tr>
<td>and configure the software and to troubleshoot and resolve technical</td>
<td></td>
</tr>
<tr>
<td>issues with Cisco products and technologies. Access to most tools on the</td>
<td></td>
</tr>
<tr>
<td>Cisco Support and Documentation website requires a Cisco.com user ID and</td>
<td></td>
</tr>
<tr>
<td>password.</td>
<td></td>
</tr>
</tbody>
</table>

### Feature Information for IPv6 Routing Multiprotocol BGP

Extensions for IPv6

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to [http://www.cisco.com/go/cfn](http://www.cisco.com/go/cfn). An account on Cisco.com is not required.

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPv6 Routing: Multiprotocol BGP Extensions for IPv6</td>
<td>Cisco IOS XE Release 2.1</td>
<td>Multiprotocol BGP extensions for IPv6 supports the same features and functionality as IPv4 BGP.</td>
</tr>
</tbody>
</table>
IPv6 Routing: Multiprotocol BGP Link-Local Address Peering

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About IPv6 Routing: Multiprotocol BGP Link-Local Address Peering

IPv6 Multiprotocol BGP Peering Using a Link-Local Address

The IPv6 multiprotocol BGP can be configured between two IPv6 devices (peers) using link-local addresses. For this function to work, you must identify the interface for the neighbor by using the neighbor update-source command, and you must configure a route map to set an IPv6 global next hop.

Border Gateway Protocol (BGP) uses third-party next hops for peering with multiple peers over IPv6 link-local addresses on the same interface. Peering over link-local addresses on different interfaces cannot use third party next hops. The neighbors peering using link-local addresses are split into one update group per interface. BGP splits update group membership for neighbors with link-local addresses based on the interface used to communicate with that neighbor.
How to Configure IPv6 Routing: Multiprotocol BGP Link-Local Address Peering

Configuring an IPv6 Multiprotocol BGP Peer Using a Link-Local Address

Configuring IPv6 multiprotocol BGP between two IPv6 routers (peers) using link-local addresses requires that the interface for the neighbor be identified by using the `update-source` command and that a route map be configured to set an IPv6 global next hop.

**Note**
- By default, neighbors that are defined using the `neighbor remote-as` command in router configuration mode exchange only IPv4 unicast address prefixes. To exchange other address prefix types, such as IPv6 prefixes, neighbors must also be activated using the `neighbor activate` command in address family configuration mode for the other prefix types, as shown for IPv6 prefixes.
- By default, route maps that are applied in router configuration mode using the `neighbor route-map` command are applied to only IPv4 unicast address prefixes. Route maps for other address families must be applied in address family configuration mode using the `neighbor route-map` command, as shown for the IPv6 address family. The route maps are applied either as the inbound or outbound routing policy for neighbors under the specified address family. Configuring separate route maps under each address family type simplifies managing complicated or different policies for each address family.
- The route-map used to modify the next hop needs to be applied outbound only. Inbound route-map to modify next-hop ipv6 address is not supported. Inbound route-map is supported only for IPV4 address family.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `neighbor {ip-address | ipv6-address[%] | peer-group-name} remote-as autonomous-system-number [alternate-as autonomous-system-number ...]`
5. `neighbor {ip-address | ipv6-address[%] | peer-group-name} update-source interface-type interface-number`
6. `address-family ipv6 [vrf vrf-name] [unicast | multicast | vpnv6]
7. neighbor {ip-address | peer-group-name | ipv6-address %} activate`
8. `neighbor {ip-address | peer-group-name | ipv6-address[]} route-map map-name {in | out}
9. `exit`
10. Repeat Step 9.
11. `route-map map-tag [permit | deny] [sequence-number]`
12. `match ipv6 address {prefix-list prefix-list-name | access-list-name}
13. set ipv6 next-hop ipv6-address [link-local-address] [peer-address]`
## DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>enable</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Device&gt; enable</td>
</tr>
<tr>
<td></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>configure terminal</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Device# configure terminal</td>
</tr>
<tr>
<td></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>router bgp autonomous-system-number</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config)# router bgp 65000</td>
</tr>
<tr>
<td></td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>neighbor {ip-address</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config-router)# neighbor FE80::1234:BFF:FE0E:A471% remote-as 64600</td>
</tr>
<tr>
<td></td>
<td>Adds the link-local IPv6 address of the neighbor in the specified remote autonomous system to the IPv6 multiprotocol BGP neighbor table of the local router.</td>
</tr>
<tr>
<td></td>
<td>• The optional % keyword is the IPv6 link-local address identifier. This keyword needs to be added whenever a link-local IPv6 address is used outside the context of its interface.</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>neighbor {ip-address</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config-router)# neighbor FE80::1234:BFF:FE0E:A471% update-source gigabitethernet0/0/0</td>
</tr>
<tr>
<td></td>
<td>Specifies the link-local address over which the peering is to occur.</td>
</tr>
<tr>
<td></td>
<td>• The optional % keyword is the IPv6 link-local address identifier. This keyword needs to be added whenever a link-local IPv6 address is used outside the context of its interface.</td>
</tr>
<tr>
<td></td>
<td>• If there are multiple connections to the neighbor and you do not specify the neighbor interface by using the interface-type and interface-number arguments in the neighbor update-source command, a TCP connection cannot be established with the neighbor using link-local addresses.</td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>address-family ipv6 [vrf vrf-name] [unicast</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config-router)# address-family ipv6</td>
</tr>
<tr>
<td></td>
<td>Specifies the IPv6 address family, and enters address family configuration mode.</td>
</tr>
<tr>
<td></td>
<td>• The unicast keyword specifies the IPv6 unicast address family. By default, the router is placed in configuration mode for the IPv6 unicast address family if the unicast keyword is not specified with the address-family ipv6 command.</td>
</tr>
</tbody>
</table>
### Purpose

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 7** neighbor {ip-address | peer-group-name | ipv6-address %} activate | - The **multicast** keyword specifies IPv6 multicast address prefixes. Enables the neighbor to exchange prefixes for the IPv6 address family with the local router using the specified link-local addresses.  
  - The optional % keyword is the IPv6 link-local address identifier. This keyword needs to be added whenever a link-local IPv6 address is used outside the context of its interface. |
| **Step 8** neighbor {ip-address | peer-group-name | ipv6-address[%]} route-map map-name {in | out} | Applies a route map to incoming or outgoing routes.  
  - The optional % keyword is the IPv6 link-local address identifier. This keyword needs to be added whenever a link-local IPv6 address is used outside the context of its interface. |
| **Step 9** exit | Exits address family configuration mode, and returns the device to router configuration mode. |
| **Step 10** Repeat Step 9. | Exits router configuration mode, and returns the device to global configuration mode. |
| **Step 11** route-map map-tag [permit | deny] [sequence-number] | Defines a route map and enters route-map configuration mode. |
| **Step 12** match ipv6 address {prefix-list prefix-list-name | access-list-name} | Distributes any routes that have a destination IPv6 network number address permitted by a prefix list, or performs policy routing on packets. |
| **Step 13** set ipv6 next-hop ipv6-address [link-local-address] [peer-address] | Overrides the next hop advertised to the peer for IPv6 packets that pass a match clause of a route map for policy routing.  
  - The **ipv6-address** argument specifies the IPv6 global address of the next hop. It need not be an adjacent router. |
### Command or Action

<table>
<thead>
<tr>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>• The <em>link-local-address</em> argument specifies the IPv6 link-local address of the next hop. It must be an adjacent router.</td>
</tr>
</tbody>
</table>

### Note

The route map sets the IPv6 next-hop addresses (global and link-local) in BGP updates. If the route map is not configured, the next-hop address in the BGP updates defaults to the unspecified IPv6 address (::), which is rejected by the peer. If you specify only the global IPv6 next-hop address (the *ipv6-address* argument) with the `set ipv6 next-hop` command after specifying the neighbor interface (the `interface-type` argument) with the `neighbor update-source` command in Step 5, the link-local address of the interface specified with the `interface-type` argument is included as the next-hop in the BGP updates. Therefore, only one route map that sets the global IPv6 next-hop address in BGP updates is required for multiple BGP peers that use link-local addresses.

---

## Configuration Examples for IPv6 Routing: Multiprotocol BGP Link-Local Address Peering

### Example: Configuring an IPv6 Multiprotocol BGP Peer Using a Link-Local Address

The following example configures the IPv6 multiprotocol BGP peer FE80::1234:BFF:FE0E:A471 over Gigabitethernet interface 0/0 and sets the route map named nh6 to include the IPv6 next-hop global address of Gigabitethernet interface 0/0 in BGP updates. The IPv6 next-hop link-local address can be set by the nh6 route map (not shown in the following example) or from the interface specified by the `neighbor update-source` command (as shown in this example).

```
Device> enable
Device# configure terminal
Device(config)# router bgp 5
Device(config-router)# neighbor internal peer-group
Device(config-router)# neighbor FE80::1234:BFF:FE0E:A471% peer-group
Device(config-router)# neighbor internal remote-as 100
Device(config-router)# neighbor FE80::1234:BFF:FE0E:A471% remote-as 64600
Device(config-router)# neighbor FE80::1234:BFF:FE0E:A471% update-source Gigabitethernet 0/0

Device(config-router)# address-family ipv6
Device(config-router-af)# neighbor FE80::1234:BFF:FE0E:A471% activate
Device(config-router-af)# neighbor FE80::1234:BFF:FE0E:A471% route-map nh6 out
Device(config-router-af)# exit
```
Device(config-router)# exit
Device(config)# route-map nh6permit 10
Device(config-router-map)# match ipv6 address prefix-list cisco
Device(config-router-map)# set ipv6 next-hop 2001:DB8:526::1
Device(config-router-map)# exit
Device(config)# ipv6 prefix-list cisco permit 2001:DB8:2F22::/48 le 128
Device(config)# ipv6 prefix-list cisco deny ::/0
Device(config)# end

Note
If you specify only the global IPv6 next-hop address (the ipv6-address argument) with the set ipv6 next-hop command after specifying the neighbor interface (the interface-type argument) with the neighbor update-source command, the link-local address of the interface specified with the interface-type argument is included as the next hop in the BGP updates. Therefore, only one route map that sets the global IPv6 next-hop address in BGP updates is required for multiple BGP peers that use link-local addresses.

Additional References

Related Documents

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<tr>
<th>Related Topic</th>
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<td>Cisco IOS IPv6 features</td>
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Standards and RFCs

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MIBs

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Technical Assistance

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<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

Feature Information for IPv6 Routing Multiprotocol BGP Link-Local Address Peering

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 20: Feature Information for IPv6 Routing: Multiprotocol BGP Link-Local Address Peering

<table>
<thead>
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<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
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<tr>
<td>IPv6 Routing: Multiprotocol BGP Link-Local Address Peering</td>
<td>Cisco IOS XE Release 2.1</td>
<td>This feature is supported.</td>
</tr>
</tbody>
</table>
IPv6 Multicast Address Family Support for Multiprotocol BGP

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

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Information About IPv6 Multicast Address Family Support for Multiprotocol BGP

Multiprotocol BGP for the IPv6 Multicast Address Family

The multiprotocol BGP for the IPv6 multicast address family feature provides multicast BGP extensions for IPv6 and supports the same features and functionality as IPv4 BGP. IPv6 enhancements to multicast BGP include support for an IPv6 multicast address family and network layer reachability information (NLRI) and next hop (the next router in the path to the destination) attributes that use IPv6 addresses.

Multicast BGP is an enhanced BGP that allows the deployment of interdomain IPv6 multicast. Multiprotocol BGP carries routing information for multiple network layer protocol address families; for example, IPv6 address family and for IPv6 multicast routes. The IPv6 multicast address family contains routes used for RPF
lookup by the IPv6 PIM protocol, and multicast BGP IPv6 provides for interdomain transport of the same. Users must use multiprotocol BGP for IPv6 multicast when using IPv6 multicast with BGP because the unicast BGP learned routes will not be used for IPv6 multicast.

Multicast BGP functionality is provided through a separate address family context. A subsequent address family identifier (SAFI) provides information about the type of the network layer reachability information that is carried in the attribute. Multiprotocol BGP unicast uses SAFI 1 messages, and multiprotocol BGP multicast uses SAFI 2 messages. SAFI 1 messages indicate that the routes are usable only for IP unicast, not IP multicast. Because of this functionality, BGP routes in the IPv6 unicast RIB must be ignored in the IPv6 multicast RPF lookup.

A separate BGP routing table is maintained to configure incongruent policies and topologies (for example, IPv6 unicast and multicast) by using IPv6 multicast RPF lookup. Multicast RPF lookup is very similar to the IP unicast route lookup.

No MRIB is associated with the IPv6 multicast BGP table. However, IPv6 multicast BGP operates on the unicast IPv6 RIB when needed. Multicast BGP does not insert or update routes into the IPv6 unicast RIB.

How to Implement IPv6 Multicast Address Family Support for Multiprotocol BGP

Configuring an IPv6 Peer Group to Perform Multicast BGP Routing

SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp as-number
4. neighbor peer-group-name peer-group
5. neighbor {ip-address | ipv6-address | peer-group-name} remote-as as-number
6. address-family ipv6 [unicast | multicast]
7. neighbor {ip-address | peer-group-name | ipv6-address} activate
8. neighbor {ip-address | ipv6-address} peer-group peer-group-name

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example: Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td>Step</td>
<td>Command or Action</td>
</tr>
<tr>
<td>------</td>
<td>------------------</td>
</tr>
<tr>
<td>Step 3</td>
<td><code>router bgp as-number</code>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;<code>Device(config)# router bgp 65000</code></td>
</tr>
<tr>
<td>Step 4</td>
<td><code>neighbor peer-group-name peer-group</code>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;<code>Device(config-router)# neighbor group1 peer-group</code></td>
</tr>
<tr>
<td>Step 5</td>
<td>`neighbor {ip-address</td>
</tr>
<tr>
<td>Step 6</td>
<td>`address-family ipv6 [unicast</td>
</tr>
<tr>
<td>Step 7</td>
<td>`neighbor {ip-address</td>
</tr>
<tr>
<td>Step 8</td>
<td>`neighbor {ip-address</td>
</tr>
</tbody>
</table>

**Advertising Routes into IPv6 Multiprotocol BGP**

By default, networks that are defined in router configuration mode using the `network` command are injected into the IPv4 unicast database. To inject a network into another database, such as the IPv6 BGP database, you must define the network using the `network` command in address family configuration mode for the other database, as shown for the IPv6 BGP database.
### SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router bgp** `as-number`
4. **address-family ipv6** `[vrf vrf-name] [unicast | multicast | vpnv6]`
5. **network** `{network-number [mask network-mask] | nsap-prefix} [route-map map-tag]`
6. **exit**

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp <code>as-number</code></td>
<td>Enters router configuration mode for the specified BGP routing process.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# router bgp 65000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> address-family ipv6 `[vrf vrf-name] [unicast</td>
<td>multicast</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router)# address-family ipv6 unicast</td>
<td>• The <strong>unicast</strong> keyword specifies the IPv6 unicast address family. By default, the device is placed in configuration mode for the IPv6 unicast address family if a keyword is not specified with the <strong>address-family ipv6</strong> command.</td>
</tr>
<tr>
<td><strong>Step 5</strong> network `{network-number [mask network-mask]</td>
<td>nsap-prefix} [route-map map-tag]`</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router-af)# network 2001:DB8::/24</td>
<td>• The prefix is injected into the database for the address family specified in the previous step.</td>
</tr>
<tr>
<td></td>
<td>• Routes are tagged from the specified prefix as “local origin.”</td>
</tr>
<tr>
<td></td>
<td>• The <strong>ipv6-prefix</strong> argument in the <strong>network</strong> command must be in the form documented in RFC 2373 where</td>
</tr>
</tbody>
</table>
Redistributing Prefixes into IPv6 Multiprotocol BGP

Redistribution is the process of redistributing, or injecting, prefixes from one routing protocol into another routing protocol. This task explains how to inject prefixes from a routing protocol into IPv6 multiprotocol BGP. Specifically, prefixes that are redistributed into IPv6 multiprotocol BGP using the `redistribute` router configuration command are injected into the IPv6 unicast database.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp as-number`
4. `address-family ipv6 [vrf vrf-name] [unicast | multicast | vpnv6]`
5. `redistribute bgp [process-id][metric metric-value] [route-map map-name] [source-protocol-options]`
6. `exit`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example: Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp as-number</td>
<td>Enters router configuration mode for the specified BGP routing process.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
</tbody>
</table>
### Assigning a BGP Administrative Distance

**Caution**
Changing the administrative distance of BGP internal routes is not recommended. One problem that can occur is the accumulation of routing table inconsistencies, which can break routing.

<table>
<thead>
<tr>
<th>Summary Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. enable</td>
</tr>
<tr>
<td>2. configure terminal</td>
</tr>
<tr>
<td>3. router bgp as-number</td>
</tr>
<tr>
<td>4. address-family ipv6 [unicast</td>
</tr>
<tr>
<td>5. distance bgp external-distance internal-distance local-distance</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Detailed Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Command or Action</td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>Step 1 enable</td>
</tr>
<tr>
<td>Example:</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
</tr>
<tr>
<td>------------------</td>
</tr>
<tr>
<td>Device&gt; enable</td>
</tr>
<tr>
<td>Step 2</td>
</tr>
<tr>
<td>configure terminal</td>
</tr>
<tr>
<td>Step 3</td>
</tr>
<tr>
<td>router bgp as-number</td>
</tr>
<tr>
<td>Step 4</td>
</tr>
<tr>
<td>address-family ipv6 [unicast</td>
</tr>
<tr>
<td>Step 5</td>
</tr>
<tr>
<td>neighbor ipv6-address translate-update ipv6 multicast [unicast]</td>
</tr>
</tbody>
</table>

**Generating Translate Updates for IPv6 Multicast BGP**

The multicast BGP translate-update feature generally is used in a multicast BGP-capable router that peers with a customer site that has only a BGP-capable router; the customer site has not or cannot upgrade its router to a multicast BGP-capable image. Because the customer site cannot originate multicast BGP advertisements, the router with which it peers will translate the BGP prefixes into multicast BGP prefixes, which are used for multicast-source RPF lookup.

**SUMMARY STEPS**

1. enable
2. configure terminal
3. router bgp as-number
4. address-family ipv6 [unicast | multicast]
5. neighbor ipv6-address translate-update ipv6 multicast [unicast]

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>enable</td>
<td>Enter your password if prompted.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
</tbody>
</table>
### Resetting IPv6 BGP Sessions

**SUMMARY STEPS**

1. **enable**
2. **clear bgp ipv6 {unicast | multicast} { | autonomous-system-number | ip-address | ipv6-address | peer-group peer-group-name} [soft | in | out]**

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device&gt; enable</td>
<td>Enter your password if prompted.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 2</strong> clear bgp ipv6 {unicast</td>
<td>multicast} {</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
</tbody>
</table>
### Clearing External BGP Peers

**SUMMARY STEPS**

1. `enable`
2. `clear bgp ipv6 {unicast | multicast} external [soft] [in | out]`
3. `clear bgp ipv6 {unicast | multicast} peer-group name`

### Detailed Steps

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> `clear bgp ipv6 {unicast</td>
<td>multicast} external [soft] [in</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device# clear bgp ipv6 unicast external soft in</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> `clear bgp ipv6 {unicast</td>
<td>multicast} peer-group name`</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device# clear bgp ipv6 unicast peer-group marketing</td>
<td></td>
</tr>
</tbody>
</table>

### Clearing IPv6 BGP Route Dampening Information

**SUMMARY STEPS**

1. `enable`
2. `clear bgp ipv6 {unicast | multicast} dampening [ipv6-prefix|prefix-length]`

### Detailed Steps

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> `clear bgp ipv6 {unicast</td>
<td>multicast} dampening [ipv6-prefix</td>
</tr>
</tbody>
</table>
Clearing IPv6 BGP Flap Statistics

SUMMARY STEPS

1. enable
2. clear bgp ipv6 \{unicast | multicast\} flap-statistics \[ipv6-prefix/prefix-length | regexp regex | filter-list list\]

DETAILED STEPS

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Command or Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enables privileged EXEC mode.</td>
<td>enable</td>
</tr>
<tr>
<td>• Enter your password if prompted.</td>
<td></td>
</tr>
<tr>
<td>Clears IPv6 BGP flap statistics.</td>
<td>clear bgp ipv6 {unicast</td>
</tr>
</tbody>
</table>

Example: Configuring an IPv6 Multicast BGP Peer Group

The following example configures the IPv6 multicast BGP peer group named group1:

```
router bgp 65000
no bgp default ipv4-unicast
neighbor group1 peer-group
neighbor 2001:DB8:0:CC00::1 remote-as 64600
```
address-family ipv6 unicast
neighbor group1 activate
neighbor 2001:DB8::0:CC00::1 peer-group group1

Example: Advertising Routes into IPv6 Multiprotocol BGP

The following example injects the IPv6 network 2001:DB8::/24 into the IPv6 unicast database of the local device. (BGP checks that a route for the network exists in the IPv6 unicast database of the local device before advertising the network.)

```
router bgp 65000
  no bgp default ipv4-unicast
  address-family ipv6 unicast
    network 2001:DB8::/24
```

Example: Redistributing Prefixes into IPv6 Multiprotocol BGP

The following example redistributes RIP routes into the IPv6 unicast database of the local device:

```
router bgp 64900
  no bgp default ipv4-unicast
  address-family ipv6 unicast
    redistribute rip
```

Example: Generating Translate Updates for IPv6 Multicast BGP

The following example shows how to generate IPv6 multicast BGP updates that correspond to unicast IPv6 updates:

```
router bgp 64900
  no bgp default ipv4-unicast
  address-family ipv6 multicast
    neighbor 2001:DB8:7000::2 translate-update ipv6 multicast
```

Additional References

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPv6 addressing and connectivity</td>
<td>IPv6 Configuration Guide</td>
</tr>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>IPv6 commands</td>
<td>Cisco IOS IPv6 Command Reference</td>
</tr>
<tr>
<td>Cisco IOS IPv6 features</td>
<td>Cisco IOS IPv6 Feature Mapping</td>
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</table>
Standards and RFCs

<table>
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<th>Title</th>
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<td>RFCs for IPv6</td>
<td>IPv6 RFCs</td>
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</table>

MIBs

<table>
<thead>
<tr>
<th>MIB</th>
<th>MIBs Link</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

Feature Information for IPv6 Multicast Address Family Support for Multiprotocol BGP

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPv6 Multicast: Address Family Support for Multiprotocol BGP</td>
<td>Cisco IOS XE Release 2.1</td>
<td>This feature provides multicast BGP extensions for IPv6 and supports the same features and functionality as IPv4 BGP.</td>
</tr>
</tbody>
</table>
CHAPTER 10

Configuring Multiprotocol BGP (MP-BGP) Support for CLNS

This module describes configuration tasks to configure multiprotocol BGP (MP-BGP) support for CLNS, which provides the ability to scale Connectionless Network Service (CLNS) networks. The multiprotocol extensions of Border Gateway Protocol (BGP) add the ability to interconnect separate Open System Interconnection (OSI) routing domains without merging the routing domains, thus providing the capability to build very large OSI networks.

• Finding Feature Information, on page 217
• Restrictions for Configuring MP-BGP Support for CLNS, on page 217
• Information About Configuring MP-BGP Support for CLNS, on page 218
• How to Configure MP-BGP Support for CLNS, on page 222
• Configuration Examples for MP-BGP Support for CLNS, on page 242
• Additional References, on page 251
• Feature Information for Configuring MP-BGP Support for CLNS, on page 251
• Glossary, on page 254

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Restrictions for Configuring MP-BGP Support for CLNS

The configuration of MP-BGP support for CLNS does not support the creation and use of BGP confederations within the CLNS network. We recommend the use of route reflectors to address the issue of a large internal BGP mesh. BGP extended communities are not supported by the MP-BGP Support for CLNS feature. The following BGP commands are not supported by the MP-BGP Support for CLNS feature:
Information About Configuring MP-BGP Support for CLNS

Address Family Routing Information

By default, commands entered under the `router bgp` command apply to the IPv4 address family. This will continue to be the case unless you enter the `no bgp default ipv4-unicast` command as the first command under the `router bgp` command. The `no bgp default ipv4-unicast` command is configured on the router to disable the default behavior of the BGP routing process exchanging IPv4 addressing information with BGP neighbor routers.

Design Features of MP-BGP Support for CLNS

The configuration of MP-BGP support for CLNS allows BGP to be used as an interdomain routing protocol in networks that use CLNS as the network-layer protocol. This feature was developed to solve a scaling issue with a data communications network (DCN) where large numbers of network elements are managed remotely. For details about the DCN issues and how to implement this feature in a DCN topology, see the DCN Network Topology, on page 220.

BGP, as an Exterior Gateway Protocol, was designed to handle the volume of routing information generated by the Internet. Network administrators can control the BGP routing information because BGP neighbor relationships (peering) are manually configured and routing updates use incremental broadcasts. Some interior routing protocols such as Intermediate System-to-Intermediate System (IS-IS), in contrast, use a form of automatic neighbor discovery and broadcast updates at regular intervals.

CLNS uses network service access point (NSAP) addresses to identify all its network elements. Using the BGP address-family support, NSAP address prefixes can be transported using BGP. In CLNS, BGP prefixes are inserted into the CLNS Level 2 prefix table. This functionality allows BGP to be used as an interdomain routing protocol between separate CLNS routing domains.

Implementing BGP in routers at the edge of each internal network means that the existing interior protocols need not be changed, minimizing disruption in the network.

Generic BGP CLNS Network Topology

The figure below shows a generic BGP CLNS network containing nine routers that are grouped into four different autonomous systems (in BGP terminology) or routing domains (in OSI terminology). To avoid confusion, we will use the BGP terminology of autonomous systems because each autonomous system is numbered and therefore more easily identified in the diagram and in the configuration discussion.
Within each autonomous system, IS-IS is used as the intradomain routing protocol. Between autonomous systems, BGP and its multiprotocol extensions are used as the interdomain routing protocol. Each router is running either a BGP or Level 2 IS-IS routing process. To facilitate this feature, the BGP routers are also running a Level 2 IS-IS process. Although the links are not shown in the figure, each Level 2 IS-IS router is connected to multiple Level 1 IS-IS routers that are, in turn, connected to multiple CLNS networks.

Each autonomous system in this example is configured to demonstrate various BGP features and how these features work with CLNS to provide a scalable interdomain routing solution. In the figure above, the autonomous system AS65101 has a single Level 2 IS-IS router, R1, and is connected to just one other autonomous system, AS65202. Connectivity to the rest of the network is provided by R2, and a default route is generated for R1 to send to R2 all packets with destination NSAP addresses outside of AS65101.

In AS65202 there are two routers, R2 and R3, both with different external BGP (eBGP) neighbors. Routers R2 and R3 are configured to run internal BGP (iBGP) over the internal connection between them.

AS65303 shows how the use of BGP peer groups and route reflection can minimize the need for TCP connections between routers. Fewer connections between routers simplifies the network design and the amount of traffic in the network.

AS65404 shows how to use redistribution to communicate network reachability information to a Level 2 IS-IS router that is not running BGP.

The configuration tasks and examples are based on the generic network design shown in the figure above. Configurations for all the routers in the figure are listed in the Implementing MP-BGP Support for CLNS Example, on page 245.
DCN Network Topology

The Multiprotocol BGP (MP-BGP) Support for CLNS feature can benefit a DCN managing a large number of remote SONET rings. SONET is typically used by telecommunications companies to send data over fiber-optic networks.

The figure below shows some components of a DCN network. To be consistent with the BGP terminology, the figure contains labels to indicate three autonomous systems instead of routing domains. The network elements--designated by NE in Figure 2--of a SONET ring are managed by OSI protocols such as File Transfer, Access, and Management (FTAM) and Common Management Information Protocol (CMIP). FTAM and CMIP run over the CLNS network-layer protocol, which means that the routers providing connectivity must run an OSI routing protocol.

*Figure 20: Components in a DCN Network*

IS-IS is a link-state protocol used in this example to route CLNS. Each routing node (networking device) is called an intermediate system (IS). The network is divided into areas defined as a collection of routing nodes. Routing within an area is referred to as Level 1 routing. Routing between areas involves Level 2 routing. Routers that link a Level 1 area with a Level 2 area are defined as Level 1-2 routers. A network element that connects to the Level 2 routers that provide a path to the DCN core is represented by a gateway network element--GNE in Figure 2. The network topology here is a point-to-point link between each network element router. In this example, a Level 1 IS-IS router is called an NE router.
Smaller Cisco routers such as the Cisco 2600 series were selected to run as the Level 1-2 routers because shelf space in the central office (CO) of a service provider is very expensive. A Cisco 2600 series router has limited processing power if it is acting as the Level 1 router for four or five different Level 1 areas. The number of Level 1 areas under this configuration is limited to about 200. The entire Level 2 network is also limited by the speed of the slowest Level 2 router.

To provide connectivity between NE routers, in-band signaling is used. The in-band signaling is carried in the SONET/Synchronous Digital Hierarchy (SDH) frame on the data communications channel (DCC). The DCC is a 192-KB channel, which is a very limited amount of bandwidth for the management traffic. Due to the limited signaling bandwidth between network elements and the limited amount of processing power and memory in the NE routers running IS-IS, each area is restricted to a maximum number of 30 to 40 routers. On average, each SONET ring consists of 10 to 15 network elements.

With a maximum of 200 areas containing 10 to 15 network elements per area, the total number of network element routers in a single autonomous system must be fewer than 3000. Service providers are looking to implement over 10,000 network elements as their networks grow, but the potential number of network elements in an area is limited. The current solution is to break down the DCN into a number of smaller autonomous systems and connect them using static routes or ISO Interior Gateway Routing Protocol (IGRP). ISO IGRP is a proprietary protocol that can limit future equipment implementation options. Static routing does not scale because the growth in the network can exceed the ability of a network administrator to maintain the static routes. BGP has been shown to scale to over 100,000 routes.

To implement the Multiprotocol BGP (MP-BGP) Support for CLNS feature in this example, configure BGP to run on each router in the DCN core network--AS64800 in Figure 2--to exchange routing information between all the autonomous systems. In the autonomous systems AS64600 and AS64700, only the Level 2 routers will run BGP. BGP uses TCP to communicate with BGP-speaking neighbor routers, which means that both an IP-addressed network and an NSAP-addressed network must be configured to cover all the Level 2 IS-IS routers in the autonomous systems AS64600 and AS64700 and all the routers in the DCN core network.

Assuming that each autonomous system--for example, AS64600 and AS64700 in Figure 2--remains the same size with up to 3000 nodes, we can demonstrate how large DCN networks can be supported with this feature. Each autonomous system advertises one address prefix to the core autonomous system. Each address prefix can have two paths associated with it to provide redundancy because there are two links between each autonomous system and the core autonomous system. BGP has been shown to support 100,000 routes, so the core autonomous system can support many other directly linked autonomous systems because each autonomous system generates only a few routes. We can assume that the core autonomous system can support about 2000 directly linked autonomous systems. With the hub-and-spoke design where each autonomous system is directly linked to the core autonomous system, and not acting as a transit autonomous system, the core autonomous system can generate a default route to each linked autonomous system. Using the default routes, the Level 2 routers in the linked autonomous systems process only a small amount of additional routing information. Multiplying the 2000 linked autonomous systems by the 3000 nodes within each autonomous system could allow up to 6 million network elements.

**Benefits of MP-BGP Support for CLNS**

The Multiprotocol BGP (MP-BGP) Support for CLNS feature adds the ability to interconnect separate OSI routing domains without merging the routing domains, which provides the capability to build very large OSI networks. The benefits of using this feature are not confined to DCN networks, and can be implemented to help scale any network using OSI routing protocols with CLNS.
How to Configure MP-BGP Support for CLNS

Configuring and Activating a BGP Neighbor to Support CLNS

To configure and activate a BGP routing process and an associated BGP neighbor (peer) to support CLNS, perform the steps in this procedure.

### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `router bgp as-number`
4. `no bgp default ipv4-unicast`
5. `neighbor {ip-address | peer-group-name} remote-as as-number`
6. `address-family nsap [unicast]`
7. `neighbor ip-address activate`
8. `end`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><code>Router&gt; enable</code></td>
<td></td>
</tr>
</tbody>
</table>

| **Step 2** configure terminal | Enters global configuration mode. |
| Example:                      |         |
| `Router# configure terminal`  |         |

| **Step 3** router bgp as-number | Configures a BGP routing process and enters router configuration mode. |
| Example:                        | • The `as-number` argument identifies the autonomous system in which the router resides. Valid values are from 0 to 65535. Private autonomous system numbers that can be used in internal networks range from 64512 to 65535. |
| `Router(config)# router bgp 65101` |         |

| **Step 4** no bgp default ipv4-unicast | Disables the default behavior of the BGP routing process exchanging IPv4 addressing information with BGP neighbor routers. |
| Example:                               |         |
| `Router(config-router)# no bgp default ipv4-unicast` |         |
**Command or Action** | **Purpose** |
--- | --- |
**Step 5** neighbor \{ip-address | peer-group-name\} remote-as as-number  | Adds an IP address or peer group name of the BGP neighbor in the specified autonomous system to the BGP neighbor table of the local router.  
*Example:*  
Router(config-router)# neighbor 10.1.2.2 remote-as 64202  
**Step 6** address-family nsap [unicast]  | Specifies the NSAP address family and enters address family configuration mode.  
*Example:*  
Router(config-router)# address-family nsap  
**Step 7** neighbor ip-address activate  | Enables the BGP neighbor to exchange prefixes for the NSAP address family with the local router.  
*Note* If you have configured a peer group as a BGP neighbor, you do not use this command because peer groups are automatically activated when any peer group parameter is configured.  
*Example:*  
Router(config-router-af)# neighbor 10.1.2.2 activate  
**Step 8** end  | Exits address family configuration mode and returns to privileged EXEC mode.  
*Example:*  
Router(config-router-af)# end

---

### Configuring an IS-IS Routing Process

When an integrated IS-IS routing process is configured, the first instance of the IS-IS routing process configured is by default a Level 1-2 (intra-area and interarea) router. All subsequent IS-IS routing processes on a network running CLNS are configured as Level 1. All subsequent IS-IS routing processes on a network running IP are configured as Level-1-2. To use the Multiprotocol BGP (MP-BGP) Support for CLNS feature, configure a Level 2 routing process.

To configure an IS-IS routing process and assign it as a Level-2-only process, perform the steps in this procedure.

**SUMMARY STEPS**

1. enable  
2. configure terminal  
3. router isis area-tag  
4. net network-entity-title  
5. is-type [level-1 | level-1-2 | level-2-only]
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** enable | Enables privileged EXEC mode.  
- Enter your password if prompted.  
**Example:**  
Router> enable |
| **Step 2** configure terminal | Enters global configuration mode.  
**Example:**  
Router# configure terminal |
| **Step 3** router isis area-tag | Configures an IS-IS routing process and enters router configuration mode for the specified routing process.  
- The area-tag argument is a meaningful name for a routing process. It must be unique among all IP and CLNS routing processes for a given router.  
**Example:**  
Router(config)# router isis osi-as-101 |
| **Step 4** net network-entity-title | Configures a network entity title (NET) for the routing process.  
- If you are configuring multiarea IS-IS, you must specify a NET for each routing process.  
**Example:**  
Router(config-router)# net 49.0101.1111.1111.1111.1111.00 |
| **Step 5** is-type [level-1 | level-1-2 | level-2-only] | Configures the router to act as a Level 1 (intra-area) router, as both a Level 1 router and a Level 2 (interarea) router, or as an interarea router only.  
- In multiarea IS-IS configurations, the first instance of the IS-IS routing process configured is by default a Level 1-2 (intra-area and interarea) router. All subsequent IS-IS routing processes on a network running CLNS are configured as Level 1. All subsequent IS-IS routing processes on a network running IP are configured as Level 1-2.  
**Example:**  
Router(config-router)# is-type level-1 |
| **Step 6** end | Exits router configuration mode and returns to privileged EXEC mode.  
**Example:**  
Router(config-router)# end |
Configuring Interfaces That Connect to BGP Neighbors

When a router running IS-IS is directly connected to an eBGP neighbor, the interface between the two eBGP neighbors is activated using the `clns enable` command, which allows CLNS packets to be forwarded across the interface. The `clns enable` command activates the End System-to-Intermediate System (ES-IS) protocol to search for neighboring OSI systems.

Note

Running IS-IS across the same interface that is connected to an eBGP neighbor can lead to undesirable results if the two OSI routing domains merge into a single domain.

When a neighboring OSI system is found, BGP checks that it is also an eBGP neighbor configured for the NSAP address family. If both the preceding conditions are met, BGP creates a special BGP neighbor route in the CLNS Level 2 prefix routing table. The special BGP neighbor route is automatically redistributed into the Level 2 routing updates so that all other Level 2 IS-IS routers in the local OSI routing domain know how to reach this eBGP neighbor.

To configure interfaces that are being used to connect with eBGP neighbors, perform the steps in this procedure. These interfaces will normally be directly connected to their eBGP neighbor.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `interface type number`
4. `ip address ip-address mask`
5. `clns enable`
6. `no shutdown`
7. `end`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
</tr>
<tr>
<td><code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Router&gt; enable</code></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td></td>
</tr>
<tr>
<td><code>configure terminal</code></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Router# configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td></td>
</tr>
<tr>
<td><code>interface type number</code></td>
<td>Specifies the interface type and number and</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>enters interface configuration mode.</td>
</tr>
<tr>
<td><code>Router(config)# interface serial 2/0/0</code></td>
<td></td>
</tr>
</tbody>
</table>
### Configuring Interfaces Connected to the Local OSI Routing Domain

To configure interfaces that are connected to the local OSI routing domain, perform the steps in this procedure.

#### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `interface type number`
4. `ip address ip-address mask`
5. `clns router isis area-tag`
6. `ip router isis area-tag`
7. `no shutdown`
8. `end`

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1**  
*enable*  
*Example:*  
*Router*> *enable* | Enables privileged EXEC mode.  
*• Enter your password if prompted.* |
### Purpose

**Step 2**

Enter global configuration mode.

**Configure terminal**

**Example:**

```console
Router# configure terminal
```

**Step 3**

Specify the interface type and number and enters interface configuration mode.

**Interface type number**

**Example:**

```console
Router(config)# interface gigabitethernet 0/1/1
```

**Step 4**

Configure the interface with an IP address.

**Ip address ip-address mask**

**Example:**

```console
Router(config-if)# ip address 10.2.3.1 255.255.255.0
```

**Note** This step is required only when the interface needs to communicate with an iBGP neighbor.

**Step 5**

Specify that the interface is actively routing IS-IS when the network protocol is ISO CLNS and identifies the area associated with this routing process.

**Clns router isis area-tag**

**Example:**

```console
Router(config-if)# clns router isis osi-as-202
```

**Step 6**

Specify that the interface is actively routing IS-IS when the network protocol is IP and identifies the area associated with this routing process.

**Ip router isis area-tag**

**Example:**

```console
Router(config-if)# ip router isis osi-as-202
```

**Note** This step is required only when the interface needs to communicate with an iBGP neighbor, and the IGP is IS-IS.

**Step 7**

Turns on the interface.

**No shutdown**

**Example:**

```console
Router(config-if)# no shutdown
```

**Step 8**

Exits interface configuration mode and returns to privileged EXEC mode.

**End**

**Example:**

```console
Router(config-if)# end
```

---

### Advertising Networking Prefixes

Advertising NSAP address prefix forces the prefixes to be added to the BGP routing table. To configure advertisement of networking prefixes, perform the steps in this procedure.
SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp as-number
4. no bgp default ipv4-unicast
5. neighbor \{ip-address | peer-group-name\} remote-as as-number
6. address-family nsap [unicast]
7. network nsap-prefix [route-map map-tag]
8. neighbor ip-address activate
9. end

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Router&gt; enable</td>
<td></td>
</tr>
</tbody>
</table>

| Step 2 configure terminal | Enters global configuration mode. |
| Example:                  |         |
| Router# configure terminal |         |

| Step 3 router bgp as-number | Configures a BGP routing process and enters router configuration mode for the specified routing process. |
| Example:                    |         |
| Router(config)# router bgp 65101 |         |

| Step 4 no bgp default ipv4-unicast | Disables the default behavior of the BGP routing process exchanging IPv4 addressing information with BGP neighbor routers. |
| Example:                           |         |
| Router(config-router)# no bgp default ipv4-unicast |         |

| Step 5 neighbor \{ip-address | peer-group-name\} remote-as as-number | Adds an IP address or peer group name of the BGP neighbor in the specified autonomous system to the BGP neighbor table of the local router. |
| Example:                            |         |
| Router(config-router)# neighbor 10.1.2.2 remote-as 64202 |         |

| Step 6 address-family nsap [unicast] | Specifies the NSAP address family and enters address family configuration mode. |
| Example:                             | • The optional unicast keyword specifies the NSAP unicast address prefixes. By default, the router is placed in unicast NSAP address family configuration mode if the unicast keyword is not specified with the address-family nsap command. |
| Router(config-router)# address-family nsap |         |
### Purpose

**Step 7**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>network nsap-prefix [route-map map-tag]</td>
<td>Advertises a single prefix of the local OSI routing domain and enters it in the BGP routing table.</td>
</tr>
</tbody>
</table>

**Example:**

```bash
Router(config-router-af)#
network 49.0101.1111.1111.1111.1111.00
```

**Note**

It is possible to advertise a single prefix, in which case this prefix could be the unique NSAP address prefix of the local OSI routing domain. Alternatively, multiple longer prefixes, each covering a small portion of the OSI routing domain, can be used to selectively advertise different areas.

- The advertising of NSAP address prefixes can be controlled by using the optional `route-map` keyword. If no route map is specified, all NSAP address prefixes are redistributed.

---

**Step 8**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>neighbor ip-address activate</td>
<td>Specifies that NSAP routing information will be sent to the specified BGP neighbor.</td>
</tr>
</tbody>
</table>

**Example:**

```bash
Router(config-router-af) neighbor 10.1.2.2 activate
```

**Note**

See the description of the `neighbor` command in the documents listed in the "Additional References" for more details on the use of this command.

---

**Step 9**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>end</td>
<td>Exits address family configuration mode and returns to privileged EXEC mode.</td>
</tr>
</tbody>
</table>

**Example:**

```bash
Router(config-router-af)#
end
```

---

### Redistributing Routes from BGP into IS-IS

Route redistribution must be approached with caution. We do not recommend injecting the full set of BGP routes into IS-IS because excessive routing traffic will be added to IS-IS. Route maps can be used to control which dynamic routes are redistributed.

To configure route redistribution from BGP into IS-IS, perform the steps in this procedure.

### SUMMARY STEPS

1. enable
2. configure terminal
3. router isis area-tag
4. net network-entity-title
5. redistribute protocol as-number [route-type] [route-map map-tag]
6. end
## Redistributing Routes from IS-IS into BGP

Route redistribution must be approached with caution because redistributed route information is stored in the routing tables. Large routing tables may make the routing process slower. Route maps can be used to control which dynamic routes are redistributed.

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router isis</td>
<td>Configures an IS-IS routing process and enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td><strong>area-tag</strong></td>
<td>Note: You cannot redistribute BGP routes into a Level 1-only IS-IS routing process.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router(config)# router isis osi-as-404</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> net</td>
<td>Configures a NET for the routing process.</td>
</tr>
<tr>
<td><strong>network-entity-title</strong></td>
<td>• If you are configuring multiarea IS-IS, you must specify a NET for each routing process.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router(config-router)# net 49.0404.7777.7777.7777.7777.00</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> redistribute</td>
<td>Redistributes NSAP prefix routes from BGP into the CLNS Level 2 routing table associated with the IS-IS routing process when the protocol argument is set to bgp and the route-type argument is set to clns.</td>
</tr>
<tr>
<td><strong>protocol as-number</strong></td>
<td>• The as-number argument is defined as the autonomous system number of the BGP routing process to be redistributed into CLNS.</td>
</tr>
<tr>
<td><strong>route-type</strong></td>
<td>• The redistribution of routes can be controlled by using the optional route-map keyword. If no route map is specified, all BGP routes are redistributed.</td>
</tr>
<tr>
<td><strong>route-map map-tag</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router(config-router)# redistribute bgp 65404 clns</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> end</td>
<td>Exits router configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router(config-router)# end</td>
<td></td>
</tr>
</tbody>
</table>
To configure route redistribution from IS-IS into BGP, perform the steps in this procedure.

**SUMMARY STEPS**

1. enable
2. configure terminal
3. router bgp *as-number*
4. no bgp default ipv4-unicast
5. address-family nsap [unicast]
6. redistribute *protocol* [process-id] [route-type] [route-map map-tag]
7. end

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Router&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example: Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp <em>as-number</em></td>
<td>Configures a BGP routing process and enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td>Example: Router(config)# router bgp 65202</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> no bgp default ipv4-unicast</td>
<td>Disables the default behavior of the BGP routing process exchanging IPv4 addressing information with BGP neighbor routers.</td>
</tr>
<tr>
<td>Example: Router(config-router)# no bgp default ipv4-unicast</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> address-family nsap [unicast]</td>
<td>Specifies the NSAP address family and enters address family configuration mode.</td>
</tr>
<tr>
<td>Example: Router(config-router)# address-family nsap</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> redistribute <em>protocol</em> [process-id] [route-type] [route-map map-tag]</td>
<td>Redistributes routes from the CLNS Level 2 routing table associated with the IS-IS routing process into BGP as NSAP prefixes when the <em>protocol</em> argument is set to <em>isis</em> and the <em>route-type</em> argument is set to <em>clns</em>.</td>
</tr>
<tr>
<td>Example: Router(config-router-af)# redistribute isis osi-as-202 clns route-map internal-routes-only</td>
<td>• The <em>process-id</em> argument is defined as the area name for the relevant IS-IS routing process to be redistributed.</td>
</tr>
</tbody>
</table>
Configuring BGP Peer Groups and Route Reflectors

BGP peer groups reduce the number of configuration commands by applying a BGP `neighbor` command to multiple neighbors. Using a BGP peer group with a local router configured as a BGP route reflector allows BGP routing information received from one member of the group to be replicated to all other group members. Without a peer group, each route reflector client must be specified by IP address.

To create a BGP peer group and use the group as a BGP route reflector client, perform the steps in this procedure. This is an optional task and is used with internal BGP neighbors. In this task, some of the BGP syntax is shown with the `peer-group-name` argument only and only one neighbor is configured as a member of the peer group. Repeat Step 9 to configure other BGP neighbors as members of the peer group.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp as-number`
4. `no bgp default ipv4-unicast`
5. `neighbor peer-group-name peer-group`
6. `neighbor peer-group-name remote-as as-number`
7. `address-family nsap [unicast]`
8. `neighbor peer-group-name route-reflector-client`
9. `neighbor ip-address peer-group peer-group`
10. `end`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><code>enable</code></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><code>configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
</tbody>
</table>
### Command or Action

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Command or Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Configures a BGP routing process and enters router configuration mode for the specified routing process.</td>
<td><strong>Step 3</strong> <code>router bgp as-number</code>&lt;br&gt;Example: <code>Router(config)# router bgp 65303</code>&lt;br&gt;Disables the default behavior of the BGP routing process exchanging IPv4 addressing information with BGP neighbor routers.</td>
</tr>
</tbody>
</table>
Filtering Inbound Routes Based on NSAP Prefixes

Perform this task to filter inbound BGP routes based on NSAP prefixes. The `neighbor prefix-list in` command is configured in address family configuration mode to filter inbound routes.

**Before you begin**

You must specify either a CLNS filter set or a CLNS filter expression before configuring the `neighbor` command. See descriptions for the `clns filter-expr` and `clns filter-set` commands for more information.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp as-number`
4. `no bgp default ipv4-unicast`
5. `address-family nsap [unicast]`
6. `neighbor {ip-address|peer-group-name} prefix-list {clns-filter-expr-name|clns-filter-set-name} in`
7. `end`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Router&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp as-number</td>
<td>Configures a BGP routing process and enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config)# router bgp 65200</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> no bgp default ipv4-unicast</td>
<td>Disables the default behavior of the BGP routing process exchanging IPv4 addressing information with BGP neighbor routers.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config-router)# no bgp default ipv4-unicast</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>Specifies the address family and enters address family configuration mode.</td>
</tr>
<tr>
<td>address-family nsap [unicast]</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config-router)# address-family nsap</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>Specifies a CLNS filter set or CLNS filter expression to be used to filter inbound BGP routes.</td>
</tr>
<tr>
<td>neighbor {ip-address</td>
<td>peer-group-name} prefix-list {clns-filter-expr-name</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config-router-af)# neighbor 10.23.4.1 prefix-list abc in</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>Exits address family configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td>end</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config-router-af)# end</td>
<td></td>
</tr>
</tbody>
</table>

**Filtering Outbound BGP Updates Based on NSAP Prefixes**

Perform this task to filter outbound BGP updates based on NSAP prefixes, use the neighbor prefix-list out command in address family configuration mode. This task is configured at Router 7 in the figure above (in the "Generic BGP CLNS Network Topology" section). In this task, a CLNS filter is created with two entries to deny NSAP prefixes starting with 49.0404 and to permit all other NSAP prefixes starting with 49. A BGP peer group is created and the filter is applied to outbound BGP updates for the neighbor that is a member of the peer group.

**SUMMARY STEPS**

1. enable
2. configure terminal
3. clns filter-set name [deny] template
4. clns filter-set name [permit] template
5. router bgp as-number
6. no bgp default ipv4-unicast
7. neighbor peer-group-name peer-group
8. neighbor {ip-address | peer-group-name} remote-as as-number
9. address-family nsap [unicast]
10. neighbor {ip-address | peer-group-name} prefix-list {clns-filter-expr-name | clns-filter-set-name} out
11. neighbor ip-address peer-group peer-group
12. end
## DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** | enable | Enables privileged EXEC mode.  
- Enter your password if prompted.  
  
Example:  
  
| Router> enable |
| **Step 2** | configure terminal | Enters global configuration mode.  
  
Example:  
  
| Router# configure terminal |
| **Step 3** | clns filter-set name [deny] template | Defines a NSAP prefix match for a deny condition for use in CLNS filter expressions.  
- In this example, a deny action is returned if an address starts with 49.0404.  
  
Example:  
  
| Router(config)# clns filter-set routes0404 deny 49.0404... |
| **Step 4** | clns filter-set name [permit] template | Defines a NSAP prefix match for a permit condition for use in CLNS filter expressions.  
- In this example, a permit action is returned if an address starts with 49.  
  
Example:  
  
| Router(config)# clns filter-set routes0404 permit 49... |
| **Step 5** | router bgp as-number | Configures a BGP routing process and enters router configuration mode for the specified routing process.  
  
Example:  
  
| Router(config)# router bgp 65404 |
| **Step 6** | no bgp default ipv4-unicast | Disables the default behavior of the BGP routing process exchanging IPv4 addressing information with BGP neighbor routers.  
  
Example:  
  
| Router(config-router)# no bgp default ipv4-unicast |
| **Step 7** | neighbor peer-group-name peer-group | Creates a BGP peer group.  
- In this example, the BGP peer group named ebgp-peers is created.  
  
Example:  
  
| Router(config-router)# neighbor ebgp-peers peer-group |
| **Step 8** | neighbor {ip-address | peer-group-name} remote-as as-number | Adds an IP address or peer group name of the BGP neighbor in the specified autonomous system to the BGP neighbor table of the local router.  
  
Example:  
  
<p>| Router(config-router)# neighbor ebgp-peers remote-as 65404 |</p>
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Router(config-router)# neighbor ebgp-peers remote-as 65303</td>
<td>• In this example, the peer group named ebgp-peers is added to the BGP neighbor table.</td>
</tr>
<tr>
<td>Step 9 address-family nsap [unicast]</td>
<td>Specifies the NSAP address family and enters address family configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config-router)# address-family nsap</td>
<td></td>
</tr>
<tr>
<td>Step 10 neighbor {ip-address</td>
<td>peer-group-name} prefix-list {clns-filter-expr-name</td>
</tr>
<tr>
<td>Example:</td>
<td>• The clns-filter-expr-name argument is defined with the clns filter-expr configuration command.</td>
</tr>
<tr>
<td>Router(config-router-af)# neighbor ebgp-peers prefix-list routes0404 out</td>
<td>• The clns-filter-set-name argument is defined with the clns filter-set configuration command.</td>
</tr>
<tr>
<td></td>
<td>• In this example, the filter set named routes0404 was created in Step 3 and Step 4.</td>
</tr>
<tr>
<td>Step 11 neighbor ip-address peer-group peer-group</td>
<td>Assigns a BGP neighbor to a BGP peer group.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config-router-af)# neighbor 10.6.7.8 peer-group ebgp-peers</td>
<td></td>
</tr>
<tr>
<td>Step 12 end</td>
<td>Exits address family configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config-router-af)# end</td>
<td></td>
</tr>
</tbody>
</table>

**Originating Default Routes for a Neighboring Routing Domain**

To create a default CLNS route that points to the local router on behalf of a neighboring OSI routing domain, perform the steps in this procedure. This is an optional task and is normally used only with external BGP neighbors.

**SUMMARY STEPS**

1. enable
2. configure terminal
3. router bgp as-number
4. no bgp default ipv4-unicast
5. address-family nsap [unicast]
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1**
  - enable
  - Example:
    - `Router> enable`
| Enables privileged EXEC mode.  
  - Enter your password if prompted. |
| **Step 2**
  - configure terminal
  - Example:
    - `Router# configure terminal`
| Enters global configuration mode. |
| **Step 3**
  - router bgp as-number
  - Example:
    - `Router(config)# router bgp 64803`
| Configures a BGP routing process and enters router configuration mode for the specified routing process. |
| **Step 4**
  - no bgp default ipv4-unicast
  - Example:
    - `Router(config-router)# no bgp default ipv4-unicast`
| Disables the default behavior of the BGP routing process exchanging IPv4 addressing information with BGP neighbor routers. |
| **Step 5**
  - address-family nsap [unicast]
  - Example:
    - `Router(config-router)#`
| Specifies the NSAP address family and enters address family configuration mode. |
| **Step 6**
  - neighbor {ip-address | peer-group-name} default-originate [route-map map-tag]
  - Example:
    - `Router(config-router-af)# neighbor 172.16.2.3 default-originate`
| Generates a default CLNS route that points to the local router and that will be advertised to the neighboring OSI routing domain. |
| **Step 7**
  - end
  - Example:
    - `Router(config-router-af)# end`
| Exits address family configuration mode and returns to privileged EXEC mode. |
Verifying MP-BGP Support for CLNS

To verify the configuration, use the `show running-config` EXEC command. Sample output is located in the Implementing MP-BGP Support for CLNS Example, on page 245. To verify that the Multiprotocol BGP (MP-BGP) Support for CLNS feature is working, perform the following steps.

**SUMMARY STEPS**

1. `show clns neighbors`
2. `show clns route`
3. `show bgp nsap unicast summary`
4. `show bgp nsap unicast`

**DETAILED STEPS**

**Step 1**  
`show clns neighbors`

Use this command to confirm that the local router has formed all the necessary IS-IS adjacencies with other Level 2 IS-IS routers in the local OSI routing domain. If the local router has any directly connected external BGP peers, the output from this command will show that the external neighbors have been discovered, in the form of ES-IS adjacencies.

In the following example, the output is displayed for router R2, shown in the figure above (in the "Generic BGP CLNS Network Topology" section). R2 has three CLNS neighbors. R1 and R4 are ES-IS neighbors because these nodes are in different autonomous systems from R2. R3 is an IS-IS neighbor because it is in the same autonomous system as R2. Note that the system ID is replaced by CLNS hostnames (r1, r3, and r4) that are defined at the start of each configuration file. Specifying the CLNS hostname means that you need not remember which system ID corresponds to which hostname.

*Example:*

```
Router# show clns neighbors
Tag osi-as-202:
System Id Interface SNPA State Holdtime Type Protocol
r1  via r1, Se2/0  *HDLC* Up 274 IS ES-IS
r3  Et0/1 0002.16de.8481 Up 9 L2 IS-IS
r4  Se2/2  *HDLC* Up 275 IS ES-IS
```

**Step 2**  
`show clns route`

Use this command to confirm that the local router has calculated routes to other areas in the local OSI routing domain. In the following example of output from router R2, shown in the figure above (in the "Generic BGP CLNS Network Topology" section), the routing table entry--i 49.0202.3333 [110/10] via R3--shows that router R2 knows about other local IS-IS areas within the local OSI routing domain.

*Example:*

```
Router# show clns route
Codes: C - connected, S - static, d - DecnetIV
       I - ISO-IGRP, i - IS-IS, e - ES-IS
       B - BGP, b - eBGP-neighbor
C 49.0202.2222 [2/0], Local IS-IS Area
C 49.0202.2222.2222.2222.00 [1/0], Local IS-IS NET
b 49.0101.1111.1111.1111.00 [15/10]
   via r1, Serial2/0
i 49.0202.3333 [110/10]
   via r3, GigabitEthernet0/1/1
```
Verifying MP-BGP Support for CLNS

Step 3  
**show bgp nsap unicast summary**

Use this command to verify that the TCP connection to a particular neighbor is active. In the following example output, search the appropriate row based on the IP address of the neighbor. If the State/PfxRcd column entry is a number, including zero, the TCP connection for that neighbor is active.

**Example:**

```
Router# show bgp nsap unicast summary
BGP router identifier 10.1.57.11, local AS number 65202
BGP table version is 6, main routing table version 6
5 network entries and 8 paths using 1141 bytes of memory
6 BGP path attribute entries using 360 bytes of memory
4 BGP AS-PATH entries using 96 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP activity 5/0 prefixes, 8/0 paths, scan interval 60 secs
Neighbor     V  AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd
10.1.2.1     4 65101 34 34 6 0 0 00:29:11 1
10.2.3.3     4 65202 35 36 6 0 0 00:29:16 3
```

Step 4  
**show bgp nsap unicast**

Enter the **show bgp nsap unicast** command to display all the NSAP prefix routes that the local router has discovered. In the following example of output from router R2, shown in the figure above (in the "Generic BGP CLNS Network Topology" section), a single valid route to prefix 49.0101 is shown. Two valid routes--marked by a *--are shown for the prefix 49.0404. The second route is marked with a *=>i sequence, representing the best route to this prefix.

**Example:**

```
Router# show bgp nsap unicast
BGP table version is 3, local router ID is 192.168.3.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal, r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete
Network     Next Hop                  Metric LocPrf Weight Path
*> 49.0101   49.0101.1111.1111.1111.1111.00 0 65101 i
* 49.0202.2222 49.0202.3333.3333.3333.00 100 0 ?
  > 49.0202.2222.2222.2222.2222.00 32768 ?
* 49.0202.3333 49.0202.3333.3333.3333.00 100 0 ?
  > 49.0202.2222.2222.2222.2222.00 32768 ?
*> 49.0303   49.0303.4444.4444.4444.4444.00 0 65303 i
*  49.0404   49.0303.4444.4444.4444.4444.00 0 65303 65404 i
```
**Troubleshooting MP-BGP Support for CLNS**

The `debug bgp nsap unicast` commands enable diagnostic output concerning various events relating to the operation of the CLNS packets in the BGP routing protocol to be displayed on a console. These commands are intended only for troubleshooting purposes because the volume of output generated by the software when they are used can result in severe performance degradation on the router. See the *Cisco IOS Debug Command Reference* for more information about using these `debug` commands.

To troubleshoot problems with the configuration of MP-BGP support for CLNS and to minimize the impact of the `debug` commands used in this procedure, perform the following steps.

**SUMMARY STEPS**

1. Attach a console directly to a router running the Cisco software release that includes the Multiprotocol BGP (MP-BGP) Support for CLNS feature.
2. `no logging console`
3. Use Telnet to access a router port.
4. `enable`
5. `terminal monitor`
6. `debug bgp nsap unicast [neighbor-address | dampening | keepalives | updates]`
7. `no terminal monitor`
8. `no debug bgp nsap unicast [neighbor-address | dampening | keepalives | updates]`
9. `logging console`

**DETAILED STEPS**

**Step 1**  
Attach a console directly to a router running the Cisco software release that includes the Multiprotocol BGP (MP-BGP) Support for CLNS feature.

Note This procedure will minimize the load on the router created by the `debug bgp nsap unicast` commands because the console port will no longer be generating character-by-character processor interrupts. If you cannot connect to a console directly, you can run this procedure via a terminal server. If you must break the Telnet connection, however, you may not be able to reconnect because the router may be unable to respond due to the processor load of generating the `debug bgp nsap unicast` output.

**Step 2**  
`no logging console`

This command disables all logging to the console terminal.

**Step 3**  
Use Telnet to access a router port.

**Step 4**  
`enable`

Enter this command to access privileged EXEC mode.

**Step 5**  
`terminal monitor`
This command enables logging on the virtual terminal.

**Step 6**

```
depbug bgp nsap unicast [neighbor-address | dampening | keepalives | updates]
```

Enter only specific `debug bgp nsap unicast` commands to isolate the output to a certain subcomponent and minimize the load on the processor. Use appropriate arguments and keywords to generate more detailed debug information on specified subcomponents.

**Step 7**

```
no terminal monitor
```

This command disables logging on the virtual terminal.

**Step 8**

```
no debug bgp nsap unicast [neighbor-address | dampening | keepalives | updates]
```

Enter the specific `no debug bgp nsap unicast` command when you are finished.

**Step 9**

```
logging console
```

This command reenables logging to the console.

---

### Configuration Examples for MP-BGP Support for CLNS

#### Example: Configuring and Activating a BGP Neighbor to Support CLNS

In the following example, the router R1, shown in the figure below, in the autonomous system AS65101 is configured to run BGP and activated to support CLNS. Router R1 is the only Level 2 IS-IS router in autonomous system AS65101, and it has only one connection to another autonomous system via router R2 in AS65202. The `no bgp default ipv4-unicast` command is configured on the router to disable the default behavior of the BGP routing process exchanging IPv4 addressing information with BGP neighbor routers. After the NSAP address family configuration mode is enabled with the `address-family nsap` command, the router is configured to advertise the NSAP prefix of 49.0101 to its BGP neighbors and to send NSAP routing information to the BGP neighbor at 10.1.2.2.

```
router bgp 65101
no bgp default ipv4-unicast
address-family nsap
    network 49.0101...
    neighbor 10.1.2.2 activate
    exit-address-family
```

#### Example: Configuring an IS-IS Routing Process

In the following example, R1, shown in the figure below, is configured to run an IS-IS process:

```
router isis esi-as-101
    net 49.0101.1111.1111.1111.1111.00
```

The default IS-IS routing process level is used.
Configuring Interfaces Example

In the following example, two of the interfaces of the router R2, shown in the figure below, in the autonomous system AS65202 are configured to run CLNS. GigabitEthernet interface 0/1/1 is connected to the local OSI routing domain and is configured to run IS-IS when the network protocol is CLNS using the `clns router isis` command. The serial interface 2/0 with the local IP address of 10.1.2.2 is connected with an eBGP neighbor and is configured to run CLNS through the `clns enable` command:

```conf
interface serial 2/0
  ip address 10.1.2.2 255.255.255.0
  clns enable
  no shutdown
!
interface gigabitethernet 0/1/1
  ip address 10.2.3.1 255.255.255.0
  clns router isis osi-as-202
  no shutdown
```

Advertising Networking Prefixes Example

In the following example, the router R1, shown in the figure below, is configured to advertise the NSAP prefix of 49.0101 to other routers. The NSAP prefix unique to autonomous system AS65101 is advertised to allow the other autonomous systems to discover the existence of autonomous system AS65101 in the network.

```conf
router bgp 65101
  no bgp default ipv4-unicast
  neighbor 10.1.2.2 remote-as 64202
  address-family nsap
    network 49.0101...
    neighbor 10.1.2.2 activate
```

Example: Redistributing Routes from BGP into IS-IS

In the following example, the routers R7 and R9, shown in the figure below, in the autonomous system AS65404 are configured to redistribute BGP routes into the IS-IS routing process called osi-as-404. Redistributing the BGP routes allows the Level 2 IS-IS router, R8, to advertise routes to destinations outside the autonomous system AS65404. Without a route map being specified, all BGP routes are redistributed.

**Router R7**

```conf
router isis osi-as-404
  net 49.0404.7777.7777.7777.7777.00
  redistribute bgp 65404 clns
```

**Router R9**

```conf
router isis osi-as-404
  net 49.0404.9999.9999.9999.9999.00
  redistribute bgp 65404 clns
```
Example: Redistributing Routes from IS-IS into BGP

In the following example, the router R2, shown in the figure below, in the autonomous system AS65202 is configured to redistribute Level 2 CLNS NSAP routes into BGP. A route map is used to permit only routes from within the local autonomous system to be redistributed into BGP. Without a route map being specified, every NSAP route from the CLNS level 2 prefix table is redistributed. The `no bgp default ipv4-unicast` command is configured on the router to disable the default behavior of the BGP routing process exchanging IPv4 addressing information with BGP neighbor routers.

```plaintext
clns filter-set internal-routes permit 49.0202...
! route-map internal-routes-only permit 10
  match clns address internal-routes
!
router isis osi-as-202
  net 49.0202.2222.2222.2222.2222.00
!
router bgp 65202
  no bgp default ipv4-unicast
  address-family nsap
  redistribute isis osi-as-202 clns route-map internal-routes-only
```

Configuring BGP Peer Groups and Route Reflectors Example

Router R5, shown in the figure above (in the "Generic BGP CLNS Network Topology" section), has only iBGP neighbors and runs IS-IS on both interfaces. To reduce the number of configuration commands, configure R5 as a member of a BGP peer group called ibgp-peers. The peer group is automatically activated under the `address-family nsap` command by configuring the peer group as a route reflector client allowing it to exchange NSAP routing information between group members. The BGP peer group is also configured as a BGP route reflector client to reduce the need for every iBGP router to be linked to each other.

In the following example, the router R5 in the autonomous system AS65303 is configured as a member of a BGP peer group and a BGP route reflector client:

```plaintext
router bgp 65303
  no bgp default ipv4-unicast
  neighbor ibgp-peers peer-group
  neighbor ibgp-peers remote-as 65303
  address-family nsap
  neighbor ibgp-peers route-reflector-client
  neighbor 10.4.5.4 peer-group ibgp-peers
  neighbor 10.5.6.6 peer-group ibgp-peers
  exit-address-family
```

Filtering Inbound Routes Based on NSAP Prefixes Example

In the following example, the router R1, shown in the figure below, in the autonomous system AS65101 is configured to filter inbound routes specified by the default-prefix-only prefix list:

```plaintext
clns filter-set default-prefix-only deny 49...
clns filter-set default-prefix-only permit default
!
router isis osi-as-101
  net 49.0101.1111.1111.1111.1111.00
!```
Example: Filtering Outbound BGP Updates Based on NSAP Prefixes

In the following example, outbound BGP updates are filtered based on NSAP prefixes. This example is configured at Router 7 in the figure below. In this task, a CLNS filter is created with two entries to deny NSAP prefixes starting with 49.0404 and to permit all other NSAP prefixes starting with 49. A BGP peer group is created and the filter is applied to outbound BGP updates for the neighbor that is a member of the peer group.

```bash
clns filter-set routes0404 deny 49.0404...
clns filter-set routes0404 permit 49...
```

Example: Originating a Default Route and Outbound Route Filtering

In the following example, the router R2, shown in the figure below, in the autonomous system AS65202 is configured to send only the default route NSAP addressing information in the BGP update messages to router R1.

```bash
clns filter-set default-prefix-only deny 49...
clns filter-set default-prefix-only permit default
```

Implementing MP-BGP Support for CLNS Example

The figure below shows a generic BGP CLNS network containing nine routers that are grouped into four different autonomous systems (in BGP terminology) or routing domains (in OSI terminology). This section contains complete configurations for all routers shown in the figure below.
If you need more details about commands used in the following examples, see the configuration tasks earlier in this document and the documents listed in the Additional References, on page 251.

**Autonomous System AS65101**

**Router 1**

```plaintext
clns filter-set default-prefix-only deny 49...
clns filter-set default-prefix-only permit default
router isis osi-as-101
  net 49.0101.1111.1111.1111.1111.00
  
router bgp 65101
  no bgp default ipv4-unicast
  neighbor 10.1.2.2 remote-as 65202
  address-family nsap
  neighbor 10.1.2.2 activate
  neighbor 10.1.2.2 prefix-list default-prefix-only in
  network 49.0101...
  exit-address-family

interface serial 2/0
  ip address 10.1.2.1 255.255.255.0
  clns enable
  no shutdown
```
Autonomous System AS65202

**Router 2**

clns filter-set default-prefix-only deny 49...
clns filter-set default-prefix-only permit default
!
clns filter-set internal-routes permit 49.0202...
!
route-map internal-routes-only permit 10
 match clns address internal-routes
 !
router isis osi-as-202
 net 49.0202.2222.2222.2222.2222.00
!
router bgp 65202
 no bgp default ipv4-unicast
 neighbor 10.1.2.1 remote-as 65101
 neighbor 10.2.3.3 remote-as 65202
 neighbor 10.2.4.4 remote-as 65303
 address-family nsap
   neighbor 10.1.2.1 activate
   neighbor 10.2.3.3 activate
   neighbor 10.2.4.4 activate
 redistribute isis osi-as-202 clns route-map internal-routes-only
neighbor 10.1.2.1 default-originate
neighbor 10.1.2.1 prefix-list default-prefix-only out
exit-address-family
!
interface gigabitethernet 0/1/1
 ip address 10.2.3.2 255.255.255.0
 clns router isis osi-as-202
 no shutdown
!
interface serial 2/0
 ip address 10.1.2.2 255.255.255.0
 clns enable
 no shutdown
!
interface serial 2/2
 ip address 10.2.4.2 255.255.255.0
 clns enable
 no shutdown

**Router 3**

clns filter-set internal-routes permit 49.0202...
!
route-map internal-routes-only permit 10
 match clns address internal-routes
!
router isis osi-as-202
 net 49.0202.3333.3333.3333.3333.00
!
router bgp 65202
 no bgp default ipv4-unicast
 neighbor 10.2.3.2 remote-as 65202
 neighbor 10.3.9.9 remote-as 65404
 address-family nsap
   neighbor 10.2.3.2 activate
   neighbor 10.3.9.9 activate
Autonomous System AS65303

Router 4

    router isis osi-as-303
    net 49.0303.4444.4444.4444.4444.00
    
    router bgp 65303
    no bgp default ipv4-unicast
    neighbor 10.2.4.2 remote-as 65202
    neighbor 10.4.5.5 remote-as 65303
    address-family nsap
    no synchronization
    neighbor 10.2.4.2 activate
    neighbor 10.4.5.5 activate
    network 49.0303...
    exit-address-family
    
    interface gigabitethernet 0/2/1
    ip address 10.4.5.4 255.255.255.0
    clns router isis osi-as-303
    no shutdown
    
    interface serial 2/3
    ip address 10.2.4.4 255.255.255.0
    clns enable
    no shutdown

Router 5

    router isis osi-as-303
    net 49.0303.5555.5555.5555.5555.00
    
    router bgp 65303
    no bgp default ipv4-unicast
    neighbor ibgp-peers peer-group
    neighbor ibgp-peers remote-as 65303
    address-family nsap
    no synchronization
    neighbor ibgp-peers route-reflector-client
    neighbor 10.4.5.4 peer-group ibgp-peers
    neighbor 10.5.6.6 peer-group ibgp-peers
    exit-address-family
    
    interface gigabitethernet 0/2/1
    ip address 10.4.5.5 255.255.255.0
    clns router isis osi-as-303
no shutdown
!
interface gigabitethernet 0/3/1
  ip address 10.5.6.5 255.255.255.0
  clns router isis osi-as-303
  no shutdown

Router 6

router isis osi-as-303
  net 49.0303.6666.6666.6666.6666.00
!
router bgp 65303
  no bgp default ipv4-unicast
  neighbor 10.5.6.5 remote-as 65303
  neighbor 10.6.7.7 remote-as 65404
  address-family nsap
    no synchronization
  neighbor 10.5.6.5 activate
  neighbor 10.6.7.7 activate
  network 49.0303...
!
interface gigabitethernet 0/3/1
  ip address 10.5.6.6 255.255.255.0
  clns router isis osi-as-303
  no shutdown
!
interface serial 2/2
  ip address 10.6.7.6 255.255.255.0
  clns enable
  no shutdown

Autonomous System AS65404

Router 7

clns filter-set external-routes deny 49.0404...
clns filter-set external-routes permit 49...
!
route-map noexport permit 10
  match clns address external-routes
  set community noexport
!
router isis osi-as-404
  net 49.0404.7777.7777.7777.7777.00
  redistribute bgp 404 clns
!
router bgp 65404
  no bgp default ipv4-unicast
  neighbor 10.6.7.6 remote-as 65303
  neighbor 10.8.9.9 remote-as 65404
  address-family nsap
    neighbor 10.6.7.6 activate
    neighbor 10.8.9.9 activate
    neighbor 10.8.9.9 send-community
    neighbor 10.8.9.9 route-map noexport out
    network 49.0404...
!
interface gigabitethernet 1/0/1
  ip address 10.7.8.7 255.255.255.0
clns router isis osi-as-404
ip router isis osi-as-404
no shutdown
!
interface serial 2/3
ip address 10.6.7.7 255.255.255.0
clns enable
no shutdown

Router 8

router isis osi-as-404
net 49.0404.8888.8888.8888.8888.00
!
interface gigabitethernet 1/0/1
ip address 10.7.8.8 255.255.255.0
clns router isis osi-as-404
ip router isis osi-as-404
no shutdown
!
interface gigabitethernet 1/1/1
ip address 10.8.9.8 255.255.255.0
clns router isis osi-as-404
ip router isis osi-as-404
no shutdown

Router 9

clns filter-set external-routes deny 49.0404...
clns filter-set external-routes permit 49...
!
route-map noexport permit 10
match clns address external-routes
set community noexport
!
router isis osi-as-404
net 49.0404.9999.9999.9999.9999.00
redistribute bgp 404 clns
!
router bgp 65404
no bgp default ipv4-unicast
neighbor 10.3.9.3 remote-as 65202
neighbor 10.7.8.7 remote-as 65404
address-family nsap
  network 49.0404...
  neighbor 10.3.9.3 activate
  neighbor 10.7.8.7 activate
  neighbor 10.7.8.7 send-community
  neighbor 10.7.8.7 route-map noexport out
!
interface serial 2/3
ip address 10.3.9.9 255.255.255.0
clns enable
no shutdown
!
interface gigabitethernet 1/1/1
ip address 10.8.9.9 255.255.255.0
clns router isis osi-as-404
ip router isis osi-as-404
no shutdown
### Additional References

#### Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
</tbody>
</table>

#### Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

### Feature Information for Configuring MP-BGP Support for CLNS

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to [http://www.cisco.com/go/cfn](http://www.cisco.com/go/cfn). An account on Cisco.com is not required.
### Feature Information for Configuring MP-BGP Support for CLNS

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiprotocol BGP (MP-BGP) Support for CLNS</td>
<td>Cisco IOS XE Release 2.6</td>
<td></td>
</tr>
</tbody>
</table>
### Feature Information

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>The Multiprotocol BGP (MP-BGP) Support for CLNS feature provides the ability to scale Connectionless Network Service (CLNS) networks. The multiprotocol extensions of Border Gateway Protocol (BGP) add the ability to interconnect separate Open System Interconnection (OSI) routing domains without merging the routing domains, thus providing the capability to build very large OSI networks.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The following commands were introduced or modified by this feature:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• address-family nsap</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• clear bgp nsap</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• clear bgp nsap dampening</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• clear bgp nsap external</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• clear bgp nsap flap-statistics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• clear bgp nsap peer-group</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• debug bgp nsap</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• debug bgp nsap dampening</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• debug bgp nsap updates</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• neighbor prefix-list</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• network (BGP and multiprotocol BGP)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• redistribute (BGP to ISO ISIS)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• redistribute (ISO ISIS to BGP)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• show bgp nsap</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• show bgp nsap community</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• show bgp nsap community-list</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• show bgp nsap dampened-paths</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• show bgp nsap filter-list</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• show bgp nsap flap-statistics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• show bgp nsap inconsistent-as</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• show bgp nsap neighbors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• show bgp nsap paths</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• show bgp nsap quote-regexp</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• show bgp nsap regexp</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• show bgp nsap summary</td>
</tr>
</tbody>
</table>
**address family** -- A group of network protocols that share a common format of network address. Address families are defined by RFC 1700.

**AS** -- autonomous system. An IP term to describe a routing domain that has its own independent routing policy and is administered by a single authority. Equivalent to the OSI term "routing domain."

**BGP** -- Border Gateway Protocol. Interdomain routing protocol that exchanges reachability information with other BGP systems.

**CLNS** -- Connectionless Network Service. An OSI network-layer protocol.

**CMIP** -- Common Management Information Protocol. In OSI, a network management protocol created and standardized by ISO for the monitoring and control of heterogeneous networks.

**DCC** -- data communications channel.

**DCN** -- data communications network.

**ES-IS** -- End System-to-Intermediate System. OSI protocol that defines how end systems (hosts) announce themselves to intermediate systems (routers).

**FTAM** -- File Transfer, Access, and Management. In OSI, an application-layer protocol developed for network file exchange and management between diverse types of computers.

**IGP** -- Interior Gateway Protocol. Internet protocol used to exchange routing information within an autonomous system.

**IGRP** -- Interior Gateway Routing Protocol. A proprietary Cisco protocol developed to address the issues associated with routing in large, heterogeneous networks.

**IS** -- intermediate system. Routing node in an OSI network.

**IS-IS** -- Intermediate System-to-Intermediate System. OSI link-state hierarchical routing protocol based on DECnet Phase V routing, where routers exchange routing information based on a single metric, to determine network topology.

**ISO** -- International Organization for Standardization. International organization that is responsible for a wide range of standards, including those relevant to networking. ISO developed the Open System Interconnection (OSI) reference model, a popular networking reference model.

**NSAP address** -- network service access point address. The network address format used by OSI networks.

**OSI** -- Open System Interconnection. International standardization program created by ISO and ITU-T to develop standards for data networking that facilitate multivendor equipment interoperability.

**routing domain** -- The OSI term that is equivalent to autonomous system for BGP.

**SDH** -- Synchronous Digital Hierarchy. Standard that defines a set of rate and format standards that are sent using optical signals over fiber.

**SONET** -- Synchronous Optical Network. High-speed synchronous network specification designed to run on optical fiber.
BGP IPv6 Admin Distance

The BGP IPv6 Admin Distance feature lets you prioritize the BGP IPv6 routes in your network by enabling you to configure the source specific distance of a route and associate a prefix-list with the route. The RIB uses the distance from the source to determine the priority of the BGP IPv6 route in the network.

• Information About BGP IPv6 Admin Distance, on page 255
• Configuring BGP IPv6 Admin Distance, on page 255
• Additional References for BGP IPv6 Admin Distance, on page 257
• Feature Information for BGP IPv6 Admin Distance, on page 258

Information About BGP IPv6 Admin Distance

The BGP IPv6 Admin Distance feature supports selection of route path for a set prefix by prioritizing the BGP routes in the RIB. The BGP routes provided in the RIB are prioritized based on the distance they are configured from a source. With BGP IPv6 Admin Distance feature you can configure the distance from a source and can associate the route with a prefix-list. The route with the source specific distance and the prefix-list is then utilized by the RIB to prioritize the BGP IPv6 routes.

Benefits of Using BGP IPv6 Admin Distance

The BGP IPv6 Admin Distance feature can be used to prioritize or de-prioritize the BGP IPv6 routes in your network.

Configuring BGP IPv6 Admin Distance

SUMMARY STEPS

1. enable
2. configure terminal
3. ipv6 unicast-routing
4. router bgp autonomous-system-number
5. address-family ipv6 unicast
6. distance admin-distance ipv6-address/prefix prelength/interface name prefix-list
7. end
**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><code>enable</code></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device&gt; enable</td>
<td></td>
</tr>
</tbody>
</table>

| **Step 2**        | Enters global configuration mode. |
| `configure terminal` | |
| **Example:**      | |
| Device# configure terminal | |

| **Step 3**        | Enables the forwarding of IPv6 unicast datagrams |
| `ipv6 unicast-routing` | |
| **Example:**      | |
| Device(config)# ipv6 unicast-routing | |

| **Step 4**        | Specifies the number of an autonomous system that identifies the router to other BGP routers and tags the routing information that is passed along. |
| `router bgp autonomous-system-number` | • The range is from 1 to 65535. |
| **Example:**      | |
| Device(config)# router bgp 5 | |

| **Step 5**        | Enters the address family configuration mode for configuring routing sessions. |
| `address-family ipv6 unicast` | |
| **Example:**      | |
| Device(config-router)# address-family ipv6 unicast | |

| **Step 6**        | Specifies the administrative distance, IPv6 address, prefix length and prefix list name for configuring the source specific distance for BGP routes. |
| `distance admin-distance ipv6-address|prefix prelength|interface name|prefix-list` | Interface name is optional and is required only if the neighbor address is a link local address. |
| **Example:**      | |
| Device(config-router-af)# distance 12 2001:DB8:0:CC00::1/128 list1 | |

| **Step 7**        | Exits address family configuration mode and returns to privileged EXEC mode. |
| `end`             | |
| **Example:**      | |
| Device(config-router-af)# end | |

**Verifying BGP Admin Distance Configuration**

Use the `show run sec bgp` command to verify the BGP configuration:

```plaintext
Device(config-device-af)# show run | sec bgp
router bgp 200
bgp log-neighbor-changes
neighbor FE80::A8BB:CCFF:FE02:BE01%Ethernet0/0 remote-as 200
neighbor FE80::A8BB:CCFF:FE02:BE01%Ethernet0/0 update-source Ethernet0/0
```
address-family ipv4
no neighbor FE80::A8BB:CCFF:FE02:BE01%Ethernet0/0 activate
exit-address-family

address-family ipv6
distance 90 FE80::A8BB:CCFF:FE02:BE01/128 interface Ethernet0/0
network 1::1/120
neighbor FE80::A8BB:CCFF:FE02:BE01%Ethernet0/0 activate
exit-address-family

Use the do show ipv6 route command to verify the IPv6 route configuration:

Device(config-device-af)# show ipv6 route
IPv6 Routing Table - default - 4 entries
Codes:  C - Connected,  L - Local,  S - Static,  U - Per-user Static route
       B - BGP,  R - RIP,  H - NHDP,  I1 - ISIS L1
       I2 - ISIS L2,  IA - ISIS interarea,  IS - ISIS summary,  D - EIGRP
       EX - EIGRP external,  ND - ND Default,  NDP - ND Prefix,  DCE - Destination
       NDr - Redirect,  O - OSPF Intra,  OI - OSPF Inter,  OE1 - OSPF ext 1
       OE2 - OSPF ext 2,  ON1 - OSPF NSSA ext 1,  ON2 - OSPF NSSA ext 2
      la - LISP alt,  lr - LISP site-registrations,  ld - LISP dyn-eid
     LA - LISP away,  a - Application
      C 1::1::1::1/120 [0/0]
         via Ethernet0/0, directly connected
     L 1::1::2/128 [0/0]
         via Ethernet0/0, receive
     B 3:4::5:6::1/128 [0/0]
         via FE80::A8BB:CCFF:FE02:BF01, Ethernet0/0
     L FF00::/8 [0/0]
         via Null0, receive

Additional References for BGP IPv6 Admin Distance

Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>Cisco IOS IP Routing: BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>
The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

**Table 23: Feature Information for ASR1K NPTv6**

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Configuration Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP IPv6 Admin Distance</td>
<td>Cisco IOS XE Denali 16.3.1</td>
<td>The BGP IPv6 Admin Distance feature lets you prioritize the BGP IPv6 routes in your network by enabling you to configure the source specific distance of a route and associate a prefix-list with the route. The RIB uses the distance from the source to determine the priority of the BGP IPv6 route in the network. The following commands were modified: <code>distance</code></td>
</tr>
</tbody>
</table>
CHAPTER 12

Connecting to a Service Provider Using External BGP

This module describes configuration tasks that will enable your Border Gateway Protocol (BGP) network to access peer devices in external networks such as those from Internet service providers (ISPs). BGP is an interdomain routing protocol that is designed to provide loop-free routing between organizations. External BGP (eBGP) peering sessions are configured to allow peers from different autonomous systems to exchange routing updates. Tasks to help manage the traffic that is flowing inbound and outbound are described, as are tasks to configure BGP policies to filter the traffic. Multihoming techniques that provide redundancy for connections to a service provider are also described.

• Finding Feature Information, on page 259
• Prerequisites for Connecting to a Service Provider Using External BGP, on page 260
• Restrictions for Connecting to a Service Provider Using External BGP, on page 260
• Information About Connecting to a Service Provider Using External BGP, on page 260
• How to Connect to a Service Provider Using External BGP, on page 270
• Configuration Examples for Connecting to a Service Provider Using External BGP, on page 323
• Where to Go Next, on page 332
• Additional References, on page 332
• Feature Information for Connecting to a Service Provider Using External BGP, on page 334

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.
Prerequisites for Connecting to a Service Provider Using External BGP

- Before connecting to a service provider you need to understand how to configure the basic BGP process and peers. See the “Cisco BGP Overview” and “Configuring a Basic BGP Network” modules for more details.

- The tasks and concepts in this chapter will help you configure BGP features that would be useful if you are connecting your network to a service provider. For each connection to the Internet, you must have an assigned autonomous system number from the Internet Assigned Numbers Authority (IANA).

Restrictions for Connecting to a Service Provider Using External BGP

- A router that runs Cisco IOS software can be configured to run only one BGP routing process and to be a member of only one BGP autonomous system. However, a BGP routing process and autonomous system can support multiple address family configurations.

- Policy lists are not supported in versions of Cisco IOS software prior to Cisco IOS Release 12.0(22)S and 12.2(15)T. Reloading a router that is running an older version of Cisco IOS software may cause some routing policy configurations to be lost.

Information About Connecting to a Service Provider Using External BGP

External BGP Peering

BGP is an interdomain routing protocol designed to provide loop-free routing links between organizations. BGP is designed to run over a reliable transport protocol and it uses TCP (port 179) as the transport protocol. The destination TCP port is assigned 179, and the local port is assigned a random port number. Cisco IOS software supports BGP version 4, which has been used by ISPs to help build the Internet. RFC 1771 introduced and discussed a number of new BGP features to allow the protocol to scale for Internet use.

External BGP peering sessions are configured to allow BGP peers from different autonomous systems to exchange routing updates. By design, a BGP routing process expects eBGP peers to be directly connected, for example, over a WAN connection. However, there are many real-world scenarios where this rule would prevent routing from occurring. Peering sessions for multihop neighbors are configured with the `neighbor ebgp-multihop` command. The figure below shows simple eBGP peering between three routers. Router B peers with Router A and Router E. In the figure below, the `neighbor ebgp-multihop` command could be used to establish peering between Router A and Router E although this is a very simple network design. BGP forwards information about the next hop in the network using the NEXT_HOP attribute, which is set to the IP address of the interface that advertises a route in an eBGP peering session by default. The source interface can be a physical interface or a loopback interface.
Loopback interfaces are preferred for establishing eBGP peering sessions because loopback interfaces are less susceptible to interface flapping. Interfaces on networking devices can fail, and they can also be taken out of service for maintenance. When an interface is administratively brought up or down, due to failure or maintenance, it is referred to as a flap. Loopback interfaces provide a stable source interface to ensure that the IP address assigned to the interface is always reachable as long as the IP routing protocols continue to advertise the subnet assigned to the loopback interface. Loopback interfaces allow you to conserve address space by configuring a single address with /32 bit mask. Before a loopback interface is configured for an eBGP peering session, you must configure the `neighbor update-source` command and specify the loopback interface. With this configuration, the loopback interface becomes the source interface and its IP address is advertised as the next hop for routes that are advertised through this loopback. If loopback interfaces are used to connect single-hop eBGP peers, you must configure the `neighbor disable-connected-check` command before you can establish the eBGP peering session.

Connecting to external networks enables traffic from your network to be forwarded to other networks and across the Internet. Traffic will also be flowing into, and possibly through, your network. BGP contains various techniques to influence how the traffic flows into and out of your network, and to create BGP policies that filter the traffic, inbound and outbound. To influence the traffic flow, BGP uses certain BGP attributes that can be included in update messages or used by the BGP routing algorithm. BGP policies to filter traffic also use some of the BGP attributes with route maps, access lists including AS-path access lists, filter lists, policy lists, and distribute lists. Managing your external connections may involve multihoming techniques where there is more than one connection to an ISP or connections to more than one ISP for backup or performance purposes. Tagging BGP routes with different community attributes across autonomous system or physical boundaries can prevent the need to configure long lists of individual permit or deny statements.

**BGP Autonomous System Number Formats**

Prior to January 2009, BGP autonomous system numbers that were allocated to companies were 2-octet numbers in the range from 1 to 65535 as described in RFC 4271, *A Border Gateway Protocol 4 (BGP-4)*. Due to increased demand for autonomous system numbers, the Internet Assigned Number Authority (IANA) will start in January 2009 to allocate four-octet autonomous system numbers in the range from 65536 to 4294967295. RFC 5396, *Textual Representation of Autonomous System (AS) Numbers*, documents three methods of representing autonomous system numbers. Cisco has implemented the following two methods:
• Asplain—Decimal value notation where both 2-byte and 4-byte autonomous system numbers are represented by their decimal value. For example, 65526 is a 2-byte autonomous system number and 234567 is a 4-byte autonomous system number.

• Asdot—Autonomous system dot notation where 2-byte autonomous system numbers are represented by their decimal value and 4-byte autonomous system numbers are represented by a dot notation. For example, 65526 is a 2-byte autonomous system number and 1.169031 is a 4-byte autonomous system number (this is dot notation for the 234567 decimal number).

For details about the third method of representing autonomous system numbers, see RFC 5396.

**Asdot Only Autonomous System Number Formatting**

In Cisco IOS Release 12.0(32)S12, 12.4(24)T, and later releases, the 4-octet (4-byte) autonomous system numbers are entered and displayed only in asdot notation, for example, 1.10 or 45000.64000. When using regular expressions to match 4-byte autonomous system numbers the asdot format includes a period which is a special character in regular expressions. A backslash must be entered before the period for example, 1\14, to ensure the regular expression match does not fail. The table below shows the format in which 2-byte and 4-byte autonomous system numbers are configured, matched in regular expressions, and displayed in `show` command output in Cisco IOS images where only asdot formatting is available.

**Table 24: Asdot Only 4-Byte Autonomous System Number Format**

<table>
<thead>
<tr>
<th>Format</th>
<th>Configuration Format</th>
<th>Show Command Output and Regular Expression Match Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>asdot</td>
<td>2-byte: 1 to 65535 4-byte: 1.0 to 65535.65535</td>
<td>2-byte: 1 to 65535 4-byte: 1.0 to 65535.65535</td>
</tr>
</tbody>
</table>

**Asplain as Default Autonomous System Number Formatting**

In Cisco IOS Release 12.0(32)SY8, 12.0(33)S3, 12.2(33)SRE, 12.2(33)XNE, 12.2(33)SX11, and later releases, the Cisco implementation of 4-byte autonomous system numbers uses asplain as the default display format for autonomous system numbers, but you can configure 4-byte autonomous system numbers in both the asplain and asdot format. In addition, the default format for matching 4-byte autonomous system numbers in regular expressions is asplain, so you must ensure that any regular expressions to match 4-byte autonomous system numbers are written in the asplain format. If you want to change the default `show` command output to display 4-byte autonomous system numbers in the asdot format, use the `bgp asnotation dot` command under router configuration mode. When the asdot format is enabled as the default, any regular expressions to match 4-byte autonomous system numbers must be written using the asdot format, or the regular expression match will fail. The tables below show that although you can configure 4-byte autonomous system numbers in either asplain or asdot format, only one format is used to display `show` command output and control 4-byte autonomous system number matching for regular expressions, and the default is asplain format. To display 4-byte autonomous system numbers in `show` command output and to control matching for regular expressions in the asdot format, you must configure the `bgp asnotation dot` command. After enabling the `bgp asnotation dot` command, a hard reset must be initiated for all BGP sessions by entering the `clear ip bgp` command.
If you are upgrading to an image that supports 4-byte autonomous system numbers, you can still use 2-byte autonomous system numbers. The show command output and regular expression match are not changed and remain in asplain (decimal value) format for 2-byte autonomous system numbers regardless of the format configured for 4-byte autonomous system numbers.

**Table 25: Default Asplain 4-Byte Autonomous System Number Format**

<table>
<thead>
<tr>
<th>Format</th>
<th>Configuration Format</th>
<th>Show Command Output and Regular Expression Match Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>asplain</td>
<td>2-byte: 1 to 65535 4-byte: 65536 to 4294967295</td>
<td>2-byte: 1 to 65535 4-byte: 65536 to 4294967295</td>
</tr>
<tr>
<td>asdot</td>
<td>2-byte: 1 to 65535 4-byte: 1.0 to 65535.65535</td>
<td>2-byte: 1 to 65535 4-byte: 65536 to 4294967295</td>
</tr>
</tbody>
</table>

**Table 26: Asdot 4-Byte Autonomous System Number Format**

<table>
<thead>
<tr>
<th>Format</th>
<th>Configuration Format</th>
<th>Show Command Output and Regular Expression Match Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>asplain</td>
<td>2-byte: 1 to 65535 4-byte: 65536 to 4294967295</td>
<td>2-byte: 1 to 65535 4-byte: 1.0 to 65535.65535</td>
</tr>
<tr>
<td>asdot</td>
<td>2-byte: 1 to 65535 4-byte: 1.0 to 65535.65535</td>
<td>2-byte: 1 to 65535 4-byte: 1.0 to 65535.65535</td>
</tr>
</tbody>
</table>

**Reserved and Private Autonomous System Numbers**

In Cisco IOS Release 12.0(32)S12, 12.0(32)SY8, 12.0(33)S3, 12.2(33)SRE, 12.2(33)XNE, 12.2(33)SX11, 12.4(24)T, and later releases, the Cisco implementation of BGP supports RFC 4893. RFC 4893 was developed to allow BGP to support a gradual transition from 2-byte autonomous system numbers to 4-byte autonomous system numbers. A new reserved (private) autonomous system number, 23456, was created by RFC 4893 and this number cannot be configured as an autonomous system number in the Cisco IOS CLI.

RFC 5398, *Autonomous System (AS) Number Reservation for Documentation Use*, describes new reserved autonomous system numbers for documentation purposes. Use of the reserved numbers allow configuration examples to be accurately documented and avoids conflict with production networks if these configurations are literally copied. The reserved numbers are documented in the IANA autonomous system number registry. Reserved 2-byte autonomous system numbers are in the contiguous block, 64496 to 64511 and reserved 4-byte autonomous system numbers are from 65536 to 65551 inclusive.

Private 2-byte autonomous system numbers are still valid in the range from 64512 to 65534 with 65535 being reserved for special use. Private autonomous system numbers can be used for internal routing domains but must be translated for traffic that is routed out to the Internet. BGP should not be configured to advertise private autonomous system numbers to external networks. Cisco IOS software does not remove private autonomous system numbers from routing updates by default. We recommend that ISPs filter private autonomous system numbers.
Autonomous system number assignment for public and private networks is governed by the IANA. For information about autonomous-system numbers, including reserved number assignment, or to apply to register an autonomous system number, see the following URL: http://www.iana.org/.

### BGP Attributes

BGP selects a single path, by default, as the best path to a destination host or network. The best-path selection algorithm analyzes path attributes to determine which route is installed as the best path in the BGP routing table. Each path carries various attributes that are used in BGP best-path analysis. Cisco IOS software provides the ability to influence BGP path selection by altering these attributes via the command-line interface (CLI). BGP path selection can also be influenced through standard BGP policy configuration.

BGP uses the best-path selection algorithm to find a set of equally good routes. These routes are the potential multipaths. In Cisco IOS Release 12.2(33)SRD and later releases, when there are more equally good multipaths available than the maximum permitted number, then the oldest paths are selected as multipaths.

BGP can include path attribute information in update messages. BGP attributes describe the characteristic of the route, and the software uses these attributes to help make decisions about which routes to advertise. Some of this attribute information can be configured at a BGP-speaking networking device. There are some mandatory attributes that are always included in the update message and some discretionary attributes. The following BGP attributes can be configured:

- **AS_Path**
- **Community**
- **Local_Pref**
- **Multi_Exit_Discriminator (MED)**
- **Next_Hop**
- **Origin**

#### AS_Path

This attribute contains a list or set of the autonomous system numbers through which routing information has passed. The BGP speaker adds its own autonomous system number to the list when it forwards the update message to external peers.

#### Community

BGP communities are used to group networking devices that share common properties, regardless of network, autonomous system, or any physical boundaries. In large networks applying a common routing policy through prefix lists or access lists requires individual peer statements on each networking device. Using the BGP community attribute BGP neighbors, with common routing policies, can implement inbound or outbound route filters based on the community tag rather than consult large lists of individual permit or deny statements.
Local_Pref

Within an autonomous system, the Local_Pref attribute is included in all update messages between BGP peers. If there are several paths to the same destination, the local preference attribute with the highest value indicates the preferred outbound path from the local autonomous system. The highest ranking route is advertised to internal peers. The Local_Pref value is not forwarded to external peers.

Multi_Exit_Discriminator

The MED attribute indicates (to an external peer) a preferred path into an autonomous system. If there are multiple entry points into an autonomous system, the MED can be used to influence another autonomous system to choose one particular entry point. A metric is assigned where a lower MED metric is preferred by the software over a higher MED metric. The MED metric is exchanged between autonomous systems, but after a MED is forwarded into an autonomous system, the MED metric is reset to the default value of 0. When an update is sent to an internal BGP (iBGP) peer, the MED is passed along without any change, allowing all the peers in the same autonomous system to make a consistent path selection.

By default, a router will compare the MED attribute for paths only from BGP peers that reside in the same autonomous system. The `bgp always-compare-med` command can be configured to allow the router to compare metrics from peers in different autonomous systems.

---

The Internet Engineering Task Force (IETF) decision regarding BGP MED assigns a value of infinity to the missing MED, making the route that lacks the MED variable the least preferred. The default behavior of BGP routers that run Cisco software is to treat routes without the MED attribute as having a MED of 0, making the route that lacks the MED variable the most preferred. To configure the router to conform to the IETF standard, use the `bgp bestpath med missing-as-worst` router configuration command.

---

Next_Hop

The Next_Hop attribute identifies the next-hop IP address to be used as the BGP next hop to the destination. The router makes a recursive lookup to find the BGP next hop in the routing table. In external BGP (eBGP), the next hop is the IP address of the peer that sent the update. Internal BGP (iBGP) sets the next-hop address to the IP address of the peer that advertised the prefix for routes that originate internally. When any routes to iBGP that are learned from eBGP are advertised, the Next_Hop attribute is unchanged.

A BGP next-hop IP address must be reachable in order for the router to use a BGP route. Reachability information is usually provided by the IGP, and changes in the IGP can influence the forwarding of the next-hop address over a network backbone.

Origin

This attribute indicates how the route was included in a BGP routing table. In Cisco software, a route defined using the BGP `network` command is given an origin code of Interior Gateway Protocol (IGP). Routes distributed from an Exterior Gateway Protocol (EGP) are coded with an origin of EGP, and routes redistributed from other protocols are defined as Incomplete. BGP decision policy for origin prefers IGP over EGP, and then EGP over Incomplete.
Multihoming

Multihoming is defined as connecting an autonomous system with more than one service provider. If you have any reliability issues with one service provider, then you have a backup connection. Performance issues can also be addressed by multihoming because better paths to the destination network can be utilized.

Unless you are a service provider, you must plan your routing configuration carefully to avoid Internet traffic traveling through your autonomous system and consuming all your bandwidth. The figure below shows that autonomous system 45000 is multihomed to autonomous system 40000 and autonomous system 50000. Assuming autonomous system 45000 is not a service provider, then several techniques such as load balancing or some form of routing policy must be configured to allow traffic from autonomous system 45000 to reach either autonomous system 40000 or autonomous system 50000 but not allow much, if any, transit traffic.

Figure 23: Multihoming Topology

MED Attribute

Configuring the MED attribute is another method that BGP can use to influence the choice of paths into another autonomous system. The MED attribute indicates (to an external peer) a preferred path into an autonomous system. If there are multiple entry points into an autonomous system, the MED can be used to influence another autonomous system to choose one particular entry point. A metric is assigned using route maps where a lower MED metric is preferred by the software over a higher MED metric.

Transit Versus Nontransit Traffic

Most of the traffic within an autonomous system contains a source or destination IP address residing within the autonomous system, and this traffic is referred to as nontransit (or local) traffic. Other traffic is defined as transit traffic. As traffic across the Internet increases, controlling transit traffic becomes more important.

A service provider is considered to be a transit autonomous system and must provide connectivity to all other transit providers. In reality, few service providers actually have enough bandwidth to allow all transit traffic, and most service providers have to purchase such connectivity from Tier 1 service providers.
An autonomous system that does not usually allow transit traffic is called a stub autonomous system and will link to the Internet through one service provider.

**BGP Policy Configuration**

BGP policy configuration is used to control prefix processing by the BGP routing process and to filter routes from inbound and outbound advertisements. Prefix processing can be controlled by adjusting BGP timers, altering how BGP handles path attributes, limiting the number of prefixes that the routing process will accept, and configuring BGP prefix dampening. Prefixes in inbound and outbound advertisements are filtered using route maps, filter lists, IP prefix lists, autonomous-system-path access lists, IP policy lists, and distribute lists. The table below shows the processing order of BGP policy filters.

<table>
<thead>
<tr>
<th>Inbound</th>
<th>Outbound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route map</td>
<td>Distribute list</td>
</tr>
<tr>
<td>Filter list, AS-path access list, or IP policy</td>
<td>IP prefix list</td>
</tr>
<tr>
<td>IP prefix list</td>
<td>Filter list, AS-path access list, or IP policy</td>
</tr>
<tr>
<td>Distribute list</td>
<td>Route map</td>
</tr>
</tbody>
</table>

**Note**

In Cisco IOS Releases 12.0(22)S, 12.2(15)T, 12.2(18)S, and later releases, the maximum number of autonomous system access lists that can be configured with the `ip as-path access-list` command is increased from 199 to 500.

Whenever there is a change in the routing policy due to a configuration change, BGP peering sessions must be reset using the `clear ip bgp` command. Cisco IOS software supports the following three mechanisms to reset BGP peering sessions:

- **Hard reset**--A hard reset tears down the specified peering sessions, including the TCP connection, and deletes routes coming from the specified peer.
- **Soft reset**--A soft reset uses stored prefix information to reconfigure and activate BGP routing tables without tearing down existing peering sessions. Soft reset uses stored update information, at the cost of additional memory for storing the updates, to allow you to apply a new BGP policy without disrupting the network. Soft reset can be configured for inbound or outbound sessions.
- **Dynamic inbound soft reset**--The route refresh capability, as defined in RFC 2918, allows the local router to reset inbound routing tables dynamically by exchanging route refresh requests to supporting peers. The route refresh capability does not store update information locally for nondisruptive policy changes. It instead relies on dynamic exchange with supporting peers. Route refresh must first be advertised through BGP capability negotiation between peers. All BGP routers must support the route refresh capability.

To determine if a BGP router supports this capability, use the `show ip bgp neighbors` command. The following message is displayed in the output when the router supports the route refresh capability:

```
Received route refresh capability from peer.
```
BGP COMMUNITIES Attribute

A BGP community is a group of routes that share a common property, regardless of their network, autonomous system, or any physical boundaries. In large networks, applying a common routing policy by using prefix lists or access lists requires individual peer statements on each networking device. Using the BGP COMMUNITIES attribute, BGP speakers with common routing policies can implement inbound or outbound route filters based on the community tag, rather than consult long lists of individual permit or deny statements. A COMMUNITIES attribute can contain multiple communities.

A route can belong to multiple communities. The network administrator defines the communities to which a route belongs. By default, all routes belong to the general Internet community.

In addition to numbered communities, there are several predefined (well-known) communities:

- no-export—Do not advertise this route to external BGP peers.
- no-advertise—Do not advertise this route to any peer.
- internet—Advertise this route to the Internet community. All BGP-speaking networking devices belong to this community.
- local-as—Do not send this route outside the local autonomous system.
- gshut—Community of routes gracefully shut down.

The COMMUNITIES attribute is optional, which means that it will not be passed on by networking devices that do not understand communities. Networking devices that understand communities must be configured to handle the communities or else the COMMUNITIES attribute will be discarded. By default, no COMMUNITIES attribute is sent to a neighbor. In order for a COMMUNITIES attribute to be sent to a neighbor, use the `neighbor send-community` command.

Extended Communities

Extended community attributes are used to configure, filter, and identify routes for virtual routing and forwarding (VRF) instances and Multiprotocol Label Switching (MPLS) Virtual Private Networks (VPNs). All of the standard rules of access lists apply to the configuration of extended community lists. Regular expressions are supported by the expanded range of extended community list numbers. All regular expression configuration options are supported. The route target (RT) and site of origin (SoO) extended community attributes are supported by the standard range of extended community lists.

Route Target Extended Community Attribute

The RT extended community attribute is configured with the `rt` keyword of the `ip extcommunity-list` command. This attribute is used to identify a set of sites and VRFs that may receive routes that are tagged with the configured route target. Configuring the route target extended community attribute with a route allows that route to be placed in the per-site forwarding tables that are used for routing traffic that is received from corresponding sites.

Site of Origin Extended Community Attribute

The SoO extended community attribute is configured with the `soo` keyword of the `ip extcommunity-list` command. This attribute uniquely identifies the site from which the provider edge (PE) router learned the route. All routes learned from a particular site must be assigned the same SoO extended community attribute, regardless if a site is connected to a single PE router or multiple PE routers. Configuring this attribute prevents
routing loops from occurring when a site is multihomed. The SoO extended community attribute is configured on the interface and is propagated into BGP through redistribution. The SoO extended community attribute can be applied to routes that are learned from VRFs. The SoO extended community attribute should not be configured for stub sites or sites that are not multihomed.

**IP Extended Community-List Configuration Mode**

Named and numbered extended community lists can be configured in IP extended community-list configuration mode. The IP extended community-list configuration mode supports all of the functions that are available in global configuration mode. In addition, the following operations can be performed:

- Configure sequence numbers for extended community list entries.
- Resequence existing sequence numbers for extended community list entries.
- Configure an extended community list to use default values.

**Default Sequence Numbering**

Extended community list entries start with the number 10 and increment by 10 for each subsequent entry when no sequence number is specified, when default behavior is configured, and when an extended community list is resequenced without specifying the first entry number or the increment range for subsequent entries.

**Resequencing Extended Community Lists**

Extended community-list entries are sequenced and resequenced on a per-extended community list basis. The resequence command can be used without any arguments to set all entries in a list to default sequence numbering. The resequence command also allows the sequence number of the first entry and increment range to be set for each subsequent entry. The range of configurable sequence numbers is from 1 to 2147483647.

**Extended Community Lists**

Extended community attributes are used to configure, filter, and identify routes for VRF instances and MPLS VPNs. The ip extcommunity-list command is used to configure named or numbered extended community lists. All of the standard rules of access lists apply to the configuration of extended community lists. Regular expressions are supported by the expanded range of extended community list numbers.

**Administrative Distance**

Administrative distance is a measure of the preference of different routing protocols. BGP has a distance bgp command that allows you to set different administrative distances for three route types: external, internal, and local. BGP, like other protocols, prefers the route with the lowest administrative distance.

**BGP Route Map Policy Lists**

BGP route map policy lists allow a network operator to group route map match clauses into named lists called policy lists. A policy list functions like a macro. When a policy list is referenced in a route map, all of the match clauses are evaluated and processed as if they had been configured directly in the route map. This enhancement simplifies the configuration of BGP routing policy in medium-size and large networks because a network operator can preconfigure policy lists with groups of match clauses and then reference these policy
lists within different route maps. The network operator no longer needs to manually reconfigure each recurring group of match clauses that occur in multiple route map entries.

A policy lists functions like a macro when it is configured in a route map and has the following capabilities and characteristics:

- When a policy list is referenced within a route map, all the match statements within the policy list are evaluated and processed.
- Two or more policy lists can be configured with a route map. Policy lists can be configured within a route map to be evaluated with AND or OR semantics.
- Policy lists can coexist with any other preexisting match and set statements that are configured within the same route map but outside of the policy lists.
- When multiple policy lists perform matching within a route map entry, all policy lists match on the incoming attribute only.

Policy lists support only match clauses and do not support set clauses. Policy lists can be configured for all applications of route maps, including redistribution, and can also coexist, within the same route map entry, with match and set clauses that are configured separately from the policy lists.

---

**Note**

Policy lists are supported only by BGP and are not supported by other IP routing protocols.

---

### How to Connect to a Service Provider Using External BGP

#### Influencing Inbound Path Selection

BGP can be used to influence the choice of paths in another autonomous system. There may be several reasons for wanting BGP to choose a path that is not the obvious best route, for example, to avoid some types of transit traffic passing through an autonomous system or perhaps to avoid a very slow or congested link. BGP can influence inbound path selection using one of the following BGP attributes:

- AS-path
- Multi-Exit Discriminator (MED)

Perform one of the following tasks to influence inbound path selection:

#### Influencing Inbound Path Selection by Modifying the AS_PATH Attribute

Perform this task to influence the inbound path selection for traffic destined for the 172.17.1.0 network by modifying the AS_PATH attribute. The configuration is performed at Router A in the figure below. For a configuration example of this task using 4-byte autonomous system numbers in asplain format, see the “Example: Influencing Inbound Path Selection by Modifying the AS_PATH Attribute Using 4-Byte AS Numbers”.

One of the methods that BGP can use to influence the choice of paths in another autonomous system is to modify the AS_PATH attribute. For example, in the figure below, Router A advertises its own network, 172.17.1.0, to its BGP peers in autonomous system 45000 and autonomous system 60000. When the routing
information is propagated to autonomous system 50000, the routers in autonomous system 50000 have network reachability information about network 172.17.1.0 from two different routes. The first route is from autonomous system 45000 with an AS_PATH consisting of 45000, 40000, the second route is through autonomous system 55000 with an AS-path of 55000, 60000, 40000. If all other BGP attribute values are the same, Router C in autonomous system 50000 would choose the route through autonomous system 45000 for traffic destined for network 172.17.1.0 because it is the shortest route in terms of autonomous systems traversed.

Autonomous system 40000 now receives all traffic from autonomous system 50000 for the 172.17.1.0 network through autonomous system 45000. If, however, the link between autonomous system 45000 and autonomous system 40000 is a really slow and congested link, the set as-path prepend command can be used at Router A to influence inbound path selection for the 172.17.1.0 network by making the route through autonomous system 45000 appear to be longer than the path through autonomous system 60000. The configuration is done at Router A in the figure below by applying a route map to the outbound BGP updates to Router B. Using the set as-path prepend command, all the outbound BGP updates from Router A to Router B will have their AS_PATH attribute modified to add the local autonomous system number 40000 twice. After the configuration, autonomous system 50000 receives updates about the 172.17.1.0 network through autonomous system 45000. The new AS_PATH is 45000, 40000, 40000, and 40000, which is now longer than the AS-path from autonomous system 55000 (unchanged at a value of 55000, 60000, 40000). Networking devices in autonomous system 50000 will now prefer the route through autonomous system 55000 to forward packets with a destination address in the 172.17.1.0 network.

**Figure 24: Network Topology for Modifying the AS_PATH Attribute**

**SUMMARY STEPS**

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. neighbor {ip-address | peer-group-name} remote-as autonomous-system-number
5. address-family ipv4 [unicast | multicast | vrf vrf-name]
6. network network-number [mask network-mask] [route-map route-map-name]
7. neighbor {ip-address | peer-group-name} activate
8. `neighbor {ip-address | peer-group-name} route-map map-name {in | out}`
9. `exit-address-family`
10. `exit`
11. `route-map map-name [permit | deny] [sequence-number]`
12. `set as-path {tag | prepend as-path-string}`
13. `end`
14. `show running-config`

### Detailed Steps

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><code>enable</code></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device&gt; enable</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><code>configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device# configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td><code>router bgp autonomous-system-number</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config)# router bgp 40000</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>Adds the IP address or peer group name of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local router.</td>
</tr>
<tr>
<td>`neighbor {ip-address</td>
<td>peer-group-name} remote-as autonomous-system-number`</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>• In this example, the BGP peer on Router B at 192.168.1.2 is added to the IPv4 multiprotocol BGP neighbor table and will receive BGP updates.</td>
</tr>
<tr>
<td><code>Device(config-router)# neighbor 192.168.1.2 remote-as 45000</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>Specifies the IPv4 address family and enters address family configuration mode.</td>
</tr>
<tr>
<td>`address-family ipv4 [unicast</td>
<td>multicast</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>• The unicast keyword specifies the IPv4 unicast address family. By default, the router is placed in address family configuration mode for the IPv4 unicast address family if the <strong>unicast</strong> keyword is not specified with the <strong>address-family ipv4</strong> command.</td>
</tr>
<tr>
<td><code>Device(config-router)# address-family ipv4 unicast</code></td>
<td></td>
</tr>
</tbody>
</table>

### Connecting to a Service Provider Using External BGP

Influencing Inbound Path Selection by Modifying the AS_PATH Attribute
<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| 6    | `network` `network-number` [mask `network-mask`] [route-map `route-map-name`] | Specifies a network as local to this autonomous system and adds it to the BGP routing table.  
- For exterior protocols the `network` command controls which networks are advertised. Interior protocols use the `network` command to determine where to send updates. |
| 7    | `neighbor` `{ip-address | peer-group-name}` `activate` | Enables address exchange for address family IPv4 unicast for the BGP neighbor at 192.168.1.2 on Router B. |
| 8    | `neighbor` `{ip-address | peer-group-name}` `route-map` `map-name` `{in | out}` | Applies a route map to incoming or outgoing routes.  
- In this example, the route map named PREPEND is applied to outbound routes to Router B. |
| 9    | `exit-address-family` | Exits address family configuration mode and enters router configuration mode. |
| 10   | `exit` | Exits router configuration mode and enters global configuration mode. |
| 11   | `route-map` `map-name` [permit | deny] [sequence-number] | Configures a route map and enters route map configuration mode.  
- In this example, a route map named PREPEND is created with a permit clause. |
| 12   | `set as-path` `{tag | prepend} as-path-string}` | Modifies an autonomous system path for BGP routes.  
- Use the `prepend` keyword to prepend an arbitrary autonomous system path string to BGP routes. Usually the local autonomous system number is prepended multiple times, increasing the autonomous system path length.  
- In this example, two additional autonomous system entries are added to the autonomous system path for outbound routes to Router B. |
### Purpose

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 13</strong> end</td>
<td>Exits route map configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config-route-map)# end</td>
<td></td>
</tr>
</tbody>
</table>

| **Step 14** show running-config | Displays the running configuration file. |
| **Example:** |         |
| Device# show running-config |         |

### Examples

**Router A**

The following partial output of the `show running-config` command shows the configuration from this task.

```
Device# show running-config
.
.
router bgp 40000
neighbor 192.168.1.2 remote-as 45000 !
address-family ipv4
neighbor 192.168.1.2 activate
neighbor 192.168.1.2 route-map PREPEND out
no auto-summary
no synchronization
network 172.17.1.0 mask 255.255.255.0
exit-address-family !
route-map PREPEND permit 10
set as-path prepend 40000 40000
.
.
```

### Influencing Inbound Path Selection by Setting the MED Attribute

One of the methods that BGP can use to influence the choice of paths into another autonomous system is to set the Multi-Exit Discriminator (MED) attribute. The MED attribute indicates (to an external peer) a preferred path to an autonomous system. If there are multiple entry points to an autonomous system, the MED can be used to influence another autonomous system to choose one particular entry point. A metric is assigned using route maps where a lower MED metric is preferred by the software over a higher MED metric.

Perform this task to influence inbound path selection by setting the MED metric attribute. The configuration is performed at Router B and Router D in the figure below. Router B advertises the network 172.16.1.0 to its BGP peer, Router E in autonomous system 50000. Using a simple route map Router B sets the MED metric to 50 for outbound updates. The task is repeated at Router D but the MED metric is set to 120. When Router E receives the updates from both Router B and Router D the MED metric is stored in the BGP routing table.
Before forwarding packets to network 172.16.1.0, Router E compares the attributes from peers in the same autonomous system (both Router B and Router D are in autonomous system 45000). The MED metric for Router B is less than the MED for Router D, so Router E will forward the packets through Router B.

**Figure 25: Network Topology for Setting the MED Attribute**

Use the `bgp always-compare-med` command to compare MED attributes from peers in other autonomous systems.

### SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. neighbor {ip-address | peer-group-name} remote-as autonomous-system-number
5. address-family ipv4 [unicast | multicast | vrf vrf-name]
6. network network-number [mask network-mask] [route-map route-map-name]
7. neighbor {ip-address | peer-group-name} route-map map-name {in | out}
8. exit
9. exit
10. route-map map-name [permit | deny] [sequence-number]
11. set metric value
12. end
13. Repeat Step 1 through Step 12 at Router D.
14. show ip bgp [network] [network-mask]

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
</tbody>
</table>
### Command or Action

<table>
<thead>
<tr>
<th>Step 2</th>
<th><code>configure terminal</code></th>
<th>Enters global configuration mode.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td>Device# configure terminal</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 3</th>
<th><code>router bgp autonomous-system-number</code></th>
<th>Enters router configuration mode for the specified routing process.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td>Device(config)# router bgp 45000</td>
<td></td>
</tr>
</tbody>
</table>

| Step 4 | `neighbor {ip-address | peer-group-name} remote-as autonomous-system-number` | Adds the IP address or peer group name of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local router. |
|--------|---------------------------------------------------------------|---------------------------------------------------------------|
| Example: | Device(config-router)# neighbor 192.168.3.2 remote-as 50000 |

| Step 5 | `address-family ipv4 [unicast | multicast | vrf vrf-name]` | Specifies the IPv4 address family and enters address family configuration mode. |
|--------|---------------------------------------------------------------|---------------------------------------------------------------|
| Example: | Device(config-router)# address-family ipv4 unicast |

<table>
<thead>
<tr>
<th>Step 6</th>
<th><code>network network-number [mask network-mask] [route-map route-map-name]</code></th>
<th>Specifies a network as local to this autonomous system and adds it to the BGP routing table.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td>Device(config-router-af)# network 172.16.1.0 mask 255.255.255.0</td>
<td></td>
</tr>
</tbody>
</table>

| Step 7 | `neighbor {ip-address | peer-group-name} route-map map-name {in | out}` | Applies a route map to incoming or outgoing routes. |
|--------|---------------------------------------------------------------|---------------------------------------------------------------|
| Example: | |

- Enter your password if prompted.
- The `unicast` keyword specifies the IPv4 unicast address family. By default, the router is placed in address family configuration mode for the IPv4 unicast address family if the `unicast` keyword is not specified with the `address-family ipv4` command.
- The `multicast` keyword specifies IPv4 multicast address prefixes.
- The `vrf` keyword and `vrf-name` argument specify the name of the VRF instance to associate with subsequent IPv4 address family configuration mode commands.
- For exterior protocols the `network` command controls which networks are advertised. Interior protocols use the `network` command to determine where to send updates.
- In this example, the route map named MED is applied to outbound routes to the BGP peer at Router E.
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device(config-router-af)# neighbor 192.168.3.2 route-map MED out</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td>Exit address family configuration mode and enters router configuration mode.</td>
</tr>
<tr>
<td>exit</td>
<td>Example:</td>
</tr>
<tr>
<td>Device(config-router-af)# exit</td>
<td></td>
</tr>
<tr>
<td><strong>Step 9</strong></td>
<td>Exit router configuration mode and enters global configuration mode.</td>
</tr>
<tr>
<td>exit</td>
<td>Example:</td>
</tr>
<tr>
<td>Device(config-router)# exit</td>
<td></td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td>Configures a route map and enters route map configuration mode.</td>
</tr>
<tr>
<td>route-map map-name [permit</td>
<td>deny] [sequence-number]</td>
</tr>
<tr>
<td>Example:</td>
<td>• In this example, a route map named MED is created.</td>
</tr>
<tr>
<td>Device(config)# route-map MED permit 10</td>
<td></td>
</tr>
<tr>
<td><strong>Step 11</strong></td>
<td>Sets the MED metric value.</td>
</tr>
<tr>
<td>set metric value</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config-route-map)# set metric 50</td>
<td></td>
</tr>
<tr>
<td><strong>Step 12</strong></td>
<td>Exit route map configuration mode and enters privileged EXEC mode.</td>
</tr>
<tr>
<td>end</td>
<td>Example:</td>
</tr>
<tr>
<td>Device(config-route-map)# end</td>
<td></td>
</tr>
<tr>
<td><strong>Step 13</strong></td>
<td>Repeat Step 1 through Step 12 at Router D.</td>
</tr>
<tr>
<td><strong>Step 14</strong></td>
<td>(Optional) Displays the entries in the BGP routing table.</td>
</tr>
<tr>
<td>show ip bgp [network] [network-mask]</td>
<td>• Use this command at Router E in the figure above when both Router B and Router D have configured the MED attribute.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Only the syntax applicable to this task is used in this example. For more details, see the <em>Cisco IOS IP Routing: BGP Command Reference</em>.</td>
</tr>
<tr>
<td>Device# show ip bgp 172.17.1.0 255.255.255.0</td>
<td></td>
</tr>
</tbody>
</table>

**Examples**

The following output is from Router E in the figure above after this task has been performed at both Router B and Router D. Note the metric (MED) values for the two routes to network 172.16.1.0. The peer 192.168.2.1 at Router D has a metric of 120 for the path to network 172.16.1.0, whereas the peer 192.168.3.1 at Router B has a metric of 50. The entry for the peer 192.168.3.1 at Router B has
the word best at the end of the entry to show that Router E will choose to send packets destined for network 172.16.1.0 via Router B because the MED metric is lower.

```
Device# show ip bgp 172.16.1.0
```

BGP routing table entry for 172.16.1.0/24, version 10
Paths: (2 available, best #2, table Default-IP-Routing-Table)
Advertised to update-groups:
   1
45000
   192.168.2.1 from 192.168.2.1 (192.168.2.1)
     Origin IGP, metric 120, localpref 100, valid, external
45000
   192.168.3.1 from 192.168.3.1 (172.17.1.99)
     Origin IGP, metric 50, localpref 100, valid, external, best

**Influencing Outbound Path Selection**

BGP can be used to influence the choice of paths for outbound traffic from the local autonomous system. This section contains two methods that BGP can use to influence outbound path selection:

- Using the Local_Pref attribute
- Using the BGP outbound route filter (ORF) capability

Perform one of the following tasks to influence outbound path selection:

**Influencing Outbound Path Selection Using the Local_Pref Attribute**

One of the methods to influence outbound path selection is to use the BGP Local-Pref attribute. Perform this task using the local preference attribute to influence outbound path selection. If there are several paths to the same destination the local preference attribute with the highest value indicates the preferred path.

Refer to the figure below for the network topology used in this task. Both Router B and Router C are configured. autonomous system 45000 receives updates for network 192.168.3.0 via autonomous system 40000 and autonomous system 50000. Router B is configured to set the local preference value to 150 for all updates to autonomous system 40000. Router C is configured to set the local preference value for all updates to autonomous system 50000 to 200. After the configuration, local preference information is exchanged within autonomous system 45000. Router B and Router C now see that updates for network 192.168.3.0 have a higher preference value from autonomous system 50000 so all traffic in autonomous system 45000 with a destination network of 192.168.3.0 is sent out via Router C.
SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. neighbor {ip-address|peer-group-name} remote-as autonomous-system-number
5. bgp default local-preference value
6. address-family ipv4 [unicast | multicast] vrf vrf-name
7. network network-number [mask network-mask][route-map route-map-name]
8. neighbor {ip-address|peer-group-name} activate
9. end
10. Repeat Step 1 through Step 9 at Router C but change the IP address of the peer, the autonomous system number, and set the local preference value to 200.
11. show ip bgp [network] [network-mask]

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
</tr>
<tr>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td></td>
</tr>
<tr>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td><strong>Example:</strong> Router(config)# router bgp 45000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> neighbor {ip-address</td>
<td>peer-group-name} remote-as autonomous-system-number</td>
</tr>
<tr>
<td><strong>Example:</strong> Router(config-router)# neighbor 192.168.1.2 remote-as 40000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> bgp default local-preference value</td>
<td>Changes the default local preference value.</td>
</tr>
</tbody>
</table>
| **Example:** Router(config-router)# bgp default local-preference 150 | • In this example, the local preference is changed to 150 for all updates from autonomous system 40000 to autonomous system 45000.  
• By default, the local preference value is 100. |
| **Step 6** address-family ipv4 [unicast | multicast | vrf vrf-name] | Specifies the IPv4 address family and enters address family configuration mode. |
| **Example:** Router(config-router)# address-family ipv4 unicast | • The **unicast** keyword specifies the IPv4 unicast address family. By default, the router is placed in address family configuration mode for the IPv4 unicast address family if the **unicast** keyword is not specified with the **address-family ipv4** command.  
• The **multicast** keyword specifies IPv4 multicast address prefixes.  
• The **vrf** keyword and **vrf-name** argument specify the name of the VRF instance to associate with subsequent IPv4 address family configuration mode commands. |
| **Step 7** network network-number [mask network-mask][route-map route-map-name] | Specifies a network as local to this autonomous system and adds it to the BGP routing table. |
| **Example:** Router(config-router-af)# network 172.17.1.0 mask 255.255.255.0 | • For exterior protocols the **network** command controls which networks are advertised. Interior protocols use the **network** command to determine where to send updates. |
| **Step 8** neighbor {ip-address|peer-group-name} activate | Adds the IP address or peer group name of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local router. |
| **Example:** Router(config-router-af)# neighbor 192.168.1.2 activate |
### Filtering Outbound BGP Route Prefixes

Perform this task to use BGP prefix-based outbound route filtering to influence outbound path selection.

**Before you begin**

BGP peering sessions must be established, and BGP ORF capabilities must be enabled on each participating router before prefix-based ORF announcements can be received.

**Note**

- BGP prefix-based outbound route filtering does not support multicast.
- IP addresses that are used for outbound route filtering must be defined in an IP prefix list. BGP distribute lists and IP access lists are not supported.
- Outbound route filtering is configured on only a per-address family basis and cannot be configured under the general session or BGP routing process.
- Outbound route filtering is configured for external peering sessions only.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `ip prefix-list list-name [seq seq-value] {deny network/length | permit network/length} [ge ge-value] [le le-value]`
4. `router bgp autonomous-system-number`
5. `neighbor {ip-address | peer-group-name} remote-as autonomous-system-number`
6. `neighbor ip-address ebgp-multihop [hop-count]`
7. `address-family ipv4 [unicast | multicast | vrf vrf-name]`
### 8. `neighbor ip-address capability orf prefix-list [send | receive | both]`

### 9. `neighbor {ip-address | peer-group-name} prefix-list prefix-list-name {in | out}`

### 10. `end`

### 11. `clear ip bgp {ip-address | *} in prefix-filter`

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| Step 1 | `enable` | Enables privileged EXEC mode.  
Example:  
`Router> enable`  
• Enter your password if prompted. |
| Step 2 | `configure terminal` | Enters global configuration mode.  
Example:  
`Router# configure terminal` |
| Step 3 | `ip prefix-list list-name [seq seq-value] {deny network/length | permit network/length} [ge ge-value] [le le-value]` | Creates a prefix list for prefix-based outbound route filtering.  
Example:  
`Router(config)# ip prefix-list FILTER seq 10 permit 192.168.1.0/24`  
• Outbound route filtering supports prefix length matching, wildcard-based prefix matching, and exact address prefix matching on a per address-family basis.  
• The prefix list is created to define the outbound route filter. The filter must be created when the outbound route filtering capability is configured to be advertised in send mode or both mode. It is not required when a peer is configured to advertise receive mode only.  
• The example creates a prefix list named FILTER that defines the 192.168.1.0/24 subnet for outbound route filtering. |
| Step 4 | `router bgp autonomous-system-number` | Enters router configuration mode, and creates a BGP routing process.  
Example:  
`Router(config)# router bgp 100` |
| Step 5 | `neighbor {ip-address | peer-group-name} remote-as autonomous-system-number` | Establishes peering with the specified neighbor or peer group. BGP peering must be established before ORF capabilities can be exchanged.  
Example:  
`Router(config-router)# neighbor 10.1.1.1 remote-as 200`  
• The example establishes peering with the 10.1.1.1 neighbor. |
| Step 6 | `neighbor ip-address ebgp-multihop [hop-count]` | Accepts or initiates BGP connections to external peers residing on networks that are not directly connected.  
Example: |
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 7**

```bash
Router(config-router)# neighbor 10.1.1.1
ebgp-multihop
```

Specifies the IPv4 address family and enters address family configuration mode.

- The `unicast` keyword specifies the IPv4 unicast address family. By default, the router is placed in address family configuration mode for the IPv4 unicast address family if the `unicast` keyword is not specified with the `address-family ipv4` command.

- The `multicast` keyword specifies IPv4 multicast address prefixes.

- The `vrf` keyword and `vrf-name` arguments specify the name of the VRF instance to associate with subsequent IPv4 address family configuration mode commands.

**Note**

Outbound route filtering is configured on a per-address family basis.

| **Step 8**

```bash
neighbor ip-address capability orf prefix-list
  [send | receive | both]
```

Enables the ORF capability on the local router, and enables ORF capability advertisement to the BGP peer specified with the `ip-address` argument.

- The `send` keyword configures a router to advertise ORF send capabilities.

- The `receive` keyword configures a router to advertise ORF receive capabilities.

- The `both` keyword configures a router to advertise send and receive capabilities.

- The remote peer must be configured to either send or receive ORF capabilities before outbound route filtering is enabled.

- The example configures the router to advertise send and receive capabilities to the 10.1.1.1 neighbor.

| **Step 9**

```bash
neighbor ip-address | peer-group-name
  prefix-list
  prefix-list-name
  [in | out]
```

Applies an inbound prefix-list filter to prevent distribution of BGP neighbor information.

- In this example, the prefix list named FILTER is applied to incoming advertisements from the 10.1.1.1 neighbor, which prevents distribution of the 192.168.1.0/24 subnet.
### Configuring BGP Peering with ISPs

BGP was developed as an interdomain routing protocol and connecting to ISPs is one of the main functions of BGP. Depending on the size of your network and the purpose of your business, there are many different ways to connect to your ISP. Multihoming to one or more ISPs provides redundancy in case an external link to an ISP fails. This section introduces some optional tasks that can be used to connect to a service provider using multihoming techniques. Smaller companies may use just one ISP but require a backup route to the ISP. Larger companies may have access to two ISPs, using one of the connections as a backup, or may need to configure a transit autonomous system.

Perform one of the following optional tasks to connect to one or more ISPs:

#### Configuring Multihoming with Two ISPs

Perform this task to configure your network to access two ISPs where one ISP is the preferred route and the second ISP is a backup route. In the figure below Router B in autonomous system 45000 has BGP peers in two ISPs, autonomous system 40000 and autonomous system 50000. Using this task, Router B will be configured to prefer the route to the BGP peer at Router A in autonomous system 40000.

All routes learned from this neighbor will have an assigned weight. The route with the highest weight will be chosen as the preferred route when multiple routes are available to a particular network.

---

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 10</strong> end</td>
<td>Exits address family configuration mode, and enters privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config-router-af)# end</td>
<td></td>
</tr>
<tr>
<td><strong>Step 11</strong> clear ip bgp {ip-address</td>
<td>*} in prefix-filter</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router# clear ip bgp 10.1.1.1 in prefix-filter</td>
<td></td>
</tr>
</tbody>
</table>

---

**Note**  
The inbound soft refresh must be initiated with the `clear ip bgp` command in order for this feature to function.
### SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router bgp** `autonomous-system-number`
4. **neighbor** `{ip-address | peer-group-name}` **remote-as** `autonomous-system-number`
5. **address-family ipv4** `{unicast | multicast | vrf vrf-name}`
6. **network** `network-number` `{mask network-mask}`
7. **neighbor** `{ip-address | peer-group-name}` **weight** `number`
8. **exit**
9. **neighbor** `{ip-address | peer-group-name}` **remote-as** `autonomous-system-number`
10. **address-family ipv4** `{unicast | multicast | vrf vrf-name}`
11. **neighbor** `{ip-address | peer-group-name}` **weight** `number`
12. **end**
13. **clear ip bgp** `{* | ip-address | peer-group-name}` `{soft [in | out]}`
14. **show ip bgp** `{network} `{network-mask}`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><code>enable</code></td>
<td>- Enter your password if prompted.</td>
</tr>
<tr>
<td>Example:</td>
<td>Router&gt; enable</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><code>configure terminal</code></td>
<td>Router# configure terminal</td>
</tr>
</tbody>
</table>
### Command or Action

<table>
<thead>
<tr>
<th>Step</th>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 3</strong></td>
<td><code>router bgp autonomous-system-number</code></td>
<td>Enters router configuration mode, and creates a BGP routing process.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>Router(config)# router bgp 45000</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>`neighbor {ip-address</td>
<td>peer-group-name} remote-as autonomous-system-number`</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>Router(config-router)# neighbor 192.168.1.2 remote-as 40000</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>`address-family ipv4 [unicast</td>
<td>multicast</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>Router(config-router)# address-family ipv4 unicast</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td><code>network network-number [mask network-mask]</code></td>
<td>Specifies a network as local to this autonomous system and adds it to the BGP routing table.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>Router(config-router-af)# network 172.17.1.0 mask 255.255.255.0</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>`neighbor {ip-address</td>
<td>peer-group-name} weight number`</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>Router(config-router-af)# neighbor 192.168.1.2 weight 150</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td><code>exit</code></td>
<td>Exits address family configuration mode and enters router configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>Router(config-router-af)# exit</code></td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td><strong>Step 9</strong> neighbor {ip-address</td>
<td>peer-group-name} remote-as autonomous-system-number</td>
<td>Adds the IP address or peer group name of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local router.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Router(config-router)# neighbor 192.168.3.2 remote-as 50000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 10</strong> address-family ipv4 [unicast</td>
<td>multicast</td>
<td>vrf vrf-name]</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Router(config-router)# address-family ipv4 unicast</td>
<td></td>
</tr>
<tr>
<td><strong>Step 11</strong> neighbor {ip-address</td>
<td>peer-group-name} weight number</td>
<td>Assigns a weight to a BGP peer connection.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Router(config-router-af)# neighbor 192.168.3.2 weight 100</td>
<td></td>
</tr>
<tr>
<td><strong>Step 12</strong> end</td>
<td>Exits address family configuration mode and enters privileged EXEC mode.</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Router(config-router-af)# end</td>
<td></td>
</tr>
<tr>
<td><strong>Step 13</strong> clear ip bgp {*</td>
<td>ip-address</td>
<td>peer-group-name} [soft [in</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Router# clear ip bgp *</td>
<td></td>
</tr>
<tr>
<td><strong>Step 14</strong> show ip bgp [network] [network-mask]</td>
<td>Displays the entries in the BGP routing table.</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Router# show ip bgp</td>
<td></td>
</tr>
</tbody>
</table>

**Note** Only the syntax applicable to this task is used in this example. For more details, see the *Cisco IOS IP Routing: BGP Command Reference*. 
Examples

The following example shows the BGP routing table at Router B with the weight attributes assigned to routes. The route through 192.168.1.2 (Router A in the figure above) has the highest weight attribute and will be the preferred route to network 10.3.0.0, wherein the network 10.3.0.0 is accessible through Router A and Router E. If this route (through Router B) fails for some reason, the route through 192.168.3.2 (Router E) will be used to reach network 10.3.0.0. This way, redundancy is provided for reaching Router B.

BGP table version is 8, local router ID is 172.17.1.99
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal, r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

<table>
<thead>
<tr>
<th>Network</th>
<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>*&gt; 10.1.1.0/24</td>
<td>192.168.1.2</td>
<td>0</td>
<td>150</td>
<td>40000</td>
<td>i</td>
</tr>
<tr>
<td>*&gt; 10.2.2.0/24</td>
<td>192.168.3.2</td>
<td>0</td>
<td>100</td>
<td>50000</td>
<td>i</td>
</tr>
<tr>
<td>*&gt; 10.3.0.0/16</td>
<td>192.168.1.2</td>
<td>0</td>
<td>150</td>
<td>40000</td>
<td>i</td>
</tr>
<tr>
<td>*</td>
<td>192.168.3.2</td>
<td>0</td>
<td>100</td>
<td>50000</td>
<td>i</td>
</tr>
<tr>
<td>*&gt; 172.17.1.0/24</td>
<td>0.0.0.0.0</td>
<td>0</td>
<td></td>
<td>32768</td>
<td>i</td>
</tr>
</tbody>
</table>

Multihoming with a Single ISP

Perform this task to configure your network to access one of two connections to a single ISP, where one of the connections is the preferred route and the second connection is a backup route. In the figure above Router E in autonomous system 50000 has two BGP peers in a single autonomous system, autonomous system 45000. Using this task, autonomous system 50000 does not learn any routes from autonomous system 45000 and is sending its own routes using BGP. This task is configured at Router E in the figure above and covers three features about multihoming to a single ISP:

- **Outbound traffic**—Router E will forward default routes and traffic to autonomous system 45000 with Router B as the primary link and Router D as the backup link. Static routes are configured to both Router B and Router D with a lower distance configured for the link to Router B.

- **Inbound traffic**—Inbound traffic from autonomous system 45000 is configured to be sent from Router B unless the link fails when the backup route is to send traffic from Router D. To achieve this, outbound filters are set using the MED metric.

- **Prevention of transit traffic**—A route map is configured at Router E in autonomous system 50000 to block all incoming BGP routing updates to prevent autonomous system 50000 from receiving transit traffic from the ISP in autonomous system 45000.

**SUMMARY STEPS**

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. neighbor [ip-address | peer-group-name] remote-as autonomous-system-number
5. address-family ipv4 [unicast | multicast | vrf vrf-name]
### Detailed Steps

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
</tr>
<tr>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><em>Example:</em></td>
<td></td>
</tr>
<tr>
<td>$Router&gt; enable$</td>
<td>Enter your password if prompted.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Step 2</strong></th>
<th>configure terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Example:</em></td>
<td>$Router# configure terminal$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Step 3</strong></th>
<th>router bgp autonomous-system-number</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Example:</em></td>
<td>$Router(config)# router bgp 45000$</td>
</tr>
</tbody>
</table>

<p>| <strong>Step 4</strong> | neighbor {ip-address | peer-group-name} remote-as autonomous-system-number |
|------------|---------------------------------------------------------------|
| <em>Example:</em> | Adds the IP address or peer group name of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local router. |</p>
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Router(config-router)# neighbor 192.168.2.1 remote-as 45000</td>
<td>- In this example, the BGP peer at Router D is added to the BGP routing table.</td>
</tr>
</tbody>
</table>

**Step 5**

**address-family ipv4 [unicast | multicast | vrf vrf-name]**

**Example:**

Router(config-router)# address-family ipv4 unicast

Specifies the IPv4 address family and enters address family configuration mode.

- The **unicast** keyword specifies the IPv4 unicast address family. By default, the router is placed in address family configuration mode for the IPv4 unicast address family if the **unicast** keyword is not specified with the **address-family ipv4** command.

- The **multicast** keyword specifies IPv4 multicast address prefixes.

- The **vrf** keyword and **vrf-name** argument specify the name of the VRF instance to associate with subsequent IPv4 address family configuration mode commands.

**Step 6**

**network network-number [mask network-mask] [route-map route-map-name]**

**Example:**

Router(config-router-af)# network 10.2.2.0 mask 255.255.255.0

Specifies a network as local to this autonomous system and adds it to the BGP routing table.

- For exterior protocols the **network** command controls which networks are advertised. Interior protocols use the **network** command to determine where to send updates.

**Step 7**

**neighbor {ip-address | peer-group-name} route-map map-name {in | out}**

**Example:**

Router(config-router-af)# neighbor 192.168.2.1 route-map BLOCK in

**Example:**

Router(config-router-af)# neighbor 192.168.2.1 route-map SETMETRIC1 out

Applies a route map to incoming or outgoing routes.

- In the first example, the route map named BLOCK is applied to inbound routes at Router E.

- In the second example, the route map named SETMETRIC1 is applied to outbound routes to Router D.

**Note** Two examples are shown here because the task example requires both these statements to be configured.

**Step 8**

Repeat Step 7 to apply another route map to the neighbor specified in Step 7.

**Step 9**

**exit**

**Example:**

Router(config-router-af)# exit

Exits address family configuration mode and enters router configuration mode.
<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| 10   | `neighbor {ip-address | peer-group-name} remote-as autonomous-system-number` | Adds the IP address or peer group name of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local router.  
   - In this example, the BGP peer at Router D is added to the BGP routing table. |
| 11   | `address-family ipv4 [unicast | multicast | vrf vrf-name]` | Specifies the IPv4 address family and enters address family configuration mode.  
   - The `unicast` keyword specifies the IPv4 unicast address family. By default, the router is placed in address family configuration mode for the IPv4 unicast address family if the `unicast` keyword is not specified with the `address-family ipv4` command.  
   - The `multicast` keyword specifies IPv4 multicast address prefixes.  
   The `vrf` keyword and `vrf-name` argument specify the name of the VRF instance to associate with subsequent IPv4 address family configuration mode commands. |
| 12   | `neighbor {ip-address | peer-group-name} route-map map-name {in | out}` | Applies a route map to incoming or outgoing routes.  
   - In the first example, the route map named BLOCK is applied to inbound routes at Router E.  
   - In the second example, the route map named SETMETRIC2 is applied to outbound routes to Router D.  
   **Note** Two examples are shown here because the task example requires both these statements to be configured. |
<p>| 13   | Repeat Step 10 to apply another route map to the neighbor specified in Step 10. | -- |
| 14   | <code>exit</code> | Exits address family configuration mode and enters router configuration mode. |
| 15   | <code>exit</code> | Exits router configuration mode and enters global configuration mode. |</p>
<table>
<thead>
<tr>
<th><strong>Command or Action</strong></th>
<th><strong>Purpose</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 16</strong></td>
<td>Establishes a static route.</td>
</tr>
</tbody>
</table>
| `ip route prefix mask {ip-address | interface-type interface-number [ip-address]} [distance] [name] [permanent | track number] [tag tag]` | • In the first example, a static route to BGP peer 192.168.2.1 is established and given an administrative distance of 50.  
• In the second example, a static route to BGP peer 192.168.3.1 is established and given an administrative distance of 40. The lower administrative distance makes this route via Router B the preferred route. |
<p>| <strong>Example:</strong> | Note: Two examples are shown here because the task example requires both these statements to be configured. |
| <code>Router(config)# ip route 0.0.0.0 0.0.0.0 192.168.2.1 50</code> | |
| <strong>Step 17</strong> | Repeat Step 14 to establish another static route. |
| <strong>Step 18</strong> | Configures a route map and enters route map configuration mode. |
| <code>route-map map-name [permit | deny] [sequence-number]</code> | • In this example, a route map named SETMETRIC1 is created. |
| <strong>Example:</strong> | |
| <code>Router(config)# route-map SETMETRIC1 permit 10</code> | |
| <strong>Step 19</strong> | Sets the MED metric value. |
| <code>set metric value</code> | |
| <strong>Example:</strong> | |
| <code>Router(config-route-map)# set metric 100</code> | |
| <strong>Step 20</strong> | Exits route map configuration mode and enters global configuration mode. |
| <code>exit</code> | |
| <strong>Example:</strong> | |
| <code>Router(config-route-map)# exit</code> | |
| <strong>Step 21</strong> | Configures a route map and enters route map configuration mode. |
| <code>route-map map-name [permit | deny] [sequence-number]</code> | • In this example, a route map named SETMETRIC2 is created. |
| <strong>Example:</strong> | |
| <code>Router(config)# route-map SETMETRIC2 permit 10</code> | |
| <strong>Step 22</strong> | Sets the MED metric value. |
| <code>set metric value</code> | |
| <strong>Example:</strong> | |
| <code>Router(config-route-map)# set metric 50</code> | |</p>
<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>exit</td>
<td>Exits route map configuration mode and enters global configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>exit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config-route-map)# exit</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>route-map map-name [permit</td>
<td>deny] [sequence-number]</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>route-map BLOCK deny 10</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>end</td>
<td>Exits route map configuration mode and enters privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>end</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config-route-map)# end</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>show ip route [ip-address] [mask] [longer-prefixes]</td>
<td>(Optional) Displays route information from the routing tables.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router# show ip route</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>show ip bgp [network] [network-mask]</td>
<td>(Optional) Displays the entries in the BGP routing table.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router# show ip bgp 172.17.1.0 255.255.255.0</td>
<td></td>
</tr>
</tbody>
</table>

**Examples**

The following example shows output from the **show ip route** command entered at Router E after this task has been configured and Router B and Router D have received update information containing the MED metric. Note that the gateway of last resort is set as 192.168.3.1, which is the route to Router B.

```
Router# show ip route
```
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2
i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
ia - IS-IS inter area, * - candidate default, U - per-user static route
o - ODR, P - periodic downloaded static route
Gateway of last resort is 192.168.3.1 to network 0.0.0.0
10.0.0.0/24 is subnetted, 1 subnets
  C 10.2.2.0 is directly connected, Ethernet0/0
  C 192.168.2.0/24 is directly connected, Serial3/0
  C 192.168.3.0/24 is directly connected, Serial2/0
  S* 0.0.0.0/0 [40/0] via 192.168.3.1

The following example shows output from the **show ip bgp** command entered at Router E after this task has been configured and Router B and Router D have received routing updates. The route map BLOCK has denied all routes coming in from autonomous system 45000 so the only network shown is the local network.

```
Router# show ip bgp

BGP table version is 2, local router ID is 10.2.2.99
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

Network Next Hop Metric LocPrf Weight Path
*> 10.2.2.0/24 0.0.0.0 0 32768 i

```

The following example shows output from the **show ip bgp** command entered at Router B after this task has been configured at Router E and Router B has received routing updates. Note the metric of 50 for network 10.2.2.0.

```
Router# show ip bgp

BGP table version is 7, local router ID is 172.17.1.99
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

Network Next Hop Metric LocPrf Weight Path
*> 10.1.1.0/24 192.168.1.2 0 0 40000 i
*> 10.2.2.0/24 192.168.3.2 50 0 50000 i
*> 172.16.1.0/24 0.0.0.0 0 32768 i
*> 172.17.1.0/24 0.0.0.0 0 32768 i

```

The following example shows output from the **show ip bgp** command entered at Router D after this task has been configured at Router E and Router D has received routing updates. Note the metric of 100 for network 10.2.2.0.

```
Router# show ip bgp

BGP table version is 3, local router ID is 192.168.2.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

Network Next Hop Metric LocPrf Weight Path
*> 10.2.2.0/24 192.168.2.2 100 0 50000 i
*> 172.16.1.0/24 0.0.0.0 0 32768 i

```
Configuring Multihoming to Receive the Full Internet Routing Table

Perform this task to configure your network to build neighbor relationships with other routers in other autonomous systems while filtering outbound routes. In this task the full Internet routing table will be received from the service providers in the neighboring autonomous systems but only locally originated routes will be advertised to the service providers. This task is configured at Router B in the figure above and uses an access list to permit only locally originated routes and a route map to ensure that only the locally originated routes are advertised outbound to other autonomous systems.

Note
Be aware that receiving the full Internet routing table from two ISPs may use all the memory in smaller routers.

SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. neighbor {ip-address | peer-group-name} remote-as autonomous-system-number
5. address-family ipv4 [unicast | multicast | vrf vrf-name]
6. network network-number [mask network-mask]
7. neighbor {ip-address | peer-group-name} route-map map-name {in | out}
8. exit
9. neighbor {ip-address | peer-group-name} remote-as autonomous-system-number
10. address-family ipv4 [unicast | multicast | vrf vrf-name]
11. neighbor {ip-address | peer-group-name} route-map map-name {in | out}
12. exit
13. exit
14. ip as-path access-list access-list-number {deny | permit} as-regular-expression
15. route-map map-name [permit | deny] [sequence-number]
16. match as-path path-list-number
17. end
18. show ip bgp [network] [network-mask]

DETAILED STEPS

<table>
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<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>enable Example:</td>
<td>- Enter your password if prompted.</td>
</tr>
<tr>
<td>Router&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>configure terminal Example:</td>
<td></td>
</tr>
<tr>
<td>Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td>Step</td>
<td>Command or Action</td>
</tr>
<tr>
<td>------</td>
<td>------------------</td>
</tr>
<tr>
<td>3</td>
<td><code>router bgp autonomous-system-number</code></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td><code>Router(config)# router bgp 45000</code></td>
</tr>
<tr>
<td>4</td>
<td>`neighbor {ip-address</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td><code>Router(config-router)# neighbor 192.168.1.2 remote-as 40000</code></td>
</tr>
<tr>
<td>5</td>
<td>`address-family ipv4 [unicast</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td><code>Router(config-router)# address-family ipv4 unicast</code></td>
</tr>
<tr>
<td>6</td>
<td><code>network network-number [mask network-mask]</code></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td><code>Router(config-router-af)# network 172.17.1.0 mask 255.255.255.0</code></td>
</tr>
<tr>
<td>7</td>
<td>`neighbor {ip-address</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td><code>Router(config-router-af)# neighbor 192.168.1.2 route-map localonly out</code></td>
</tr>
<tr>
<td>8</td>
<td><code>exit</code></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td><code>Router(config-router-af)# exit</code></td>
</tr>
<tr>
<td>Step</td>
<td>Command or Action</td>
</tr>
<tr>
<td>------</td>
<td>-------------------</td>
</tr>
<tr>
<td>9</td>
<td>neighbor {ip-address</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router(config-router)# neighbor 192.168.3.2 remote-as 50000</td>
</tr>
<tr>
<td>10</td>
<td>address-family ipv4 {unicast</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router(config-router)# address-family ipv4 unicast</td>
</tr>
<tr>
<td>11</td>
<td>neighbor {ip-address</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router(config-router-af)# neighbor 192.168.3.2 route-map localonly out</td>
</tr>
<tr>
<td>12</td>
<td>exit</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router(config-router-af)# exit</td>
</tr>
<tr>
<td>13</td>
<td>exit</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router(config-router)# exit</td>
</tr>
<tr>
<td>14</td>
<td>ip as-path access-list access-list-number {deny</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router(config)# ip as-path access-list 10 permit ^$</td>
</tr>
<tr>
<td>15</td>
<td>route-map map-name {permit</td>
</tr>
</tbody>
</table>
### Configuring BGP Policies

The tasks in this section help you configure BGP policies that filter the traffic in your BGP network. The following optional tasks demonstrate some of the various methods by which traffic can be filtered in your BGP network.

**Filtering BGP Prefixes with Prefix Lists**

Perform this task to use prefix lists to filter BGP route information. The task is configured at Router B in the figure below where both Router A and Router E are set up as BGP peers. A prefix list is configured to permit only routes from the network 10.2.2.0/24 to be outbound. In effect, this will restrict the information that is received from Router E to be forwarded to Router A. Optional steps are included to display the prefix list information and to reset the hit count.
The neighbor prefix-list and the neighbor distribute-list commands are mutually exclusive for a BGP peer.

SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `neighbor ip-address remote-as autonomous-system-number`
5. Repeat Step 5 for all BGP peers.
6. `address-family ipv4 [unicast | multicast | vrf vrf-name]`
7. `network network-number [mask network-mask]`
8. `aggregate-address address mask [as-set]`
9. `neighbor ip-address prefix-list list-name {in | out}`
10. `exit`
11. `exit`
12. `ip prefix-list list-name [seq seq-number] {deny network-length | permit network-length} [ge ge-value] [le le-value] [eq eq-value]`
13. `end`
14. `show ip prefix-list [detail | summary] [prefix-list-name [seq seq-number | network-length | longer | first-match]]`
15. `clear ip prefix-list {* | ip-address | peer-group-name} out`

DETAILED STEPS

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>• Enter your password if prompted.</td>
<td></td>
</tr>
<tr>
<td>Router&gt; enable</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Step 2**

configure terminal  
**Example:**  
Router# configure terminal

Enters global configuration mode.

**Step 3**

router bgp autonomous-system-number  
**Example:**  
Router(config)# router bgp 45000

Enters router configuration mode for the specified routing process.

**Step 4**

neighbor ip-address remote-as autonomous-system-number  
**Example:**  
Router(config-router)# neighbor 192.168.1.2 remote-as 40000

Adds the IP address of the neighbor in the specified autonomous system to the BGP neighbor table of the local router.

**Step 5**

Repeat Step 5 for all BGP peers.  
--

**Step 6**

address-family ipv4 [unicast | multicast | vrf vrf-name]  
**Example:**  
Router(config-router)# address-family ipv4 unicast

Specifies the IPv4 address family and enters address family configuration mode.

• The **unicast** keyword specifies the IPv4 unicast address family. By default, the router is placed in address family configuration mode for the IPv4 unicast address family if the **unicast** keyword is not specified with the **address-family ipv4** command.

• The **multicast** keyword specifies IPv4 multicast address prefixes.

• The **vrf** keyword and **vrf-name** argument specify the name of the VRF instance to associate with subsequent IPv4 address family configuration mode commands.

**Step 7**

network network-number [mask network-mask]  
**Example:**  
Router(config-router-af)# network 172.17.1.0 mask 255.255.255.0

(Optional) Specifies a network as local to this autonomous system and adds it to the BGP routing table.

• For exterior protocols the **network** command controls which networks are advertised. Interior protocols use the **network** command to determine where to send updates.

**Step 8**

aggregate-address address mask [as-set]  
**Example:**  

Creates an aggregate entry in a BGP routing table.

• A specified route must exist in the BGP table.
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Router(config-router-af)# aggregate-address 172.0.0.0 255.0.0.0</td>
<td>• Use the <code>aggregate-address</code> command with no keywords to create an aggregate entry if any more-specific BGP routes are available that fall in the specified range.</td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td>Only partial syntax is used in this example. For more details, see the Cisco IOS IP Routing: BGP Command Reference.</td>
</tr>
<tr>
<td><strong>Step 9</strong> neighbor ip-address prefix-list list-name {in</td>
<td>out}</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>• In this example, a prefix list called super172 is set for outgoing routes to Router A.</td>
</tr>
<tr>
<td>Router(config-router-af)# neighbor 192.168.1.2 prefix-list super172 out</td>
<td></td>
</tr>
<tr>
<td><strong>Step 10</strong> exit</td>
<td>Exits address family configuration mode and enters router configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router(config-router-af)# exit</td>
<td></td>
</tr>
<tr>
<td><strong>Step 11</strong> exit</td>
<td>Exits router configuration mode and enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router(config-router) exit</td>
<td></td>
</tr>
<tr>
<td><strong>Step 12</strong> ip prefix-list list-name [seq seq-number] {deny network/length</td>
<td>permit network/length} [ge ge-value] [le le-value] [eq eq-value]</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>• In this example, the prefix list called super172 is defined to permit only route 172.0.0.0/8 to be forwarded.</td>
</tr>
<tr>
<td>Router(config)# ip prefix-list super172 permit 172.0.0.0/8</td>
<td>• All other routes will be denied because there is an implicit deny at the end of all prefix lists.</td>
</tr>
<tr>
<td><strong>Step 13</strong> end</td>
<td>Exits access list configuration mode and enters privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router(config-access-list)# end</td>
<td></td>
</tr>
<tr>
<td><strong>Step 14</strong> show ip prefix-list [detail</td>
<td>summary] [prefix-list-name [seq seq-number</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>• In this example, details of the prefix list named super172 will be displayed, including the hit count. Hit count is the number of times the entry has matched a route.</td>
</tr>
<tr>
<td>Router# show ip prefix-list detail super172</td>
<td></td>
</tr>
<tr>
<td><strong>Step 15</strong> clear ip prefix-list {*</td>
<td>ip-address</td>
</tr>
</tbody>
</table>
### Filtering BGP Prefixes with AS-Path Filters

Perform this task to filter BGP prefixes using AS-path filters with an access list based on the value of the AS-path attribute to filter route information. An AS-path access list is configured at Router B in the figure above. The first line of the access list denies all matches to AS-path 50000, and the second line allows all other paths. The router uses the `neighbor filter-list` command to specify the AS-path access list as an outbound filter. After the filter is enabled, traffic can be received from both Router A and Router C, but updates originating from autonomous system 50000 (Router C) are not forwarded by Router B to Router A. If any updates from Router C originated from another autonomous system, they would be forwarded because they would contain both autonomous system 50000 and another autonomous system number, and that would not match the AS-path access list.

#### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `ip as-path access-list access-list-number {deny | permit} as-regular-expression`
4. Repeat Step 3 for all entries required in the AS-path access list.
5. `router bgp autonomous-system-number`
6. `neighbor {ip-address | peer-group-name} remote-as autonomous-system-number`
7. Repeat Step 6 for all BGP peers.
8. `address-family ipv4 [unicast | multicast | vrf vrf-name]`
9. `neighbor {ip-address | peer-group-name} filter-list access-list-number {in | out}
10. `end`
11. `show ip bgp regexp as-regular-expression`
## DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td><strong>enable</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Device&gt; enable</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td><strong>configure terminal</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Device# configure terminal</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td><strong>ip as-path access-list</strong> access-list-number {deny</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>Repeat Step 3 for all entries required in the AS-path access list.</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td><strong>router bgp</strong> autonomous-system-number&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Device(config)# router bgp 45000</td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td><strong>neighbor</strong> {ip-address</td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>Repeat Step 6 for all BGP peers.</td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td><strong>address-family ipv4</strong> [unicast</td>
</tr>
</tbody>
</table>
Filtering BGP Prefixes with AS-path Filters Using 4-Byte Autonomous System Numbers

In Cisco IOS Release 12.0(32)SY8, 12.0(33)S3, 12.2(33)SRE, 12.2(33)SX11, and later releases, BGP support for 4-octet (4-byte) autonomous system numbers was introduced. The 4-byte autonomous system numbers in this task are formatted in the default asplain (decimal value) format, for example, Router B is in autonomous

---

### Table: Command or Action and Purpose

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>unicast</strong> address family if the <strong>unicast</strong> keyword is not specified with the <strong>address-family ipv4</strong> command.</td>
<td></td>
</tr>
<tr>
<td><strong>•</strong> The <strong>multicast</strong> keyword specifies IPv4 multicast address prefixes.</td>
<td></td>
</tr>
<tr>
<td><strong>•</strong> The <strong>vrf</strong> keyword and <strong>vrf-name</strong> argument specify the name of the VRF instance to associate with subsequent IPv4 address family configuration mode commands.</td>
<td></td>
</tr>
</tbody>
</table>

### Step 9

**neighbor {ip-address | peer-group-name} filter-list access-list-number {in | out}**

**Example:**

```
Device(config-router-af)# neighbor 192.168.1.2 filter-list 100 out
```

Distributes BGP neighbor information as specified in a prefix list.

**Example:**

```
Device(config-router-af)# neighbor 192.168.1.2 filter-list 100 out
```

### Step 10

**end**

**Example:**

```
Device(config-router-af)# end
```

Exits address family configuration mode and returns to privileged EXEC mode.

### Step 11

**show ip bgp regexp as-regular-expression**

**Example:**

```
Device# show ip bgp regexp ^50000$
```

Displays routes that match the regular expression.

**Example:**

```
Device# show ip bgp regexp ^50000$
```

### Examples

The following output from the **show ip bgp regexp** command shows the autonomous system paths that match the regular expression—start and end with AS-path 50000:

```
Device# show ip bgp regexp ^50000$
```

BGP table version is 9, local router ID is 172.17.1.99
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal, r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? incomplete

```
Network          Next Hop     Metric   LocPrf  Weight Path
*> 10.2.2.0/24    192.168.3.2  0        150     50000 i
```

---

**Filtering BGP Prefixes with AS-path Filters Using 4-Byte Autonomous System Numbers**

In Cisco IOS Release 12.0(32)SY8, 12.0(33)S3, 12.2(33)SRE, 12.2(33)SX11, and later releases, BGP support for 4-octet (4-byte) autonomous system numbers was introduced. The 4-byte autonomous system numbers in this task are formatted in the default asplain (decimal value) format, for example, Router B is in autonomous
Perform this task to filter BGP prefixes with AS-path filters using 4-byte autonomous system numbers with an access list based on the value of the AS-path attribute to filter route information. An AS-path access list is configured at Router B in the figure below. The first line of the access list denies all matches to the AS-path 65550 and the second line allows all other paths. The router uses the `neighbor filter-list` command to specify the AS-path access list as an outbound filter. After the filtering is enabled, traffic can be received from both Router A and Router E but updates originating from autonomous system 65550 (Router E) are not forwarded by Router B to Router A. If any updates from Router E originated from another autonomous system, they would be forwarded because they would contain both autonomous system 65550 plus another autonomous system number, and that would not match the AS-path access list.

In Cisco IOS Releases 12.0(22)S, 12.2(15)T, 12.2(18)S, and later releases, the maximum number of autonomous system access lists that can be configured with the `ip as-path access-list` command is increased from 199 to 500.

**SUMMARY STEPS**

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. neighbor {ip-address | peer-group-name} remote-as autonomous-system-number
5. Repeat Step 4 for all BGP peers.
6. address-family ipv4 [unicast | multicast] vrf vrf-name
7. network network-number [mask network-mask]
8. neighbor {ip-address | peer-group-name} filter-list access-list-number{in | out}
9. exit
10. exit
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| Step 1 | **enable**<br>**Example:**<br>Router> enable | Enables privileged EXEC mode.  
• Enter your password if prompted. |
| Step 2 | **configure terminal**<br>**Example:**<br>Router# configure terminal | Enters global configuration mode. |
| Step 3 | **router bgp autonomous-system-number**<br>**Example:**<br>Router(config)# router bgp 65538 | Enters router configuration mode for the specified routing process. |
| Step 4 | **neighbor {ip-address | peer-group-name} remote-as autonomous-system-number**<br>**Example:**<br>Router(config-router-af)# neighbor 192.168.1.2 remote-as 65536 | Adds the IP address or peer group name of the neighbor in the specified autonomous system BGP neighbor table of the local router.  
• In this example, the IP address for the neighbor at Router A is added. |
| Step 5 | Repeat Step 4 for all BGP peers. | -- |
| Step 6 | **address-family ipv4 [unicast | multicast] vrf vrf-name**<br>**Example:**<br>Router(config-router)# address-family ipv4 unicast | Specifies the IPv4 address family and enters address family configuration mode.  
• The **unicast** keyword specifies the IPv4 unicast address family. By default, the router is placed in address family configuration mode for the IPv4 unicast address family if the **unicast** keyword is not specified with the **address-family ipv4** command.  
• The **multicast** keyword specifies IPv4 multicast address prefixes.  
• The **vrf** keyword and **vrf-name** argument specify the name of the VRF instance to associate with subsequent IPv4 address family configuration mode commands. |
## Connecting to a Service Provider Using External BGP

### Filtering BGP Prefixes with AS-path Filters Using 4-Byte Autonomous System Numbers

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 7</strong></td>
<td>(Optional) Specifies a network as local to this autonomous system and adds it to the BGP routing table.</td>
</tr>
<tr>
<td><strong>network</strong> network-number [mask network-mask]</td>
<td>- For exterior protocols the <code>network</code> command controls which networks are advertised. Interior protocols use the <code>network</code> command to determine where to send updates.</td>
</tr>
<tr>
<td>Example:</td>
<td><strong>Note</strong> Only partial syntax is used in this example. For more details, see the <em>Cisco IOS IP Routing: BGP Command Reference</em>.</td>
</tr>
<tr>
<td><code>Router(config-router-af)# network 172.17.1.0 mask 255.255.255.0</code></td>
<td></td>
</tr>
</tbody>
</table>

| **Step 8** | Distributes BGP neighbor information as specified in a prefix list. |
| **neighbor** {ip-address | peer-group-name} filter-list access-list-number [in | out] | - In this example, an access list number 99 is set for outgoing routes to Router A. |
| Example: | **Note** Two examples are shown here because the task example requires both these statements to be configured. |
| `Router(config-router-af)# neighbor 192.168.1.2 filter-list 99 out` | |

| **Step 9** | Exits address family configuration mode and returns to router configuration mode. |
| **exit** | |
| Example: | **Note** |
| `Router(config-router-af)# exit` | |

| **Step 10** | Exits router configuration mode and returns to global configuration mode. |
| **exit** | |
| Example: | |
| `Router(config-router)# exit` | |

| **Step 11** | Defines a BGP-related access list and enters access list configuration mode. |
| **ip as-path access-list** access-list-number {deny | permit} as-regular-expression | - In the first example, access list number 99 is defined to deny any AS-path that starts and ends with 65550. |
| Example: | - In the second example, all routes that do not match the criteria in the first example of the AS-path access list will be permitted. The period and asterisk symbols imply that all characters in the AS-path will match, so Router B will forward those updates to Router A. |
| `Router(config)# ip as-path access-list 99 deny ^65550$` | **Note** |
| Example: | |
| `and` | Two examples are shown here because the task example requires both these statements to be configured. |
| `Example:` | |
| `Router(config)# ip as-path access-list 99 permit .*` | |

| **Step 12** | Repeat Step 11 for all entries required in the AS-path access list. |
| | -- |

| **Step 13** | Exits access list configuration mode and returns to privileged EXEC mode. |
| **end** | |
| Example: | |
Purpose

Router(config-access-list)# end

<table>
<thead>
<tr>
<th>Step 14</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>show ip bgp regexp ^as-regular-expression$</td>
<td>Displays routes that match the regular expression.</td>
</tr>
<tr>
<td>Example:</td>
<td>Router# show ip bgp regexp ^65550$</td>
<td>• To verify the regular expression, you can use this command.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• In this example, all paths that match the expression &quot;starts and ends with 65550&quot; will be displayed.</td>
</tr>
</tbody>
</table>

**Examples**

The following output from the `show ip bgp regexp` command shows the autonomous system paths that match the regular expression--start and end with AS-path 65550:

```
RouterB# show ip bgp regexp ^65550$
BGP table version is 4, local router ID is 172.17.1.99
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal, r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete
Network Next Hop Metric LocPrf Weight Path
*> 10.2.2.0/24 192.168.3.2 0 0 65550 i
```

**Filtering Traffic Using Community Lists**

Perform this task to filter traffic by creating a BGP community list, referencing the community list within a route map, and then applying the route map to a neighbor.

In this task, Router B in the figure below is configured with route maps and a community list to control incoming routes.

*Figure 30: Topology for Which a Community List Is Configured*
SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. neighbor {ip-address | peer-group-name} remote-as autonomous-system-number
5. address-family ipv4 [unicast | multicast] vrf vrf-name
6. neighbor {ip-address | peer-group-name} route-map route-map-name {in | out}
7. exit
8. exit
9. route-map map-name [permit | deny] [sequence-number]
10. match community {standard-list-number | expanded-list-number | community-list-name [exact]}
11. set weight weight
12. exit
13. route-map map-name [permit | deny] [sequence-number]
14. match community {standard-list-number | expanded-list-number | community-list-name [exact]}
15. set community community-number
16. exit
17. ip community-list {standard-list-number | standard list-name [deny | permit] [community-number] [AA:NN] [internet] [local-AS] [no-advertise] [no-export]} | {expanded-list-number | expanded list-name [deny | permit] regular-expression}
18. Repeat Step 17 to create all the required community lists.
19. exit
20. show ip community-list [standard-list-number | expanded-list-number | community-list-name] [exact-match]

DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Step 2</td>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td>router bgp autonomous-system-number</td>
<td>Enters router configuration mode for the specified routing</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td>process.</td>
</tr>
<tr>
<td></td>
<td>Device(config)# router bgp 45000</td>
<td></td>
</tr>
<tr>
<td>Step 4</td>
<td>neighbor {ip-address</td>
<td>peer-group-name} remote-as autonomous-system-number</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td>specified autonomous system BGP neighbor table of the local</td>
</tr>
<tr>
<td></td>
<td></td>
<td>router.</td>
</tr>
</tbody>
</table>

Connecting to a Service Provider Using External BGP

Filtering Traffic Using Community Lists
### Command or Action

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>Device(config-router)# neighbor 192.168.3.2 remote-as 50000</code></td>
<td>Specifies the IPv4 address family and enters address family configuration mode.</td>
</tr>
<tr>
<td><strong>Step 5</strong> `address-family ipv4 [unicast</td>
<td>multicast</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>Device(config-router)# address-family ipv4 unicast</code></td>
<td>In this example, the route map called <code>2000</code> is applied to inbound routes from the BGP peer at <code>192.168.3.2</code>.</td>
</tr>
<tr>
<td><strong>Step 6</strong> `neighbor {ip-address</td>
<td>peer-group-name} route-map route-map-name {in</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>Device(config-router-af)# neighbor 192.168.3.2 route-map 2000 in</code></td>
<td>In this example, the route map called <code>2000</code> is applied to inbound routes from the BGP peer at <code>192.168.3.2</code>.</td>
</tr>
<tr>
<td><strong>Step 7</strong> <code>exit</code></td>
<td>Exits router configuration mode and enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>Device(config-router)# exit</code></td>
<td>In this example, the route map called <code>2000</code> is defined.</td>
</tr>
<tr>
<td><strong>Step 8</strong> `route-map map-name [permit</td>
<td>deny] [sequence-number]`</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>Device(config)# route-map 2000 permit 10</code></td>
<td>In this example, the route map called <code>2000</code> is defined.</td>
</tr>
<tr>
<td><strong>Step 10</strong> `match community {standard-list-number</td>
<td>expanded-list-number</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>Device(config-route-map)# match community 1</code></td>
<td>In this example, the route's community attribute is matched to communities in community list 1.</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Step 11</strong></td>
<td><strong>set weight</strong> <code>&lt;weight&gt;</code>&lt;br&gt;Example: <code>Device(config-route-map)# set weight 30</code>&lt;br&gt;Sets the weight of BGP routes that match the community list.&lt;br&gt;  - In this example, any route that matches community list 1 will have its weight set to 30.</td>
</tr>
<tr>
<td><strong>Step 12</strong></td>
<td><strong>exit</strong>&lt;br&gt;Example: <code>Device(config-route-map)# exit</code>&lt;br&gt;Exits route map configuration mode and enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Step 13</strong></td>
<td><strong>route-map</strong> <code>map-name</code> [permit</td>
</tr>
<tr>
<td><strong>Step 14</strong></td>
<td><strong>match community</strong> `{standard-list-number</td>
</tr>
<tr>
<td><strong>Step 15</strong></td>
<td><strong>set community</strong> <code>&lt;community-number&gt;</code>&lt;br&gt;Example:&lt;br&gt;<code>Device(config-route-map)# set community 99</code>&lt;br&gt;Sets the BGP communities attribute.&lt;br&gt;  - In this example, any route that matches community list 2 will have the COMMUNITIES attribute set to 99.</td>
</tr>
<tr>
<td><strong>Step 16</strong></td>
<td><strong>exit</strong>&lt;br&gt;Example: <code>Device(config-route-map)# exit</code>&lt;br&gt;Exits route map configuration mode and enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Step 17</strong></td>
<td><strong>ip community-list</strong> `{standard-list-number</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Step 18</strong></td>
<td>Repeat Step 17 to create all the required community lists.</td>
</tr>
<tr>
<td><strong>Step 19</strong></td>
<td>exit</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config)# exit</td>
<td>Exits global configuration mode and enters privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Step 20</strong></td>
<td>show ip community-list [standard-list-number</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device# show ip community-list 1</td>
<td>Displays configured BGP community list entries.</td>
</tr>
</tbody>
</table>

### Examples

The following sample output verifies that community list 1 has been created and it permits routes that have a community attribute of 100:

```
Device# show ip community-list 1
Community standard list 1
  permit 100
```

The following sample output verifies that community list 2 has been created and it effectively permits all routes by specifying the `internet` community:

```
Device# show ip community-list 2
Community standard list 2
  permit internet
```

### Filtering Traffic Using Extended Community Lists

Perform this task to filter traffic by creating an extended BGP community list to control outbound routes.
In this task, Router B in the figure above is configured with an extended named community list to specify that the BGP peer at 192.168.1.2 is not sent advertisements about any path through or from autonomous system 50000. The IP extended community-list configuration mode is used and the ability to resequence entries is shown.

A sequence number is applied to all extended community list entries by default, regardless of the configuration mode. Explicit sequencing and resequencing of extended community list entries can be configured only in IP extended community-list configuration mode, not in global configuration mode.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `ip extcommunity-list {expanded-list-number | expanded list-name | standard-list-number | standard list-name}`
4. `[sequence-number] {deny [regular-expression] | exit | permit [regular-expression]}`
5. Repeat Step 4 for all the required permit or deny entries in the extended community list.
6. `resequence [starting-sequence] [sequence-increment]`
7. `exit`
8. `router bgp autonomous-system-number`
9. `neighbor {ip-address | peer-group-name} remote-as autonomous-system-number`
10. Repeat the prior step for all of the required BGP peers.
11. `address-family ipv4 [unicast | multicast | vrf vrf-name]`
12. `network network-number [mask network-mask]`
13. `end`
14. `show ip extcommunity-list [list-name]`
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** | enable | Enables privileged EXEC mode.  
Example:  
Device> enable |
| **Step 2** | configure terminal | Enters global configuration mode.  
Example:  
Device# configure terminal |
| **Step 3** | ip extcommunity-list {expanded-list-number | expanded list-name | standard-list-number | standard list-name} | Enters IP extended community-list configuration mode to create or configure an extended community list.  
Example:  
Device(config)# ip extcommunity-list expanded DENY50000 |
| **Step 4** | [sequence-number] {deny [regular-expression] | exit | permit [regular-expression]} | Configures an expanded community list entry.  
Example:  
Device(config-extcomm-list)# 10 deny _50000_
Example:  
Device(config-extcomm-list)# 20 deny ^50000 .* |
| **Step 5** | Repeat Step 4 for all the required permit or deny entries in the extended community list. |
| **Step 6** | resequence [starting-sequence] [sequence-increment] | Resequences expanded community list entries.  
Example:  
Device(config-extcomm-list)# resequence 50 100 |

---

**Note**  
Two examples are shown here because the task example requires both these statements to be configured.

**Note**  
Only the syntax applicable to this task is used in this example. For more details, see the *Cisco IOS IP Routing: BGP Command Reference*.  

---
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 7</strong></td>
<td>Exit expanded community-list configuration mode and enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td><strong>Step 9</strong></td>
<td>Adds the IP address or peer group name of the neighbor to the specified autonomous system BGP neighbor table of the local router.</td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td>Repeat the prior step for all of the required BGP peers.</td>
</tr>
</tbody>
</table>
| **Step 11** | Specifies the IPv4 address family and enters address family configuration mode.  
- The **unicast** keyword specifies the IPv4 unicast address family. By default, the router is placed in address family configuration mode for the IPv4 unicast address family if the **unicast** keyword is not specified in the **address-family ipv4** command.  
- The **multicast** keyword specifies IPv4 multicast address prefixes.  
**Note** The **vrf** keyword and **vrf-name** argument specify the name of the VRF instance to associate with subsequent IPv4 address family configuration mode commands. |
| **Step 12** | Specifies a network as local to this autonomous system and adds it to the BGP routing table.  
- For exterior protocols, the **network** command controls which networks are advertised. Interior protocols use the **network** command to determine where to send updates.  
(Optional) |

### Example:

**Step 7**
```
Device(config-extcomm-list)# exit
```

**Step 8**
```
Device(config)# router bgp 45000
```

**Step 9**
```
Device(config-router)# neighbor 192.168.3.2 remote-as 50000
```

**Step 11**
```
Device(config-router)# address-family ipv4 unicast
```

**Step 12**
```
Device(config-router-af)# network 172.17.1.0 mask 255.255.255.0
```
Filtering Traffic Using a BGP Route Map Policy List

Perform this task to create a BGP policy list and then reference it within a route map.

A policy list is like a route map that contains only match clauses. With policy lists there are no changes to match clause semantics and route map functions. The match clauses are configured in policy lists with permit and deny statements and the route map evaluates and processes each match clause to permit or deny routes based on the configuration. AND and OR semantics in the route map function the same way for policy lists as they do for match clauses.

Policy lists simplify the configuration of BGP routing policy in medium-size and large networks. The network operator can reference preconfigured policy lists with groups of match clauses in route maps and easily apply general changes to BGP routing policy. The network operator no longer needs to manually reconfigure each recurring group of match clauses that occur in multiple route map entries.

Perform this task to create a BGP policy list to filter traffic that matches the autonomous system path and MED of a router and then create a route map to reference the policy list.

Before you begin

BGP routing must be configured in your network and BGP neighbors must be established.
• BGP route map policy lists do not support the configuration of IPv6 match clauses in policy lists.
• Policy lists are not supported in versions of Cisco IOS software prior to Cisco IOS Releases 12.0(22)S and 12.2(15)T. Reloading a router that is running an older version of Cisco IOS software may cause some routing policy configurations to be lost.
• Policy lists support only match clauses and do not support set clauses. However, policy lists can coexist, within the same route map entry, with match and set clauses that are configured separately from the policy lists.
• Policy lists are supported only by BGP. They are not supported by other IP routing protocols. This limitation does not interfere with normal operations of a route map, including redistribution, because policy list functions operate transparently within BGP and are not visible to other IP routing protocols.
• Policy lists support only match clauses and do not support set clauses. However, policy lists can coexist, within the same route map entry, with match and set clauses that are configured separately from the policy lists. The first route map example configures AND semantics, and the second route map configuration example configures semantics. Both examples in this section show sample route map configurations that reference policy lists and separate match and set clauses in the same configuration.

SUMMARY STEPS

1. enable
2. configure terminal
3. ip policy-list policy-list-name {permit | deny}
4. match as-path as-number
5. match metric metric
6. exit
7. route-map map-name [permit | deny] [sequence-number]
8. match ip address {access-list-number | access-list-name} [... access-list-number | ... access-list-name]
9. match policy-list policy-list-name
10. set community community-number [additive] [well-known-community] | none
11. set local-preference preference-value
12. end
13. show ip policy-list [policy-list-name]
14. show route-map [route-map-name]

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>configure terminal</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td></td>
</tr>
<tr>
<td>`ip policy-list policy-list-name {permit</td>
<td>deny}`</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Router(config)# ip policy-list POLICY-LIST-NAME-1 permit</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td></td>
</tr>
<tr>
<td><code>match as-path as-number</code></td>
<td>Creates a match clause to permit routes from the specified autonomous system path.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Router(config-policy-list)# match as-path 500</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td></td>
</tr>
<tr>
<td><code>match metric metric</code></td>
<td>Creates a match clause to permit routes with the specified metric.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Router(config-policy-list)# match metric 10</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td></td>
</tr>
<tr>
<td><code>exit</code></td>
<td>Exits policy list configuration mode and enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Router(config-policy-list)# exit</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td></td>
</tr>
<tr>
<td>`route-map map-name [permit</td>
<td>deny] [sequence-number]`</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Router(config)# route-map MAP-NAME-1 permit 10</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td></td>
</tr>
<tr>
<td>`match ip address {access-list-number</td>
<td>access-list-name} [... access-list-number</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Router(config-route-map)# match ip address 1</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 9</strong></td>
<td></td>
</tr>
<tr>
<td><code>match policy-list policy-list-name</code></td>
<td>Creates a clause that will match the specified policy list.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Router(config-route-map)# match policy-list POLICY-LIST-NAME-1</code></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• All match clauses within the policy list will be evaluated and processed. Multiple policy lists can be referenced with this command.</td>
</tr>
<tr>
<td></td>
<td>• This command also supports AND or OR semantics like a standard match clause.</td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td></td>
</tr>
<tr>
<td>`set community community-number [additive] [well-known-community]</td>
<td>none`</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Router(config-route-map)# set community 10:1</code></td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Step 11</strong> set local-preference  preference-value</td>
<td>Creates a clause to set the specified local preference value.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config-route-map)# set local-preference 140</td>
<td></td>
</tr>
<tr>
<td><strong>Step 12</strong> end</td>
<td>Exits route map configuration mode and enters privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config-route-map)# end</td>
<td></td>
</tr>
<tr>
<td><strong>Step 13</strong> show ip policy-list [policy-list-name]</td>
<td>Display information about configured policy lists and policy list entries.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router# show ip policy-list POLICY-LIST-NAME-1</td>
<td></td>
</tr>
<tr>
<td><strong>Step 14</strong> show route-map [route-map-name]</td>
<td>Displays locally configured route maps and route map entries.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router# show route-map</td>
<td></td>
</tr>
</tbody>
</table>

**Examples**

The following sample output verifies that a policy list has been created, with the output displaying the policy list name and configured match clauses:

```plaintext
Router# show ip policy-list POLICY-LIST-NAME-1
Policy-list POLICY-LIST-NAME-1 permit
  Match clauses:
    metric 20
    as-path (as-path filter): 1
```

**Note**

A policy list name can be specified when the `show ip policy-list` command is entered. This option can be useful for filtering the output of this command and verifying a single policy list.

The following sample output from the `show route-map` command verifies that a route map has been created and a policy list is referenced. The output of this command displays the route map name and policy lists that are referenced by the configured route maps.

```plaintext
Router# show route-map
route-map ROUTE-MAP-NAME-1, deny, sequence 10
  Match clauses:
  Set clauses:
    Policy routing matches: 0 packets, 0 bytes
route-map ROUTE-MAP-NAME-1, permit, sequence 10
```
Filtering Traffic Using Continue Clauses in a BGP Route Map

SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. neighbor {ip-address | peer-group-name} remote-as autonomous-system-number
5. address-family ipv4 [unicast | multicast | vrf vrf-name]
6. neighbor {ip-address | peer-group-name} route-map map-name {in | out}
7. exit
8. exit
9. route-map map-name {permit | deny} [sequence-number]
10. match ip address {access-list-number | access-list-name} [... access-list-number | ... access-list-name]
11. set community { { [community-number] [well-known-community] [additive] } | none}
12. continue [sequence-number]
13. end
14. show route-map [map-name]

DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td></td>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td>Step 2</td>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td>router bgp autonomous-system-number</td>
<td>Enters router configuration mode, and creates a BGP routing process.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config)# router bgp 50000</td>
<td></td>
</tr>
<tr>
<td>Step 4</td>
<td>neighbor {ip-address</td>
<td>peer-group-name} remote-as autonomous-system-number</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td><code>Device(config-router)# neighbor 10.0.0.1 remote-as 50000</code></td>
<td>Specifies the IPv4 address family and enters address family configuration mode.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> `address-family ipv4 [unicast</td>
<td>multicast</td>
<td>vrf vrf-name]<code>**Example:**</code>Device(config-router)# address-family ipv4 unicast`</td>
</tr>
<tr>
<td>• The <strong>unicast</strong> keyword specifies the IPv4 unicast address family. By default, the device is placed in address family configuration mode for the IPv4 unicast address family if the <strong>unicast</strong> keyword is not specified.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• The <strong>multicast</strong> keyword specifies IPv4 multicast address prefixes.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• The <strong>vrf</strong> keyword and <strong>vrf-name</strong> argument specify the name of the VRF instance to associate with subsequent IPv4 address family configuration mode commands.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> `neighbor {ip-address</td>
<td>peer-group-name} route-map map-name {in</td>
<td>out}<code>**Example:**</code>Device(config-router-af)# neighbor 10.0.0.1 route-map ROUTE-MAP-NAME in`</td>
</tr>
<tr>
<td><strong>Step 7</strong> <code>exit</code> <strong>Example:</strong> <code>Device(config-router-af)# exit</code></td>
<td>Exits address family configuration mode and enters router configuration mode.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong> <code>exit</code> <strong>Example:</strong> <code>Device(config-router)# exit</code></td>
<td>Exits router configuration mode and enters global configuration mode.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 9</strong> `route-map map-name {permit</td>
<td>deny} [sequence-number]<code>**Example:**</code>Device(config)# route-map ROUTE-MAP-NAME permit 10`</td>
<td>Enters route-map configuration mode to create or configure a route map.</td>
</tr>
<tr>
<td><strong>Step 10</strong> `match ip address {access-list-number</td>
<td>access-list-name} [...] access-list-number</td>
<td>... access-list-name}<code>**Example:**</code>Device(config-route-map)# match ip address 1`</td>
</tr>
<tr>
<td>• Multiple <strong>match</strong> commands can be configured. If a <strong>match</strong> command is configured, a match must occur in order for the continue statement to be executed. If</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Filtering Traffic Using Continue Clauses in a BGP Route Map

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 11</strong> set community { {{community-number} [well-known-community] [additive]}</td>
<td>Configures a <strong>set</strong> command that specifies the routing action to perform if the criteria enforced by the <strong>match</strong> commands are met.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config-route-map)# set community 10:1</td>
<td>- Multiple <strong>set</strong> commands can be configured.</td>
</tr>
<tr>
<td></td>
<td>- In this example, a clause is created to set the specified community number in aa:nn format.</td>
</tr>
<tr>
<td><strong>Step 12</strong> continue [sequence-number]</td>
<td>Configures a route map to continue to evaluate and execute match statements after a successful match occurs.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config-route-map)# continue</td>
<td>- If a sequence number is configured, the continue clause will go to the route map with the specified sequence number.</td>
</tr>
<tr>
<td></td>
<td>- If no sequence number is specified, the continue clause will go to the route map with the next sequence number. This behavior is called an “implied continue.”</td>
</tr>
<tr>
<td><strong>Step 13</strong> end</td>
<td>Exits route-map configuration mode and enters privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config-route-map)# end</td>
<td></td>
</tr>
<tr>
<td><strong>Step 14</strong> show route-map [map-name]</td>
<td>(Optional) Displays locally configured route maps. The name of the route map can be specified in the syntax of this command to filter the output.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
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<tr>
<td>Device# show route-map</td>
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</table>

### Examples

The following sample output shows how to verify the configuration of continue clauses using the **show route-map** command. The output displays configured route maps including the match, set, and continue clauses.

Device# show route-map
route-map MARKETING, permit, sequence 10
Match clauses:
   ip address (access-lists): 1
   metric 10
Continue: sequence 40
Set clauses:
   as-path prepend 10
Policy routing matches: 0 packets, 0 bytes
route-map MARKETING, permit, sequence 20
Match clauses:
   ip address (access-lists): 2
   metric 20
Set clauses:
   as-path prepend 10 10
Policy routing matches: 0 packets, 0 bytes
route-map MARKETING, permit, sequence 30
Match clauses:
Continue: to next entry 40
Set clauses:
   as-path prepend 10 10 10
Policy routing matches: 0 packets, 0 bytes
route-map MARKETING, permit, sequence 40
Match clauses:
   community (community-list filter): 10:1
Set clauses:
   local-preference 104
Policy routing matches: 0 packets, 0 bytes
route-map MKTG-POLICY-MAP, permit, sequence 10
Match clauses:
   Set clauses:
       community 655370
Policy routing matches: 0 packets, 0 bytes

Configuration Examples for Connecting to a Service Provider Using External BGP

Example: Influencing Inbound Path Selection

The following example shows how you can use route maps to modify incoming data from a neighbor. Any route received from 10.222.1.1 that matches the filter parameters set in autonomous system access list 200 will have its weight set to 200 and its local preference set to 250, and it will be accepted.

router bgp 100
!
neighbor 10.222.1.1 route-map FIX-WEIGHT in
neighbor 10.222.1.1 remote-as 1
!
ip as-path access-list 200 permit ^690$
ip as-path access-list 200 permit ^1800
!
routing-map FIX-WEIGHT permit 10
match as-path 200
set local-preference 250
set weight 200
In the following example, the route map named FINANCE marks all paths originating from autonomous system 690 with an MED metric attribute of 127. The second permit clause is required so that routes not matching autonomous system path list 1 will still be sent to neighbor 10.1.1.1.

```
router bgp 65000
  neighbor 10.1.1.1 route-map FINANCE out
  ip as-path access-list 1 permit ^690_
  ip as-path access-list 2 permit .*
  !
  route-map FINANCE permit 10
    match as-path 1
    set metric 127
!
  route-map FINANCE permit 20
    match as-path 2
```

Inbound route maps could perform prefix-based matching and set various parameters of the update. Inbound prefix matching is available in addition to autonomous system path and community list matching. The following example shows how the route map named SET-LOCAL-PREF sets the local preference of the inbound prefix 172.20.0.0/16 to 120:

```
! router bgp 65100
  network 10.108.0.0
  neighbor 10.108.1.1 remote-as 65200
  neighbor 10.108.1.1 route-map SET-LOCAL-PREF in
  !
  route-map SET-LOCAL-PREF permit 10
    match ip address 2
    set local-preference 120
!
  route-map SET-LOCAL-PREF permit 20
  !
  access-list 2 permit 172.20.0.0 0.0.255.255
  access-list 2 deny any
```

Example: Influencing Inbound Path Selection by Modifying the AS-path Attribute Using 4-Byte AS Numbers

This example shows how to configure BGP to influence the inbound path selection for traffic destined for the 172.17.1.0 network by modifying the AS-path attribute. In Cisco IOS Release 12.0(32)SY8, 12.0(33)S3, 12.2(33)SX11, and later releases, BGP support for 4-octet (4-byte) autonomous system numbers was introduced. The 4-byte autonomous system numbers in this example are formatted in the default asplain (decimal value) format; for example, Router B is in autonomous system number 65538 in the figure below. For more details about the introduction of 4-byte autonomous system numbers, see the “BGP Autonomous System Number Formats” section.

One of the methods that BGP can use to influence the choice of paths in another autonomous system is to modify the AS-path attribute. For example, in the figure below, Router A advertises its own network, 172.17.1.0, to its BGP peers in autonomous system 65538 and autonomous system 65550. When the routing information is propagated to autonomous system 65545, the routers in autonomous system 65545 have network reachability information about network 172.17.1.0 from two different routes. The first route is from autonomous system 65538 with an AS-path consisting of 65538, 65550. The second route is through autonomous system 65547 with an AS-path of 65547, 65550, 65536. If all other BGP attribute values are the same, Router C in autonomous
system 65545 would choose the route through autonomous system 65538 for traffic destined for network 172.17.1.0 because it is the shortest route in terms of autonomous systems traversed.

Autonomous system 65536 now receives all traffic from autonomous system 65545 for the 172.17.1.0 network through Router B in autonomous system 65538. If, however, the link between autonomous system 65538 and autonomous system 65536 is a really slow and congested link, the set as-path prepend command can be used at Router A to influence inbound path selection for the 172.17.1.0 network by making the route through autonomous system 65538 appear to be longer than the path through autonomous system 65550. The configuration is done at Router A in the figure below by applying a route map to the outbound BGP updates to Router B. Using the set as-path prepend command, all the outbound BGP updates from Router A to Router B will have their AS-path attribute modified to add the local autonomous system number 65536 twice. After the configuration, autonomous system 65545 receives updates about the 172.17.1.0 network through autonomous system 65538. The new AS-path is 65538, 65536, 65536, 65536, which is now longer than the AS-path from autonomous system 65547 (unchanged at a value of 65547, 65550, 65536). Networking devices in autonomous system 65545 will now prefer the route through autonomous system 65547 to forward packets with a destination address in the 172.17.1.0 network.

**Figure 32: Network Topology for Modifying the AS-path Attribute**

![Network Topology for Modifying the AS-path Attribute](image)

The configuration for this example is performed at Router A in the figure above.

```
router bgp 65536
  address-family ipv4 unicast
  network 172.17.1.0 mask 255.255.255.0
  neighbor 192.168.1.2 remote-as 65538
  neighbor 192.168.1.2 activate
  neighbor 192.168.1.2 route-map PREPEND out
  exit-address-family
  exit
  route-map PREPEND permit 10
  set as-path prepend 65536 65536
```
Example: Filtering BGP Prefixes with Prefix Lists

This section contains the following examples:

Example: Filtering BGP Prefixes Using a Single Prefix List

The following example shows how a prefix list denies the default route 0.0.0.0/0:

```
ip prefix-list abc deny 0.0.0.0/0
```

The following example shows how a prefix list permits a route that matches the prefix 10.0.0.0/8:

```
ip prefix-list abc permit 10.0.0.0/8
```

The following example shows how to configure the BGP process so that it accepts only prefixes with a prefix length of /8 to /24:

```
router bgp 40000
  network 10.20.20.0
  distribute-list prefix max24 in
  !
ip prefix-list max24 seq 5 permit 0.0.0.0/0 ge 8 le 24
```

The following example configuration shows how to conditionally originate a default route (0.0.0.0/0) in RIP when a prefix 10.1.1.0/24 exists in the routing table:

```
ip prefix-list cond permit 10.1.1.0/24
!
route-map default-condition permit 10
  match ip address prefix-list cond
!
router rip
  default-information originate route-map default-condition
```

The following example shows how to configure BGP to accept routing updates from 192.168.1.1 only, besides filtering on the prefix length:

```
router bgp 40000
  distribute-list prefix max24 gateway allowlist in
  !
ip prefix-list allowlist seq 5 permit 192.168.1.1/32
```

The following example shows how to direct the BGP process to filter incoming updates to the prefix using name1, and match the gateway (next hop) of the prefix being updated to the prefix list name2, on Gigabit Ethernet interface 0/0/0:

```
router bgp 103
  distribute-list prefix name1 gateway name2 in gigabitethernet 0/0/0
```

Example: Filtering BGP Prefixes Using a Group of Prefixes

The following example shows how to configure BGP to permit routes with a prefix length up to 24 in network 192/8:

```
ip prefix-list abc permit 192.0.0.0/8 le 24
```
The following example shows how to configure BGP to deny routes with a prefix length greater than 25 in
192/8:

```
ip prefix-list abc deny 192.0.0.0/8 ge 25
```

The following example shows how to configure BGP to permit routes with a prefix length greater than 8 and
less than 24 in all address space:

```
ip prefix-list abc permit 0.0.0.0/0 ge 8 le 24
```

The following example shows how to configure BGP to deny routes with a prefix length greater than 25 in
all address space:

```
ip prefix-list abc deny 0.0.0.0/0 ge 25
```

The following example shows how to configure BGP to deny all routes in network 10/8, because any route
in the Class A network 10.0.0.0/8 is denied if its mask is less than or equal to 32 bits:

```
ip prefix-list abc deny 10.0.0.0/8 le 32
```

The following example shows how to configure BGP to deny routes with a mask greater than 25 in
192.168.1.0/24:

```
ip prefix-list abc deny 192.168.1.0/24 ge 25
```

The following example shows how to configure BGP to permit all routes:

```
ip prefix-list abc permit 0.0.0.0/0 le 32
```

**Example: Adding or Deleting Prefix List Entries**

You can add or delete individual entries in a prefix list if a prefix list has the following initial configuration:

```
ip prefix-list abc deny 0.0.0.0/0 le 7
ip prefix-list abc deny 0.0.0.0/0 ge 25
ip prefix-list abc permit 192.168.0.0/15
```

The following example shows how to delete an entry from the prefix list so that 192.168.0.0 is not permitted,
and add a new entry that permits 10.0.0.0/8:

```
no ip prefix-list abc permit 192.168.0.0/15
ip prefix-list abc permit 10.0.0.0/8
```

The new configuration is as follows:

```
ip prefix-list abc deny 0.0.0.0/0 le 7
ip prefix-list abc deny 0.0.0.0/0 ge 25
ip prefix-list abc permit 10.0.0.0/8
```

**Example: Filtering Traffic Using COMMUNITIES Attributes**

This section contains two examples of the use of BGP COMMUNITIES attributes with route maps.

The first example configures a route map named `set-community`, which is applied to the outbound updates to
the neighbor 172.16.232.50. The routes that pass access list 1 are given the well-known COMMUNITIES
attribute value **no-export**. The remaining routes are advertised normally. The **no-export** community value automatically prevents the advertisement of those routes by the BGP speakers in autonomous system 200.

```bash
router bgp 100
  neighbor 172.16.232.50 remote-as 200
  neighbor 172.16.232.50 send-community
  neighbor 172.16.232.50 route-map set-community out

route-map set-community permit 10
  match address 1
  set community no-export

route-map set-community permit 20
  match address 2
```

The second example configures a route map named **set-community**, which is applied to the outbound updates to neighbor 172.16.232.90. All the routes that originate from autonomous system 70 have the **COMMUNITIES** attribute values 200 200 added to their already existing communities. All other routes are advertised as normal.

```bash
route-map bgp 200
  neighbor 172.16.232.90 remote-as 100
  neighbor 172.16.232.90 send-community
  neighbor 172.16.232.90 route-map set-community out

route-map set-community permit 10
  match as-path 1
  set community 200 200 additive

route-map set-community permit 20

ip as-path access-list 1 permit _109_
ip as-path access-list 2 permit _200$
ip as-path access-list 2 permit ^100$
ip as-path access-list 3 deny _690$
ip as-path access-list 3 permit .*
```

**Example: Filtering Traffic Using AS-Path Filters**

The following example shows BGP path filtering by neighbor. Only the routes that pass autonomous system path access list 2 will be sent to 192.168.12.10. Similarly, only routes passing access list 3 will be accepted from 192.168.12.10.

```bash
router bgp 200
  neighbor 192.168.12.10 remote-as 100
  neighbor 192.168.12.10 filter-list 1 out
  neighbor 192.168.12.10 filter-list 2 in

ip as-path access-list 1 permit _109_
ip as-path access-list 2 permit _200$
ip as-path access-list 2 permit ^100$
ip as-path access-list 3 deny _690$
ip as-path access-list 3 permit .*
```
Example: Filtering Traffic with AS-path Filters Using 4-Byte Autonomous System Numbers

Asplain Default Format in Cisco IOS Release 12.0(32)SY8, 12.0(33)S3, 12.2(33)SRE, 12.2(33)SXI1, and Later Releases

The following example is available in Cisco IOS Release 12.0(32)SY8, 12.0(33)S3, 12.2(33)SRE, 12.2(33)XNE, 12.2(33)SXI1, and later releases and shows BGP path filtering by neighbor using 4-byte autonomous system numbers in asplain format. Only the routes that pass autonomous system path access list 2 will be sent to 192.168.3.2.

```
ip as-path access-list 2 permit ^65536$
router bgp 65538
  address-family ipv4 unicast
  neighbor 192.168.3.2 remote-as 65550
  neighbor 192.168.3.2 activate
  neighbor 192.168.3.2 filter-list 2 in
end
```

Asdot Default Format in Cisco IOS Release 12.0(32)S12, and 12.4(24)T

The following example available in Cisco IOS Release 12.0(32)S12, 12.4(24)T, and later releases shows BGP path filtering by neighbor using 4-byte autonomous system numbers in asdot format. Only the routes that pass autonomous system path access list 2 will be sent to 192.168.3.2.

```
ip as-path access-list 2 permit ^1\.0$
router bgp 1.2
  address-family ipv4 unicast
  neighbor 192.168.3.2 remote-as 1.14
  neighbor 192.168.3.2 activate
  neighbor 192.168.3.2 filter-list 2 in
end
```

Note

In Cisco IOS Release 12.0(32)SY8, 12.0(33)S3, 12.2(33)SRE, 12.2(33)XNE, 12.2(33)SXI1, and later releases, this example works if you have configured asdot as the default display format using the `bgp asnotation dot` command.

Example: Filtering Traffic Using Extended Community Lists with 4-Byte Autonomous System Numbers

Asplain Default Format in Cisco IOS Release 12.0(32)SY8, 12.0(33)S3, 12.2(33)SRE, 12.2(33)SXI1, and Later Releases

The following example shows how to filter traffic by creating an extended BGP community list to control outbound routes. In Cisco IOS Release 12.0(32)SY8, 12.0(33)S3, 12.2(33)SRE, 12.2(33)XNE, 12.2(33)SXI1, and later releases, extended BGP communities support 4-byte autonomous system numbers in the regular expressions in asplain by default. Extended community attributes are used to configure, filter, and identify routes for VRF instances and MPLS VPNs. The `ip extcommunity-list` command is used to configure named or numbered extended community lists. All of the standard rules of access lists apply to the configuration of
extended community lists. Regular expressions are supported by the expanded range of extended community list numbers.

**Figure 33: BGP Topology for Filtering Traffic Using Extended Community Lists with 4-Byte Autonomous System Numbers in Asplain Format**

![BGP Topology Diagram]

A sequence number is applied to all extended community list entries by default regardless of the configuration mode. Explicit sequencing and resequencing of extended community list entries can be configured only in IP extended community-list configuration mode and not in global configuration mode.

In this exam the figure above is configured with an extended named community list to specify that the BGP peer at 192.168.1.2 is not sent advertisements about any path through or from the 4-byte autonomous system 65550. The IP extended community-list configuration mode is used, and the ability to resequence entries is shown.

```
ip extcommunity-list expanded DENY65550
  10 deny _65550_
  20 deny ^65550 .*
  resequence 50 100
exit
router bgp 65538
  network 172.17.1.0 mask 255.255.255.0
  address-family ipv4 unicast
  neighbor 192.168.3.2 remote-as 65550
  neighbor 192.168.1.2 remote-as 65536
  neighbor 192.168.3.2 activate
  neighbor 192.168.1.2 activate
end
show ip extcommunity-list DENY65550
```

**Asdot Default Format in Cisco IOS Release 12.0(32)S12, and 12.4(24)T**

The following example shows how to filter traffic by creating an extended BGP community list to control outbound routes. In Cisco IOS Release 12.0(32)S12, 12.4(24)T, and later releases, extended BGP communities support 4-byte autonomous system numbers in the regular expressions in asdot format only. Extended
Community attributes are used to configure, filter, and identify routes for VRF instances and MPLS VPNs. The `ip extcommunity-list` command is used to configure named or numbered extended community lists. All of the standard rules of access lists apply to the configuration of extended community lists. Regular expressions are supported by the expanded range of extended community list numbers.

**Note**
In Cisco IOS Release 12.0(32)SY8, 12.0(33)S3, 12.2(33)SXII, and later releases, this example works if you have configured asdot as the default display format using the `bgp asnotation dot` command.

Figure 34: BGP Topology for Filtering Traffic Using Extended Community Lists with 4-Byte Autonomous System Numbers in Asdot Format

A sequence number is applied to all extended community list entries by default regardless of the configuration mode. Explicit sequencing and resequencing of extended community list entries can be configured only in IP extended community-list configuration mode and not in global configuration mode.

In this exam the figure above is configured with an extended named community list to specify that the BGP peer at 192.168.1.2 is not sent advertisements about any path through or from the 4-byte autonomous system 65550. The IP extended community-list configuration mode is used, and the ability to resequence entries is shown.

```
ip extcommunity-list expanded DENY114
  10 deny _1\.14_
  20 deny ^1\.14 .*
resequence 50 100
exit
router bgp 1.2
  network 172.17.1.0 mask 255.255.255.0
  address-family ipv4 unicast
  neighbor 192.168.3.2 remote-as 1.14
  neighbor 192.168.1.2 remote-as 1.0
  neighbor 192.168.3.2 activate
  neighbor 192.168.1.2 activate
```

**Note**

Figure 34: BGP Topology for Filtering Traffic Using Extended Community Lists with 4-Byte Autonomous System Numbers in Asdot Format
Example: Filtering Traffic Using a BGP Route Map

The following example shows how to use an address family to configure BGP so that any unicast and multicast routes from neighbor 10.1.1.1 are accepted if they match access list 1:

```plaintext
route-map filter-some-multicast
  match ip address 1
  exit
router bgp 65538
  neighbor 10.1.1.1 remote-as 65537
  address-family ipv4 unicast
  neighbor 10.1.1.1 activate
  neighbor 10.1.1.1 route-map filter-some-multicast in
  exit
end
eend
```

Where to Go Next

- To configure advanced BGP feature tasks, proceed to the “Configuring Advanced BGP Features” module.
- To configure BGP neighbor session options, proceed to the “Configuring BGP Neighbor Session Options” module.
- To configure internal BGP tasks, proceed to the “Configuring Internal BGP Features” module.

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## Building Scalable Cisco Networks

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Technical Assistance

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Feature Information for Connecting to a Service Provider Using External BGP

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

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</tr>
<tr>
<td>--------------</td>
<td>----------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td>BGP Named Community Lists</td>
<td>12.2(8)T 12.2(14)S 15.0(1)S</td>
<td>The BGP Named Community Lists feature introduces a new type of community list called the named community list. The BGP Named Community Lists feature allows the network operator to assign meaningful names to community lists and increases the number of community lists that can be configured. A named community list can be configured with regular expressions and with numbered community lists. All rules of numbered communities apply to named community lists except that there is no limitation on the number of community attributes that can be configured for a named community list.</td>
</tr>
<tr>
<td>BGP Route-Map Policy List Support</td>
<td>12.0(22)S 12.2(15)T 12.2(18)S 12.2(18)SXD 12.2(27)SBC 15.0(1)S</td>
<td>The BGP Route-Map Policy List Support feature introduces new functionality to BGP route maps. This feature adds the capability for a network operator to group route map match clauses into named lists called policy lists. A policy list functions like a macro. When a policy list is referenced in a route map, all of the match clauses are evaluated and processed as if they had been configured directly in the route map. This enhancement simplifies the configuration of BGP routing policy in medium-size and large networks because a network operator can preconfigure policy lists with groups of match clauses and then reference these policy lists within different route maps. The network operator no longer needs to manually reconfigure each recurring group of match clauses that occur in multiple route map entries.</td>
</tr>
<tr>
<td>BGP Support for Named Extended Community Lists</td>
<td>12.2(25)S 12.2(27)SBC 12.2(33)SRA 12.2(33)SXH 12.3(11)T 15.0(1)S</td>
<td>The BGP Support for Named Extended Community Lists feature introduces the ability to configure extended community lists using names in addition to the existing numbered format.</td>
</tr>
<tr>
<td>BGP Support for Sequenced Entries in Extended Community Lists</td>
<td>12.2(25)S 12.2(27)SBC 12.2(33)SRA 12.2(33)SXH 12.3(11)T 15.0(1)S</td>
<td>The BGP Support for Sequenced Entries in Extended Community Lists feature introduces automatic sequencing of individual entries in BGP extended community lists. This feature also introduces the ability to remove or resequence extended community list entries without deleting the entire existing extended community list.</td>
</tr>
<tr>
<td>BGP 4 Prefix Filter and Inbound Route Maps</td>
<td>Cisco IOS XE 3.1.0SG</td>
<td></td>
</tr>
</tbody>
</table>
BGP Route-Map Continue

The BGP Route-Map Continue feature introduces the continue clause to BGP route-map configuration. The continue clause allows for more programmable policy configuration and route filtering and introduces the capability to execute additional entries in a route map after an entry is executed with successful match and set clauses. Continue clauses allow the network operator to configure and organize more modular policy definitions so that specific policy configuration need not be repeated within the same route map.

- Finding Feature Information, on page 337
- Information About BGP Route Map Continue, on page 337
- How to Filter Traffic Using Continue Clauses in a BGP Route Map, on page 339
- Configuration Examples for BGP Route Map Continue, on page 342
- Additional References, on page 344
- Feature Information for BGP Route Map Continue, on page 344

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About BGP Route Map Continue

BGP Route Map with a Continue Clause

In BGP route-map configuration, the continue clause allows for more programmable policy configuration and route filtering and introduced the capability to execute additional entries in a route map after an entry is executed with successful match and set clauses. Continue clauses allow you to configure and organize more modular policy definitions so that specific policy configurations need not be repeated within the same route map. Before the continue clause was introduced, route-map configuration was linear and did not allow any control over the flow of a route map.
Route Map Operation Without Continue Clauses

A route map evaluates match clauses until a successful match occurs. After the match occurs, the route map stops evaluating match clauses and starts executing set clauses, in the order in which they were configured. If a successful match does not occur, the route map “falls through” and evaluates the next sequence number of the route map until all configured route map entries have been evaluated or a successful match occurs. Each route map sequence is tagged with a sequence number to identify the entry. Route map entries are evaluated in order starting with the lowest sequence number and ending with the highest sequence number. If the route map contains only set clauses, the set clauses will be executed automatically, and the route map will not evaluate any other route map entries.

Route Map Operation with Continue Clauses

When a continue clause is configured, the route map will continue to evaluate and execute match clauses in the specified route map entry after a successful match occurs. The continue clause can be configured to go to (jump to) a specific route map entry by specifying the sequence number, or if a sequence number is not specified, the continue clause will go to the next sequence number. This behavior is called an “implied continue.” If a match clause exists, the continue clause is executed only if a match occurs. If no successful matches occur, the continue clause is ignored.

Match Operations with Continue Clauses

If a match clause does not exist in the route map entry but a continue clause does, the continue clause will be automatically executed and go to the specified route map entry. If a match clause exists in a route map entry, the continue clause is executed only when a successful match occurs. When a successful match occurs and a continue clause exists, the route map executes the set clauses and then goes to the specified route map entry. If the next route map entry contains a continue clause, the route map will execute the continue clause if a successful match occurs. If a continue clause does not exist in the next route map entry, the route map will be evaluated normally. If a continue clause exists in the next route map entry but a match does not occur, the route map will not continue and will “fall through” to the next sequence number if one exists.

Note

If the number of community lists in a match community clause within a route map exceed 256 characters in a line, you must nvgem multiple match community statements in a new line.

Set Operations with Continue Clauses

Set clauses are saved during the match clause evaluation process and are executed after the route-map evaluation is completed. The set clauses are evaluated and executed in the order in which they were configured. Set clauses are executed only after a successful match occurs, unless the route map does not contain a match clause. The continue statement proceeds to the specified route map entry only after configured set actions are performed. If a set action occurs in the first route map and then the same set action occurs again, with a different value, in a subsequent route map entry, the last set action may override any previous set actions that were configured with the same set command unless the set command permits more than one value. For example, the set as-path prepend command permits more than one autonomous system number to be configured.

Note

A continue clause can be executed, without a successful match, if a route map entry does not contain a match clause.
How to Filter Traffic Using Continue Clauses in a BGP Route Map

Filtering Traffic Using Continue Clauses in a BGP Route Map

Perform this task to filter traffic using continue clauses in a BGP route map.

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>enable</td>
<td>Enables higher privilege levels, such as privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td>configure</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>terminal</td>
<td></td>
</tr>
<tr>
<td>router bgp</td>
<td></td>
</tr>
<tr>
<td>autonomous-system-number</td>
<td></td>
</tr>
<tr>
<td>neighbor</td>
<td></td>
</tr>
<tr>
<td>ip-address</td>
<td>peer-group-name</td>
</tr>
<tr>
<td>neighbor</td>
<td></td>
</tr>
<tr>
<td>ip-address</td>
<td>peer-group-name</td>
</tr>
<tr>
<td>exit</td>
<td></td>
</tr>
<tr>
<td>route-map map-name</td>
<td></td>
</tr>
<tr>
<td>permit</td>
<td>deny</td>
</tr>
<tr>
<td>match ip address</td>
<td>(access-list-number</td>
</tr>
<tr>
<td>set community</td>
<td>(community-number</td>
</tr>
<tr>
<td>continue</td>
<td>(sequence-number)</td>
</tr>
<tr>
<td>end</td>
<td></td>
</tr>
<tr>
<td>show route-map</td>
<td>(map-name)</td>
</tr>
</tbody>
</table>

Note
Continue clauses can go only to a higher route map entry (a route map entry with a higher sequence number) and cannot go to a lower route map entry.

SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. neighbor {ip-address| peer-group-name} remote-as autonomous-system-number
5. neighbor {ip-address| peer-group-name} route-map map-name {in | out}
6. exit
7. route-map map-name {permit | deny} (sequence-number)
8. match ip address {access-list-number| access-list-name | ... access-list-number | ... access-list-name}
9. set community community-number {additive} [well-known-community] | none
10. continue (sequence-number)
11. end
12. show route-map [map-name]
### Command or Action

<table>
<thead>
<tr>
<th>Step 3</th>
<th>router bgp  autonomous-system-number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config)# router bgp 50000</td>
</tr>
</tbody>
</table>

**Purpose:** Enters router configuration mode, and creates a BGP routing process.

<table>
<thead>
<tr>
<th>Step 4</th>
<th>neighbor {ip-address|peer-group-name} remote-as autonomous-system-number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config-router)# neighbor 10.0.0.1 remote-as 50000</td>
</tr>
</tbody>
</table>

**Purpose:** Adds the IP address or peer group name of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local router.

<table>
<thead>
<tr>
<th>Step 5</th>
<th>neighbor {ip-address|peer-group-name} route-map map-name {in | out}</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config-router)# neighbor 10.0.0.1 route-map ROUTE-MAP-NAME in</td>
</tr>
</tbody>
</table>

**Purpose:** Applies the inbound route map to routes received from the specified neighbor, or applies an outbound route map to routes advertised to the specified neighbor.

<table>
<thead>
<tr>
<th>Step 6</th>
<th>exit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config-router)# exit</td>
</tr>
</tbody>
</table>

**Purpose:** Exits router configuration mode and enters global configuration mode.

<table>
<thead>
<tr>
<th>Step 7</th>
<th>route-map map-name {permit | deny} [sequence-number]</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config)# route-map ROUTE-MAP-NAME permit 10</td>
</tr>
</tbody>
</table>

**Purpose:** Enters route-map configuration mode to create or configure a route map.

| Step 8 | match ip address \{access-list-number\|access-list-name\} [... access-list-number | ... access-list-name] |
|--------|--------------------------------------------------------------------------------|
| **Example:** | Device(config-route-map)# match ip address 1 |

**Purpose:** Configures a match command that specifies the conditions under which policy routing and route filtering occur.

- Multiple match commands can be configured. If a match command is configured, a match must occur in order for the continue statement to be executed. If a match command is not configured, set and continue clauses will be executed.

**Note:** The match and set commands used in this task are examples that are used to help describe the operation of the continue command. For a list of specific match and set commands, see the continue command in the Cisco IOS IP Routing: BGP Command Reference.
<table>
<thead>
<tr>
<th>Step 9</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>set community community-number [additive] [well-known-community]</td>
<td>Configures a set command that specifies the routing action to perform if the criteria enforced by the match commands are met.</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Device(config-route-map)# set community 10:1</td>
<td>• Multiple set commands can be configured.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• In this example, a clause is created to set the specified community.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 10</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>continue [sequence-number]</td>
<td>Configures a route map to continue to evaluate and execute match statements after a successful match occurs.</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Device(config-route-map)# continue</td>
<td>• If a sequence number is configured, the continue clause will go to the route map with the specified sequence number.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• If no sequence number is specified, the continue clause will go to the route map with the next sequence number. This behavior is called an “implied continue.”</td>
<td></td>
</tr>
</tbody>
</table>

**Note** Continue clauses in outbound route maps are supported in Cisco IOS XE Release 2.1 and later releases.

<table>
<thead>
<tr>
<th>Step 11</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>end</td>
<td>Exits route-map configuration mode and enters privileged EXEC mode.</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Device(config-route-map)# end</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 12</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>show route-map [map-name]</td>
<td>(Optional) Displays locally configured route maps. The name of the route map can be specified in the syntax of this command to filter the output.</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Device# show route-map</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Examples**

The following sample output shows how to verify the configuration of continue clauses using the show route-map command. The output displays configured route maps including the match, set, and continue clauses.

```
Device# show route-map
route-map MARKETING, permit, sequence 10
  Match clauses:
    ip address (access-lists): 1
    metric 10
  Continue: sequence 40
  Set clauses:
    as-path prepend 10
```
Configuration Examples for BGP Route Map Continue

Examples: Filtering Traffic Using Continue Clauses in a BGP Route Map

The following example shows continue clause configuration in a route map sequence.

Note

Continue clauses in outbound route maps are supported only in Cisco IOS Release 12.0(31)S, 12.2(33)SB, 12.2(33)SRB, 12.2(33)SXI, 12.4(4)T, and later releases.

The first continue clause in route map entry 10 indicates that the route map will go to route map entry 30 if a successful matches occurs. If a match does not occur, the route map will “fall through” to route map entry 20. If a successful match occurs in route map entry 20, the set action will be executed and the route map will not evaluate any additional route map entries. Only the first successful match ip address clause is supported.

If a successful match does not occur in route map entry 20, the route map will fall through to route map entry 30. This sequence does not contain a match clause, so the set clause will be automatically executed and the continue clause will go to the next route map entry because a sequence number is not specified.

If there are no successful matches, the route map will fall through to route map entry 30 and execute the set clause. A sequence number is not specified for the continue clause, so route map entry 40 will be evaluated.

There are two behaviors that can occur when the same set command is repeated in subsequent continue clause entries. For set commands that configure an additive or accumulative value (for example, set community additive, set extended community additive, and set as-path prepend), subsequent values are added by subsequent entries. The following example illustrates this behavior. After each set of match clauses, a set as-path prepend command is configured to add an autonomous system number to the as-path. After a match occurs, the route map stops evaluating match clauses and starts executing the set clauses, in the order in which
they were configured. Depending on how many successful match clauses occur, the as-path is prepended by one, two, or three autonomous system numbers.

```plaintext
route-map ROUTE-MAP-NAME permit 10
match ip address 1
match metric 10
set as-path prepend 10
continue 30
!
route-map ROUTE-MAP-NAME permit 20
match ip address 2
match metric 20
set as-path prepend 10 10
!
route-map ROUTE-MAP-NAME permit 30
set as-path prepend 10 10 10
continue
!
route-map ROUTE-MAP-NAME permit 40
match community 10:1
set local-preference 104
```

In this example, the same `set` command is repeated in subsequent `continue` clause entries, but the behavior is different from the first example. For `set` commands that configure an absolute value, the value from the last instance will overwrite the previous value(s). The following example illustrates this behavior. The set clause value in sequence 20 overwrites the set clause value from sequence 10. The next hop for prefixes from the 172.16/16 network is set to 10.2.2.2, not 10.1.1.1.

```plaintext
ip prefix-list 1 permit 172.16.0.0/16
ip prefix-list 2 permit 192.168.1.0/24
route-map RED permit 10
match ip address prefix-list 1
set ip next hop 10.1.1.1
continue 20
exit
route-map RED permit 20
match ip address prefix-list 2
set ip next hop 10.2.2.2
end
```

**Note**

Route maps have a linear behavior and not a nested behavior. Once a route is matched in a route map permit entry with a continue command clause, it will not be processed by the implicit deny at the end of the route-map. The following example illustrates this case.

In the following example, when routes match an as-path of 10, 20, or 30, the routes are permitted and the continue clause jumps over the explicit deny clause to process the match ip address prefix list. If a match occurs here, the route metric is set to 100. Only routes that do not match an as-path of 10, 20, or 30 and do match a community number of 30 are denied. To deny other routes, you must configure an explicit deny statement.

```plaintext
route-map test permit 10
match as-path 10 20 30
continue 30
exit
route-map test deny 20
match community 30
```
exit
route-map test permit 30
match ip address prefix-list 1
set metric 100
exit

Additional References

Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
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</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
</tbody>
</table>

Standards and RFCs

<table>
<thead>
<tr>
<th>Standard/RFC</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFC 2918</td>
<td>Route Refresh Capability for BGP-4</td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
<tr>
<td>download documentation, software, and tools. Use these resources to</td>
<td></td>
</tr>
<tr>
<td>install and configure the software and to troubleshoot and resolve</td>
<td></td>
</tr>
<tr>
<td>technical issues with Cisco products and technologies. Access to most</td>
<td></td>
</tr>
<tr>
<td>tools on the Cisco Support and Documentation website requires a Cisco.com</td>
<td></td>
</tr>
<tr>
<td>user ID and password.</td>
<td></td>
</tr>
</tbody>
</table>

Feature Information for BGP Route Map Continue

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.
Table 29: Feature Information for BGP Route Map Continue

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP Route Map Continue</td>
<td>12.2(27)SBC</td>
<td>The BGP Route Map Continue feature introduces the continue clause to BGP route map configuration. The continue clause allows for more programmable policy configuration and route filtering and introduces the capability to execute additional entries in a route map after an entry is executed with successful match and set clauses. Continue clauses allow the network operator to configure and organize more modular policy definitions so that specific policy configuration need not be repeated within the same route map. This feature was introduced on the Cisco ASR 1000 Series Routers.</td>
</tr>
<tr>
<td></td>
<td>Cisco IOS XE Release 2.1</td>
<td></td>
</tr>
</tbody>
</table>
BGP Route-Map Continue Support for Outbound Policy

The BGP Route-Map Continue Support for an Outbound Policy feature introduces support for continue clauses to be applied to outbound route maps.

- Finding Feature Information, on page 347
- Information About BGP Route-Map Continue Support for Outbound Policy, on page 347
- How to Filter Traffic Using Continue Clauses in a BGP Route Map, on page 349
- Configuration Examples for BGP Route-Map Continue Support for Outbound Policy, on page 353
- Additional References, on page 354
- Feature Information for BGP Route-Map Continue Support for Outbound Policy, on page 355

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About BGP Route-Map Continue Support for Outbound Policy

BGP Route Map with a Continue Clause

Subsequent to the Cisco implementation of route maps, the continue clause was introduced into BGP route map configuration. The continue clause allows for more programmable policy configuration and route filtering. The continue clause introduces the ability to execute additional entries in a route map after an entry is executed with successful match and set clauses. Continue clauses allow you to configure and organize more modular policy definitions so that specific policy configurations need not be repeated within the same route map.
Before the continue clause was introduced, route map configuration was linear and did not allow any control over the flow of a route map.

**Route Map Operation Without Continue Clauses**

A route map evaluates match clauses until a successful match occurs. After the match occurs, the route map stops evaluating match clauses and starts executing set clauses, in the order in which they were configured. If a successful match does not occur, the route map “falls through” and evaluates the next sequence number of the route map until all configured route map entries have been evaluated or a successful match occurs. Each route map sequence is tagged with a sequence number to identify the entry. Route map entries are evaluated in order starting with the lowest sequence number and ending with the highest sequence number. If the route map contains only set clauses, the set clauses will be executed automatically, and the route map will not evaluate any other route map entries.

**Route Map Operation with Continue Clauses**

When a continue clause is configured, the route map will continue to evaluate and execute match clauses in the specified route map entry after a successful match occurs. The continue clause can be configured to go to (jump to) a specific route map entry by specifying the sequence number, or if a sequence number is not specified, the continue clause will go to the next sequence number. This behavior is called an “implied continue.” If a match clause exists, the continue clause is executed only if a match occurs. If no successful matches occur, the continue clause is ignored.

**Match Operations with Continue Clauses**

If a match clause does not exist in the route map entry but a continue clause does, the continue clause will be automatically executed and go to the specified route map entry. If a match clause exists in a route map entry, the continue clause is executed only when a successful match occurs. When a successful match occurs and a continue clause exists, the route map executes the set clauses and then goes to the specified route map entry. If the next route map entry contains a continue clause, the route map will execute the continue clause if a successful match occurs. If a continue clause does not exist in the next route map entry, the route map will be evaluated normally. If a continue clause exists in the next route map entry but a match does not occur, the route map will not continue and will “fall through” to the next sequence number if one exists.

---

**Note**

If the number of community lists in a match community clause within a route map exceed 256 characters in a line, you must nvgem multiple match community statements in a new line.

---

**Set Operations with Continue Clauses**

Set clauses are saved during the match clause evaluation process and are executed after the route-map evaluation is completed. The set clauses are evaluated and executed in the order in which they were configured. Set clauses are executed only after a successful match occurs, unless the route map does not contain a match clause. The continue statement proceeds to the specified route map entry only after configured set actions are performed. If a set action occurs in the first route map and then the same set action occurs again, with a different value, in a subsequent route map entry, the last set action may override any previous set actions that were configured with the same `set` command unless the `set` command permits more than one value. For example, the `set as-path prepend` command permits more than one autonomous system number to be configured.
A continue clause can be executed, without a successful match, if a route map entry does not contain a match clause.

Route maps have a linear behavior, not a nested behavior. Once a route is matched in a route map permit entry with a continue command clause, it will not be processed by the implicit deny at the end of the route-map. For an example, see the “Examples: Filtering Traffic Using Continue Clauses in a BGP Route Map” section.

How to Filter Traffic Using Continue Clauses in a BGP Route Map

Filtering Traffic Using Continue Clauses in a BGP Route Map

SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. neighbor {ip-address | peer-group-name} remote-as autonomous-system-number
5. address-family ipv4 [unicast | multicast | vrf vrf-name]
6. neighbor {ip-address | peer-group-name} route-map map-name {in | out}
7. exit
8. exit
9. route-map map-name {permit | deny} [sequence-number]
10. match ip address {access-list-number | access-list-name} [... access-list-number | ... access-list-name]
11. set community { {community-number} | [well-known-community] | [additive]} | none
12. continue [sequence-number]
13. end
14. show route-map [map-name]

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Device# configure terminal</td>
<td></td>
</tr>
</tbody>
</table>
| **Step 3** | router bgp  *autonomous-system-number*  
Example: 
Device(config)# router bgp 50000 | Enters router configuration mode, and creates a BGP routing process. |
| **Step 4** | neighbor {ip-address | peer-group-name} remote-as  
*autonomous-system-number*  
Example: 
Device(config-router)# neighbor 10.0.0.1 remote-as 50000 | Adds the IP address or peer group name of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local device. |
| **Step 5** | address-family ipv4 [unicast | multicast | vrf vrf-name]  
Example: 
Device(config-router)# address-family ipv4 unicast | Specifies the IPv4 address family and enters address family configuration mode.  
- The **unicast** keyword specifies the IPv4 unicast address family. By default, the device is placed in address family configuration mode for the IPv4 unicast address family if the **unicast** keyword is not specified.  
- The **multicast** keyword specifies IPv4 multicast address prefixes.  
- The **vrf** keyword and vrf-name argument specify the name of the VRF instance to associate with subsequent IPv4 address family configuration mode commands. |
| **Step 6** | neighbor {ip-address | peer-group-name} route-map  
map-name {in | out}  
Example: 
Device(config-router-af)# neighbor 10.0.0.1 route-map ROUTE-MAP-NAME in | Applies the inbound route map to routes received from the specified neighbor, or applies an outbound route map to routes advertised to the specified neighbor. |
| **Step 7** | exit  
Example: 
Device(config-router-af)# exit | Exits address family configuration mode and enters router configuration mode. |
| **Step 8** | exit  
Example: 
Device(config-router)# exit | Exits router configuration mode and enters global configuration mode. |
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 9</strong></td>
<td>Enters route-map configuration mode to create or configure a route map.</td>
</tr>
<tr>
<td>`route-map map-name {permit</td>
<td>deny} [sequence-number]`</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config)# route-map ROUTE-MAP-NAME permit 10</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td>Configures a <strong>match</strong> command that specifies the conditions under which policy routing and route filtering occur.</td>
</tr>
<tr>
<td>`match ip address {access-list-number</td>
<td>access-list-name} [... access-list-number</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config-route-map)# match ip address 1</code></td>
<td></td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td>The <code>match</code> and <code>set</code> commands used in this task are examples that are used to help describe the operation of the <code>continue</code> command. For a list of specific <code>match</code> and <code>set</code> commands, see the <code>continue</code> command in the <em>Cisco IOS IP Routing: BGP Command Reference</em>.</td>
</tr>
<tr>
<td><strong>Step 11</strong></td>
<td>Configures a <strong>set</strong> command that specifies the routing action to perform if the criteria enforced by the <code>match</code> commands are met.</td>
</tr>
<tr>
<td>`set community { { [community-number] [well-known-community] [additive] }</td>
<td>none}`</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config-route-map)# set community 10:1</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 12</strong></td>
<td>Configures a route map to continue to evaluate and execute match statements after a successful match occurs.</td>
</tr>
<tr>
<td><code>continue [sequence-number]</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config-route-map)# continue</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 13</strong></td>
<td>Exits route-map configuration mode and enters privileged EXEC mode.</td>
</tr>
<tr>
<td><code>end</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config-route-map)# end</code></td>
<td></td>
</tr>
</tbody>
</table>
### Command or Action

**Step 14**

**show route-map [map-name]**

**Example:**

Device# show route-map

<table>
<thead>
<tr>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Optional) Displays locally configured route maps. The name of the route map can be specified in the syntax of this command to filter the output.</td>
</tr>
</tbody>
</table>

### Examples

The following sample output shows how to verify the configuration of continue clauses using the show route-map command. The output displays configured route maps including the match, set, and continue clauses.

Device# show route-map

route-map MARKETING, permit, sequence 10
  Match clauses:
  - ip address (access-lists): 1
  - metric 10
  Continue: sequence 40
  Set clauses:
  - as-path prepend 10
  Policy routing matches: 0 packets, 0 bytes
route-map MARKETING, permit, sequence 20
  Match clauses:
  - ip address (access-lists): 2
  - metric 20
  Set clauses:
  - as-path prepend 10 10
  Policy routing matches: 0 packets, 0 bytes
route-map MARKETING, permit, sequence 30
  Match clauses:
  - Continue: to next entry 40
  Set clauses:
  - as-path prepend 10 10 10
  Policy routing matches: 0 packets, 0 bytes
route-map MARKETING, permit, sequence 40
  Match clauses:
  - community (community-list filter): 10:1
  Set clauses:
  - local-preference 104
  Policy routing matches: 0 packets, 0 bytes
route-map MKTG-POLICY-MAP, permit, sequence 10
  Match clauses:
  - Set clauses:
  - community 655370
  Policy routing matches: 0 packets, 0 bytes
Configuration Examples for BGP Route-Map Continue Support for Outbound Policy

Examples: Filtering Traffic Using Continue Clauses in a BGP Route Map

The following example shows continue clause configuration in a route map sequence.

The first continue clause in route map entry 10 indicates that the route map will go to route map entry 30 if a successful match occurs. If a match does not occur, the route map will “fall through” to route map entry 20. If a successful match occurs in route map entry 20, the set action will be executed and the route map will not evaluate any additional route map entries. Only the first successful match ip address clause is supported.

If a successful match does not occur in route map entry 20, the route map will fall through to route map entry 30. This sequence does not contain a match clause, so the set clause will be automatically executed and the continue clause will go to the next route map entry because a sequence number is not specified.

If there are no successful matches, the route map will fall through to route map entry 30 and execute the set clause. A sequence number is not specified for the continue clause, so route map entry 40 will be evaluated.

There are two behaviors that can occur when the same set command is repeated in subsequent continue clause entries. For set commands that configure an additive or accumulative value (for example, set community additive, set extended community additive, and set as-path prepend), subsequent values are added by subsequent entries. The following example illustrates this behavior. After each set of match clauses, a set as-path prepend command is configured to add an autonomous system number to the as-path. After a match occurs, the route map stops evaluating match clauses and starts executing the set clauses, in the order in which they were configured. Depending on the number of successful match clauses, the as-path is prepended by one, two, or three autonomous system numbers.

```plaintext
route-map ROUTE-MAP-NAME permit 10
  match ip address 1
  match metric 10
  set as-path prepend 10
  continue 30
!
route-map ROUTE-MAP-NAME permit 20
  match ip address 2
  match metric 20
  set as-path prepend 10 10
!
route-map ROUTE-MAP-NAME permit 30
  set as-path prepend 10 10 10
  continue
!
route-map ROUTE-MAP-NAME permit 40
  match community 10:1
  set local-preference 104
```

In this example, the same set command is repeated in subsequent continue clause entries but the behavior is different from the first example. For set commands that configure an absolute value, the value from the last instance will overwrite the previous value(s). The following example illustrates this behavior. The set clause value in sequence 20 overwrites the set clause value from sequence 10. The next hop for prefixes from the 172.16/16 network is set to 10.2.2.2 and not 10.1.1.1.
ip prefix-list 1 permit 172.16.0.0/16
ip prefix-list 2 permit 192.168.1.0/24
route-map RED permit 10
  match ip address prefix-list 1
  set ip next hop 10.1.1.1
  continue 20
  exit
route-map RED permit 20
  match ip address prefix-list 2
  set ip next hop 10.2.2.2
end

Note

Route maps have a linear behavior, not a nested behavior. Once a route is matched in a route map permit entry with a continue command clause, it will not be processed by the implicit deny at the end of the route map. The following example illustrates this case.

In the following example, when routes match an AS-path of 10, 20, or 30, the routes are permitted and the continue clause jumps over the explicit deny clause to process the `match ip address prefix-list` command. If a match occurs here, the route metric is set to 100. Only routes that do not match an AS-path of 10, 20, or 30 and do match a community number of 30 are denied. To deny other routes, you must configure an explicit deny statement.

```
route-map test permit 10
  match as-path 10 20 30
  continue 30
  exit
route-map test deny 20
  match community 30
  exit
route-map test permit 30
  match ip address prefix-list 1
  set metric 100
  exit
```

## Additional References

### Related Documents

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<tr>
<th>Related Topic</th>
<th>Document Title</th>
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</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
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</table>
Technical Assistance

<table>
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<tr>
<th>Description</th>
<th>Link</th>
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<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

Feature Information for BGP Route-Map Continue Support for Outbound Policy

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
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<tbody>
<tr>
<td>BGP Route-Map Continue Support for Outbound Policy</td>
<td>12.2(33)SB</td>
<td>The BGP Route-Map Continue Support for an Outbound Policy feature introduces support for continue clauses to be applied to outbound route maps.</td>
</tr>
<tr>
<td></td>
<td>12.2(33)SRB</td>
<td>This feature was introduced on the Cisco ASR 1000 Series Routers.</td>
</tr>
<tr>
<td></td>
<td>Cisco IOS XE Release 2.1</td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER 15

Removing Private AS Numbers from the AS Path in BGP

Private autonomous system numbers (ASNs) are used by ISPs and customer networks to conserve globally unique AS numbers. Private AS numbers cannot be used to access the global Internet because they are not unique. AS numbers appear in eBGP AS paths in routing updates. Removing private ASNs from the AS path is necessary if you have been using private ASNs and you want to access the global Internet.

- Finding Feature Information, on page 357
- Restrictions on Removing and Replacing Private ASNs from the AS Path, on page 357
- Information About Removing and Replacing Private ASNs from the AS Path, on page 358
- How to Remove and Replace Private ASNs from the AS Path, on page 359
- Configuration Examples for Removing and Replacing Private ASNs from the AS Path, on page 362
- Additional References, on page 365
- Feature Information for Removing and Replacing Private ASNs from the AS Path, on page 366

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Restrictions on Removing and Replacing Private ASNs from the AS Path

- The feature applies to eBGP neighbors only.
- The feature applies to routers in a public AS only. The workaround to this restriction would be to apply the neighbor local-as command on a per-neighbor basis, with the local AS number being a public AS number.
Information About Removing and Replacing Private ASNs from the AS Path

Public and Private AS Numbers

Public AS numbers are assigned by InterNIC and are globally unique. They range from 1 to 64511. Private AS numbers are used to conserve globally unique AS numbers, and they range from 64512 to 65535. Private AS numbers cannot be leaked to a global BGP routing table because they are not unique, and BGP best path calculations require unique AS numbers. Therefore, it might be necessary to remove private AS numbers from an AS path before the routes are propagated to a BGP peer.

Benefit of Removing and Replacing Private ASNs from the AS Path

External BGP requires that globally unique AS numbers be used when routing to the global Internet. Using private AS numbers (which are not unique) would prevent access to the global Internet. This feature allows routers that belong to a private AS to access the global Internet. A network administrator configures the routers to remove private AS numbers from the AS path contained in outgoing update messages and optionally, to replace those numbers with the ASN of the local router, so that the AS Path length remains unchanged.

Former Restrictions to Removing Private ASNs from the AS Path

The ability to remove private AS numbers from the AS path has been available for a long time. Prior to Cisco IOS XE Release 3.1S, this feature had the following restrictions:

- If the AS path included both private and public AS numbers, using the `neighbor remove-private-as` command would not remove the private AS numbers.

- If the AS path contained confederation segments, using the `neighbor remove-private-as` command would remove private AS numbers only if the private AS numbers followed the confederation portion of the autonomous path.

- If the AS path contained the AS number of the eBGP neighbor, the private AS numbers would not be removed.

Enhancements to Removing Private ASNs from the AS Path

The ability to remove and replace private AS numbers from the AS path is enhanced in the following ways:

- The `neighbor remove-private-as` command will remove private AS numbers from the AS path even if the path contains both public and private ASNs.

- The `neighbor remove-private-as` command will remove private AS numbers even if the AS path contains only private AS numbers. There is no likelihood of a 0-length AS path because this command can be applied to eBGP peers only, in which case the AS number of the local router is appended to the AS path.

- The `neighbor remove-private-as` command will remove private AS numbers even if the private ASNs appear before the confederation segments in the AS path.
• The `replace-as` keyword is available to replace the private AS numbers being removed from the path with the local AS number, thereby retaining the same AS path length.

• The feature can be applied to neighbors per address family (address family configuration mode). Therefore, you can apply the feature for a neighbor in one address family and not on another, affecting update messages on the outbound side for only the address family for which the feature is configured.

• The feature can be applied in peer group template mode.

• When the feature is configured, output from the `show ip bgp update-group` and `show ip bgp neighbor` commands indicates that private AS numbers were removed or replaced.

How to Remove and Replace Private ASNs from the AS Path

Removing and Replacing Private ASNs from the AS Path (Cisco IOS XE Release 3.1S and Later)

To remove private AS numbers from the AS path on the outbound side of an eBGP neighbor, perform the following task. To also replace private AS numbers with the local router’s AS number, include the `all replace-as` keywords in Step 17.

The examples in this task reflect the configuration for Router 2 in the scenario in the figure below.

SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `interface type number`
4. `ip address ip-address mask`
5. `exit`
6. `interface type number`
7. `ip address ip-address mask`
8. `exit`
9. `interface type number`
10. `ip address ip-address mask`
11. `exit`
12. `router bgp autonomous-system-number`
13. `network network-number`
14. `network network-number`
15. `neighbor {ip-address | ipv6-address[%]} peer-group-name` `remote-as autonomous-system-number`
16. `neighbor {ip-address | ipv6-address[%]} peer-group-name` `remote-as autonomous-system-number`
17. `neighbor {ip-address | peer-group-name} remove-private-as [all [replace-as]]`
18. `end`
19. `show ip bgp update-group`
20. `show ip bgp neighbors`
## DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Router&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> interface type number</td>
<td>Configures an interface.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config)# interface gigabitethernet 0/0</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> ip address ip-address mask</td>
<td>Sets a primary or secondary IP address for an interface.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config-if)# ip address 172.30.1.1 255.255.0.0</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> exit</td>
<td>Returns to the next highest configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config-if)# exit</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> interface type number</td>
<td>Configures an interface.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config)# interface serial 0/0</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong> ip address ip-address mask</td>
<td>Sets a primary or secondary IP address for an interface.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config-if)# ip address 172.16.0.2 255.255.255.0</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong> exit</td>
<td>Returns to the next highest configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config-if)# exit</td>
<td></td>
</tr>
<tr>
<td><strong>Step 9</strong> interface type number</td>
<td>Configures an interface.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config)# interface serial 1/0</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
</tbody>
</table>
| **Step 10** | ip address *ip-address mask*  
Example:  
Router(config-if)# ip address 192.168.0.1 255.255.255.0  
Sets a primary or secondary IP address for an interface. |
| **Step 11** | exit  
Example:  
Router(config-if)# exit  
Returns to the next highest configuration mode. |
| **Step 12** | router bgp *autonomous-system-number*  
Example:  
Router(config)# router bgp 5  
Specifies a BGP instance. |
| **Step 13** | network *network-number*  
Example:  
Router(config-router)# network 172.30.0.0  
Specifies a network to be advertised by BGP. |
| **Step 14** | network *network-number*  
Example:  
Router(config-router)# network 192.168.0.0  
Specifies a network to be advertised by BGP. |
| **Step 15** | neighbor {ip-address | ipv6-address[|peer-group-name]} remote-as *autonomous-system-number*  
Example:  
Router(config-router)# neighbor 172.16.0.1 remote-as 65000  
Adds an entry to the routing table.  
• This example configures Router 3 as an eBGP neighbor in private AS 65000. |
| **Step 16** | neighbor {ip-address | ipv6-address[|peer-group-name]} remote-as *autonomous-system-number*  
Example:  
Router(config-router)# neighbor 192.168.0.2 remote-as 1  
Adds an entry to the routing table.  
• This example configures Router 1 as an eBGP neighbor in public AS 1. |
| **Step 17** | neighbor {ip-address | peer-group-name} remove-private-as [all | replace-as]  
Example:  
Router(config-router)# neighbor 192.168.0.2 remove-private-as all replace-as  
Removes private AS numbers from the AS Path in outgoing updates.  
• This example removes the private AS numbers from the AS path in outgoing eBGP updates and replaces them with 5, which is the public AS number of the local router. |
### Configuration Examples for Removing and Replacing Private ASNs from the AS Path

#### Example Removing Private ASNs (Cisco IOS XE Release 3.1S)

In the example below, Router A has the `neighbor remove-private-as` command configured, which removes private AS numbers in updates sent to the neighbor at 172.30.0.7. The subsequent `show` command asks for information about the route to host 1.1.1.1. The output includes private AS numbers 65200, 65201, 65201 in the AS path of 1001652006520165201100210031003.

To prove that the private AS numbers were removed from the AS path, the `show` command on Router B also asks for information about the route to host 1.1.1.1. The output indicates a shorter AS path of 1001001100210031003, which excludes private AS numbers 65200, 65201, and 65201. The 100 prepended in the path is Router B’s own AS number.

**Router A**

```
routing bgp 100  
  bgp log-neighbor-changes  
  neighbor 19.0.101.1 remote-as 1001  
  neighbor 172.30.0.7 remote-as 200  
  neighbor 172.30.0.7 remove-private-as all  
  no auto-summary
```

```
RouterA# show ip bgp 1.1.1.1  
BGP routing table entry for 1.1.1.1/32, version 2  
Paths: (1 available, best #1, table default)  
  Advertised to update-groups:  
    1 2  
    1001 65200 65201 65201 1002 1003 1003  
    19.0.101.1 from 19.0.101.1 (19.0.101.1)  
  Origin IGP, localpref 100, valid, external, best RouterA#
```
Router B (All Private ASNs Have Been Removed)

RouterB# show ip bgp 1.1.1.1
BGP routing table entry for 1.1.1.1/32, version 3
Paths: (1 available, best #1, table default)
  Not advertised to any peer
  100 1001 1002 1003 1003
    172.30.0.6 from 172.30.0.6 (19.1.0.1)
    Origin IGP, localpref 100, valid, external, best

Example Removing and Replacing Private ASNs (Cisco IOS XE Release 3.1S)

In the following example, when Router A sends prefixes to the peer 172.30.0.7, all private ASNs in the AS path are replaced with the router’s own ASN, which is 100.

Router A

router bgp 100
  bgp log-neighbor-changes
  neighbor 172.16.101.1 remote-as 1001
  neighbor 172.16.101.1 update-source Loopback0
  neighbor 172.30.0.7 remote-as 200
  neighbor 172.30.0.7 remove-private-as all replace-as
  no auto-summary

Router A receives 1.1.1.1 from peer 172.16.101.1 which has some private ASNs (65200, 65201, and 65201) in the AS path list, as shown in the following output:

RouterA# show ip bgp 1.1.1.1
BGP routing table entry for 1.1.1.1/32, version 2
Paths: (1 available, best #1, table default)
  Advertised to update-groups:
    1 2
    1001 65200 65201 65201 1002 1003 1003
    172.16.101.1 from 172.16.101.1 (172.16.101.1)
    Origin IGP, localpref 100, valid, external, best

Because Router A is configured with neighbor 172.30.0.7 remove-private-as all replace-as, Router A sends prefix 1.1.1.1 with all private ASNs replaced with 100:

Router B

RouterB# show ip bgp 1.1.1.1
BGP routing table entry for 1.1.1.1/32, version 3
Paths: (1 available, best #1, table default)
  Not advertised to any peer
  100 1001 100 100 1002 1003 1003
    172.30.0.6 from 172.30.0.6 (192.168.1.2)
    Origin IGP, localpref 100, valid, external, best

Router B

router bgp 200
  bgp log-neighbor-changes
  neighbor 172.30.0.6 remote-as 100
  no auto-summary
Example Removing Private ASNs (Cisco IOS XE Release 2)

In this example, Router 3 uses private ASN 65000. Router 1 and Router 2 use public ASNs AS 1 and AS 5 respectively.

The figure below illustrates Router 2 belonging to a service provider, with Router 1 and Router 3 as its clients.

Figure 35: Removing Private AS Numbers

In this example, Router 2, belonging to the Service Provider, removes private AS numbers as follows.

1. Router 3 advertises the network 10.0.0.0/24 with the AS path attribute 65000 to Router 2.

2. Router 2 receives the update from Router 3 and makes an entry for the network 10.0.0.0/24 in its routing table with the next hop as 172.16.0.1 (serial interface S0 on Router 3).

3. Router 2 (service provider device), when configured with the `neighbor 192.168.0.2 remove-private-as` command, strips off the private AS number and constructs a new update packet with its own AS number as the AS path attribute for the 10.0.0.0/24 network and sends the packet to Router 1.

4. Router 1 receives the eBGP update for network 10.0.0.0/24 and makes an entry in its routing table with the next hop as 192.168.0.1 (serial interface S1 on Router 2). The AS path attribute for this network as seen on Router 1 is AS 5 (Router 2). Thus, the private AS numbers are prevented from entering the BGP tables of the Internet.

The configurations of Router 3, Router 2, and Router 1 follow.

**Router 3**

```plaintext
interface gigabitethernet 0/0
 ip address 10.0.0.1 255.255.255.0
!
interface Serial 0
 ip address 172.16.0.1 255.255.255.0
!
routing bgp 65000
 network 10.0.0.0 mask 255.255.255.0
```

In this example, Router 2, belonging to the Service Provider, removes private AS numbers as follows.
neighbor 172.16.0.2 remote-as 5
!---Configures Router 2 as an eBGP neighbor in public AS 5.
end

Router 2

interface gigabitethernet 0/0
 ip address 172.30.1.1 255.255.0.0
!
interface Serial 0
 ip address 172.16.0.2 255.255.255.0
!
interface Serial 1
 ip address 192.168.0.1 255.255.255.0
!
router bgp 5
 network 172.30.0.0
 network 192.168.0.0
 neighbor 172.16.0.1 remote-as 65000
!---Configures Router 3 as an eBGP neighbor in private AS 65000.
 neighbor 192.168.0.2 remote-as 1
!---Configures Router 1 as an eBGP neighbor in public AS 1.
 neighbor 192.168.0.2 remove-private-as
!---Removes the private AS numbers from outgoing eBGP updates.
end

Router 1

version 12.2
!
!
interface Serial 0
 ip address 192.168.0.2 255.255.255.0
!
router bgp 1
 neighbor 192.168.0.1 remote-as 5
!---Configures Router 2 as an eBGP neighbor in public AS 5.
end

Additional References

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<tr>
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<td>Cisco IOS Master Commands List, All Releases</td>
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<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
</tbody>
</table>
Feature Information for Removing and Replacing Private ASNs from the AS Path

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.
Table 31: Feature Information for BGP--Remove/Replace Private AS

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP--Remove/Replace Private AS Filter</td>
<td>Cisco IOS XE</td>
<td>Private autonomous system (AS) numbers are used by ISPs and customer networks to conserve globally unique AS numbers. Private AS numbers cannot be used to access the global Internet because they are not unique. AS numbers appear in eBGP AS paths in routing tables. Removing private AS numbers from the AS path is necessary if you have been using private AS numbers and you want to access the global Internet. The following command is modified:</td>
</tr>
<tr>
<td></td>
<td>Release 3.1S</td>
<td></td>
</tr>
</tbody>
</table>

- `neighbor remove-private-as`
Configuring BGP Neighbor Session Options

This module describes configuration tasks to configure various options involving Border Gateway Protocol (BGP) neighbor peer sessions. BGP is an interdomain routing protocol designed to provide loop-free routing between organizations. This module contains tasks that use BGP neighbor session commands to configure:

• Options to help an autonomous system migration
• TTL Security Check, a lightweight security mechanism to protect External BGP (eBGP) peering sessions from CPU-utilization-based attacks

Finding Feature Information, on page 369
Information About Configuring BGP Neighbor Session Options, on page 369
How to Configure BGP Neighbor Session Options, on page 373
Configuration Examples for BGP Neighbor Session Options, on page 392
Where to Go Next, on page 394
Additional References, on page 394
Feature Information for Configuring BGP Neighbor Session Options, on page 396

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About Configuring BGP Neighbor Session Options

BGP Neighbor Sessions

BGP is mainly used to connect a local network to an external network to gain access to the Internet or to connect to other organizations. A BGP-speaking router does not discover another BGP-speaking device
automatically. A network administrator usually manually configures the relationships between BGP-speaking routers.

A BGP neighbor device is a BGP-speaking router that has an active TCP connection to another BGP-speaking device. This relationship between BGP devices is often referred to as a peer instead of neighbor because a neighbor may imply the idea that the BGP devices are directly connected with no other router in between. Configuring BGP neighbor or peer sessions uses BGP neighbor session commands so this module uses the term “neighbor” over “peer.”

BGP Support for Fast Peering Session Deactivation

BGP Hold Timer

By default, the BGP hold timer is set to run every 180 seconds in Cisco software. This timer value is set as the default to protect the BGP routing process from instability that can be caused by peering sessions with other routing protocols. BGP devices typically carry large routing tables, so frequent session resets are not desirable.

BGP Fast Peering Session Deactivation

BGP fast peering session deactivation improves BGP convergence and response time to adjacency changes with BGP neighbors. This feature is event driven and configured on a per-neighbor basis. When this feature is enabled, BGP will monitor the peering session with the specified neighbor. Adjacency changes are detected and terminated peering sessions are deactivated in between the default or configured BGP scanning interval.

Selective Address Tracking for BGP Fast Session Deactivation

In Cisco IOS Release 12.4(4)T, 12.2(31)SB, 12.2(33)SRB, and later releases, the BGP Selective Address Tracking feature introduced the use of a route map with BGP fast session deactivation. The route-map keyword and map-name argument are used with the neighbor fall-over BGP neighbor session command to determine if a peering session with a BGP neighbor should be reset when a route to the BGP peer changes. The route map is evaluated against the new route, and if a deny statement is returned, the peer session is reset. The route map is not used for session establishment.

Note

The neighbor fall-over command is not supported in Cisco IOS Release 15.0(1)SY. The route-map and map-name keyword-argument pair in the bgp nexthop command are not supported in Cisco IOS Release 15.0(1)SY.

Note

Only match ip address and match source-protocol commands are supported in the route map. No set commands or other match commands are supported.

BFD Support of BGP IPv6 Neighbors

In Cisco IOS Release 15.1(2)S and later releases, Bidirectional Forwarding Detection (BFD) can be used to track fast forwarding path failure of BGP neighbors that have an IPv6 address. BFD is a detection protocol that is designed to provide fast forwarding path failure detection times for all media types, encapsulations,
topologies, and routing protocols. BFD provides faster reconvergence time for BGP after a forwarding path failure.

**TTL Security Check for BGP Neighbor Sessions**

**BGP Support for the TTL Security Check**

When implemented for BGP, the TTL Security Check feature introduces a lightweight security mechanism to protect eBGP neighbor sessions from CPU utilization-based attacks. These types of attacks are typically brute force Denial of Service (DoS) attacks that attempt to disable the network by flooding the network with IP packets that contain forged source and destination IP addresses.

The TTL Security Check feature protects the eBGP neighbor session by comparing the value in the TTL field of received IP packets against a hop count that is configured locally for each eBGP neighbor session. If the value in the TTL field of the incoming IP packet is greater than or equal to the locally configured value, the IP packet is accepted and processed normally. If the TTL value in the IP packet is less than the locally configured value, the packet is silently discarded and no Internet Control Message Protocol (ICMP) message is generated. This is designed behavior; a response to a forged packet is unnecessary.

Although it is possible to forge the TTL field in an IP packet header, accurately forging the TTL count to match the TTL count from a trusted peer is impossible unless the network to which the trusted peer belongs has been compromised.

The TTL Security Check feature supports both directly connected neighbor sessions and multihop eBGP neighbor sessions. The BGP neighbor session is not affected by incoming packets that contain invalid TTL values. The BGP neighbor session will remain open, and the router will silently discard the invalid packet. The BGP session, however, can still expire if keepalive packets are not received before the session timer expires.

**TTL Security Check Support for Multihop BGP Neighbor Sessions**

The BGP Support for TTL Security Check feature is configured with the `neighbor ttl-security` command in router configuration mode or address family configuration mode. When this feature is enabled, BGP will establish or maintain a session only if the TTL value in the IP packet header is equal to or greater than the TTL value configured for the peering session. Enabling this feature secures the eBGP session in the incoming direction only and has no effect on outgoing IP packets or the remote router. The `hop-count` argument is used to configure the maximum number of hops that separate the two peers. The TTL value is determined by the router from the configured hop count. The value for this argument is a number from 1 to 254.

The BGP Support for TTL Security Check feature supports both directly connected neighbor sessions and multihop neighbor sessions. When this feature is configured for a multihop neighbor session, the `neighbor ebgp-multihop` router configuration command cannot be configured and is not needed to establish the neighbor session. These commands are mutually exclusive, and only one command is required to establish a multihop neighbor session. If you attempt to configure both commands for the same peering session, an error message will be displayed in the console.

To configure this feature for an existing multihop session, you must first disable the existing neighbor session with the `no neighbor ebgp-multihop` command. The multihop neighbor session will be restored when you enable this feature with the `neighbor ttl-security` command.
This feature should be configured on each participating router. To maximize the effectiveness of this feature, the hop-count argument should be strictly configured to match the number of hops between the local and external network. However, you should also consider path variation when configuring this feature for a multihop neighbor session.

**Benefits of the BGP Support for TTL Security Check**

The BGP Support for TTL Security Check feature provides an effective and easy-to-deploy solution to protect eBGP neighbor sessions from CPU utilization-based attacks. When this feature is enabled, a host cannot attack a BGP session if the host is not a member of the local or remote BGP network or if the host is not directly connected to a network segment between the local and remote BGP networks. This solution greatly reduces the effectiveness of DoS attacks against a BGP autonomous system.

**BGP Support for TCP Path MTU Discovery per Session**

**Path MTU Discovery**

The IP protocol family was designed to use a wide variety of transmission links. The maximum IP packet length is 65000 bytes. Most transmission links enforce a smaller maximum packet length limit, called the maximum transmission unit (MTU), which varies with the type of the transmission link. The design of IP accommodates link packet length limits by allowing intermediate routers to fragment IP packets as necessary for their outgoing links. The final destination of an IP packet is responsible for reassembling its fragments as necessary.

All TCP sessions are bounded by a limit on the number of bytes that can be transported in a single packet, and this limit is known as the maximum segment size (MSS). TCP breaks up packets into chunks in a transmit queue before passing packets down to the IP layer. A smaller MSS may not be fragmented at an IP device along the path to the destination device, but smaller packets increase the amount of bandwidth needed to transport the packets. The maximum TCP packet length is determined by both the MTU of the outbound interface on the source device and the MSS announced by the destination device during the TCP setup process.

Path MTU discovery (PMTUD) was developed as a solution to the problem of finding the optimal TCP packet length. PMTUD is an optimization (detailed in RFC 1191) wherein a TCP connection attempts to send the longest packets that will not be fragmented along the path from source to destination. It does this by using a flag, don’t fragment (DF), in the IP packet. This flag is supposed to alter the behavior of an intermediate router that cannot send the packet across a link because it is too long. Normally the flag is off, and the router should fragment the packet and send the fragments. If a router tries to forward an IP datagram, with the DF bit set, to a link that has a lower MTU than the size of the packet, the router will drop the packet and return an ICMP Destination Unreachable message to the source of this IP datagram, with the code indicating “fragmentation needed and DF set.” When the source device receives the ICMP message, it will lower the send MSS, and when TCP retransmits the segment, it will use the smaller segment size.

**BGP Neighbor Session TCP PMTUD**

TCP path MTU discovery is enabled by default for all BGP neighbor sessions, but there are situations when you may want to disable TCP path MTU discovery for one or all BGP neighbor sessions. Although PMTUD works well for larger transmission links (for example, Packet over Sonet links), a badly configured TCP implementation or a firewall may slow or stop the TCP connections from forwarding any packets. In this type of situation, you may need to disable TCP path MTU discovery.

In Cisco software, configuration options were introduced to permit TCP path MTU discovery to be disabled, or subsequently reenabled, either for a single BGP neighbor session or for all BGP sessions. To disable the
TCP path MTU discovery globally for all BGP neighbors, use the `no bgp transport path-mtu-discovery` command in router configuration mode. To disable the TCP path MTU discovery for a single neighbor, use the `no neighbor transport path-mtu-discovery` command in router configuration mode or address family configuration mode. For more details, see the “Disabling TCP Path MTU Discovery Globally for All BGP Sessions” section or the “Disabling TCP Path MTU Discovery for a Single BGP Neighbor” section.

## How to Configure BGP Neighbor Session Options

### Configuring Fast Session Deactivation

The tasks in this section show how to configure BGP next-hop address tracking. BGP next-hop address tracking significantly improves the response time of BGP to next-hop changes in the RIB. However, unstable Interior Gateway Protocol (IGP) peers can introduce instability to BGP neighbor sessions. We recommend that you aggressively dampen unstable IGP peering sessions to reduce the possible impact to BGP. For more details about route dampening, see the “Configuring Internal BGP Features” module.

### Configuring Fast Session Deactivation for a BGP Neighbor

Perform this task to establish a peering session with a BGP neighbor and then configure the peering session for fast session deactivation to improve the network convergence time if the peering session is deactivated.

Enabling fast session deactivation for a BGP neighbor can significantly improve BGP convergence time. However, unstable IGP peers can still introduce instability to BGP neighbor sessions. We recommend that you aggressively dampen unstable IGP peering sessions to reduce the possible impact to BGP.

### SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. Enter one of the following commands:
   - `address-family ipv4 [unicast [vrf vrf-name] | vrf vrf-name]`
   - `address-family ipv6 [unicast [vrf vrf-name] | vrf vrf-name]`
5. neighbor ip-address remote-as autonomous-system-number
6. neighbor ip-address fall-over
7. end

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device&gt; enable</td>
<td></td>
</tr>
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</table>

---

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<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Device# configure terminal</td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode to create or configure a BGP routing process.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Device(config)# router bgp 50000</td>
</tr>
<tr>
<td><strong>Step 4</strong> Enter one of the following commands:</td>
<td>Enters address family configuration mode and enables IPv4 or IPv6 addressing. Perform this step when configuring fast session deactivation for a VRF address-family.</td>
</tr>
<tr>
<td>- address-family ipv4 [unicast [vrf vrf-name]</td>
<td>Note: Step 4 is only required if you are configuring fast session deactivation on a VRF. If you are not configuring fast session deactivation on a VRF, skip this step and perform the following commands under router BGP mode (config-router) rather than address family configuration mode (config-router-af).</td>
</tr>
<tr>
<td>vrf vrf-name]</td>
<td></td>
</tr>
<tr>
<td>- address-family ipv6 [unicast [vrf vrf-name]</td>
<td></td>
</tr>
<tr>
<td>vrf vrf-name]</td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Device(config-router)# address-family ipv4 unicast vrf blue</td>
</tr>
<tr>
<td><strong>Step 5</strong> neighbor ip-address remote-as autonomous-system-number</td>
<td>Establishes a peering session with a BGP neighbor.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Device(config-router-af)# neighbor 10.0.0.1 remote-as 50000</td>
</tr>
<tr>
<td><strong>Step 6</strong> neighbor ip-address fall-over</td>
<td>Configures the BGP peering to use fast session deactivation.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Device(config-router-af)# neighbor 10.0.0.1 fall-over</td>
</tr>
<tr>
<td><strong>Step 7</strong> end</td>
<td>Exits address family configuration mode and enters privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Device(config-router-af)# end</td>
</tr>
</tbody>
</table>

**Configuring Selective Address Tracking for Fast Session Deactivation**

Perform this task to configure selective address tracking for fast session deactivation. The optional `route-map` keyword and `map-name` argument of the `neighbor fall-over` command are used to determine if a peering session with a BGP neighbor should be deactivated (reset) when a route to the BGP peer changes. The route map is evaluated against the new route, and if a deny statement is returned, the peer session is reset.
Only `match ip address` and `match source-protocol` commands are supported in the route map. No `set` commands or other `match` commands are supported.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `neighbor {ip-address | peer-group-name} remote-as autonomous-system-number`
5. `neighbor ip-address fall-over [route-map map-name]`
6. `exit`
7. `ip prefix-list list-name [seq seq-value] [deny network / length | permit network / length] [ge ge-value] [le le-value]`
8. `route-map map-name [permit | deny] [sequence-number]`
9. `match ip address prefix-list prefix-list-name [prefix-list-name...]`
10. `end`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** | `enable` | Enables privileged EXEC mode.  
Example:  
```
Device> enable
``` |
| **Step 2** | `configure terminal` | Enters global configuration mode.  
Example:  
```
Device# configure terminal
``` |
| **Step 3** | `router bgp autonomous-system-number` | Enters router configuration mode for the specified routing process.  
Example:  
```
Device(config)# router bgp 45000
``` |
| **Step 4** | `neighbor {ip-address | peer-group-name} remote-as autonomous-system-number` | Adds the IP address or peer group name of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local router.  
Example:  
```
Device(config-router)# neighbor 192.168.1.2 remote-as 40000
``` |
| **Step 5** | `neighbor ip-address fall-over [route-map map-name]` | Applies a route map when a route to the BGP changes.  
Example:  
```
``` |
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device(config-router)# neighbor 192.168.1.2 fall-over route-map CHECK-NBR</td>
<td>• In this example, the route map named CHECK-NBR is applied when the route to neighbor 192.168.1.2 changes.</td>
</tr>
</tbody>
</table>

**Step 6**

**exit**

**Example:**

Device(config-router)# exit

Exits router configuration mode and enters global configuration mode.

**Step 7**

**ip prefix-list list-name [seq seq-value] [deny network [length] | permit network [length] [ge ge-value] [le le-value]]**

**Example:**

Device(config)# ip prefix-list FILTER28 seq 5 permit 0.0.0.0/0 ge 28

Creates a prefix list for BGP next-hop route filtering.

• Selective next-hop route filtering supports prefix-length matching or source-protocol matching on a per-address family basis.

• The example creates a prefix list named FILTER28 that permits routes only if the mask length is greater than or equal to 28.

**Step 8**

**route-map map-name [permit | deny] [sequence-number]**

**Example:**

Device(config)# route-map CHECK-NBR permit 10

Configures a route map and enters route-map configuration mode.

• In this example, a route map named CHECK-NBR is created. If there is an IP address match in the following match command, the IP address will be permitted.

**Step 9**

**match ip address prefix-list prefix-list-name [prefix-list-name...]**

**Example:**

Device(config-route-map)# match ip address prefix-list FILTER28

Matches the IP addresses in the specified prefix list.

• Use the prefix-list-name argument to specify the name of a prefix list. The ellipsis means that more than one prefix list can be specified.

**Note** Only the syntax applicable to this task is used in this example. For more details, see the Cisco IOS IP Routing: BGP Command Reference.

**Step 10**

**end**

**Example:**

Device(config-route-map)# end

Exits route-map configuration mode and enters privileged EXEC mode.

**What to Do Next**

After the peer policy template is created, the configuration of the peer policy template can be inherited or applied by another peer policy template. For details about peer policy inheritance, see the “Configuring Peer Policy Template Inheritance with the inherit peer-policy Command” section or the “Configuring Peer Policy Template Inheritance with the neighbor inherit peer-policy Command” section.
Configuring BFD for BGP IPv6 Neighbors

In Cisco IOS Release 15.1(2)S and later releases, Bidirectional Forwarding Detection (BFD) can be used for BGP neighbors that have an IPv6 address.

Once it has been verified that BFD neighbors are up, the `show bgp ipv6 unicast neighbors` command will indicate that BFD is being used to detect fast fallover on the specified neighbor.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `ipv6 unicast-routing`
4. `ipv6 cef`
5. `interface type number`
6. `ipv6 address ipv6-address / prefix-length`
7. `bfd interval milliseconds min_rx milliseconds multiplier multiplier-value`
8. `no shutdown`
9. `exit`
10. `router bgp autonomous-system-number`
11. `no bgp default ipv4-unicast`
12. `address-family ipv6 [vrf vrf-name] [unicast | multicast | vpnv6]`
13. `neighbor ipv6-address remote-as autonomous-system-number`
14. `neighbor ipv6-address fall-over bfd`
15. `exit`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device&gt; enable</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><code>configure terminal</code></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device# configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Enables the forwarding of IPv6 unicast datagrams.</td>
</tr>
<tr>
<td><code>ipv6 unicast-routing</code></td>
<td>Enables the forwarding of IPv6 unicast datagrams.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config)# ipv6 unicast-routing</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>Enables Cisco Express Forwarding for IPv6.</td>
</tr>
<tr>
<td><code>ipv6 cef</code></td>
<td>Enables Cisco Express Forwarding for IPv6.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config)# ipv6 cef</code></td>
<td></td>
</tr>
<tr>
<td>Step</td>
<td>Command or Action</td>
</tr>
<tr>
<td>------</td>
<td>------------------</td>
</tr>
<tr>
<td>5</td>
<td><strong>interface</strong> <em>type number</em> &lt;br&gt;Example: &lt;br&gt;Device(config)# interface fastethernet 0/1</td>
</tr>
<tr>
<td>6</td>
<td>ipv6 address <em>ipv6-address</em> / <em>prefix-length</em> &lt;br&gt;Example: &lt;br&gt;Device(config-if)# ipv6 address 2001:DB8:1:1::1/64</td>
</tr>
<tr>
<td>7</td>
<td>bfd interval <em>milliseconds</em> min_rx <em>milliseconds</em> multiplier <em>multiplier-value</em> &lt;br&gt;Example: &lt;br&gt;Device(config-if)# bfd interval 500 min_rx 500 multiplier 3</td>
</tr>
<tr>
<td>8</td>
<td>no shutdown &lt;br&gt;Example: &lt;br&gt;Device(config-if)# no shutdown</td>
</tr>
<tr>
<td>9</td>
<td>exit &lt;br&gt;Example: &lt;br&gt;Device(config-if)# exit</td>
</tr>
<tr>
<td>10</td>
<td>router bgp <em>autonomous-system-number</em> &lt;br&gt;Example: &lt;br&gt;Device(config)# router bgp 40000</td>
</tr>
</tbody>
</table>
| 11   | no bgp default ipv4-unicast <br>Example: <br>Device(config-router)# no bgp default ipv4-unicast | Disables the default IPv4 unicast address family for establishing peering sessions.  
  * We recommend configuring this command in the global scope. |
| 12   | address-family ipv6 [vrf _vrf-name_] [unicast | multicast | vpnv6] <br>Example: <br>Device(config-router)# address-family ipv6 | Enters address family configuration mode and enables IPv6 addressing. |
| 13   | neighbor _ipv6-address_ remote-as _autonomous-system-number_ <br>Example: | Adds the IP address of the neighbor in the specified autonomous system to the IPv6 BGP neighbor table of the local router. |
### Configuring BGP Neighbor Session Options

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device(config-router-af)# neighbor 2001:DB8:2:1::4 remote-as 45000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 14</strong> neighbor_ipv6-address fall-over bfd</td>
<td>Enables BGP to monitor the peering session of an IPv6 neighbor using BFD.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config-router-af)# neighbor 2001:DB8:2:1::4 fall-over bfd</td>
<td></td>
</tr>
<tr>
<td><strong>Step 15</strong> end</td>
<td>Exits address family configuration mode and enters privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config-router-af)# end</td>
<td></td>
</tr>
</tbody>
</table>

### Configuring the TTL Security Check for BGP Neighbor Sessions

Perform this task to allow BGP to establish or maintain a session only if the TTL value in the IP packet header is equal to or greater than the TTL value configured for the BGP neighbor session.

**Before you begin**

- To maximize the effectiveness of the BGP Support for TTL Security Check feature, we recommend that you configure it on each participating router. Enabling this feature secures the eBGP session in the incoming direction only and has no effect on outgoing IP packets or the remote router.

**Note**

- The `neighbor ebgp-multihop` command is not needed when the BGP Support for TTL Security Check feature is configured for a multihop neighbor session and should be disabled before configuring this feature.
- The effectiveness of the BGP Support for TTL Security Check feature is reduced in large-diameter multihop peerings. In the event of a CPU utilization-based attack against a BGP router that is configured for large-diameter peering, you may still need to shut down the affected neighbor sessions to handle the attack.
- This feature is not effective against attacks from a peer that has been compromised inside of the local and remote network. This restriction also includes peers that are on the network segment between the local and remote network.

**SUMMARY STEPS**

1. enable
2. trace [protocol] destination
3. configure terminal
4. router bgp autonomous-system-number
5. neighbor ip-address ttl-security hops hop-count
6. end
7. `show running-config`
8. `show ip bgp neighbors [ip-address]`

## DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1**

*enable*

**Example:**

Device> Enable

| **Step 2**

*trace [protocol] destination*

**Example:**

Device# trace ip 10.1.1.1

| **Step 3**

*configure terminal*

**Example:**

Device# Configure terminal

| **Step 4**

*router bgp autonomous-system-number*

**Example:**

Device(config)# Router bgp 65000

| **Step 5**

*neighbor ip-address ttl-security hops hop-count*

**Example:**

Device(config-router)# neighbor 10.1.1.1 ttl-security hops 2

**Purpose**

- Enables privileged EXEC mode.
  - Enter your password if prompted.

- Discovers the routes of the specified protocol that packets will actually take when traveling to their destination.
  - Enter the `trace` command to determine the number of hops to the specified peer.

- Enters global configuration mode.

- Enters router configuration mode, and creates a BGP routing process.

- Configures the maximum number of hops that separate two peers.
  - The `hop-count` argument is set to the number of hops that separate the local and remote peer. If the expected TTL value in the IP packet header is 254, then the number 1 should be configured for the `hop-count` argument. The range of values is a number from 1 to 254.
  - When the BGP Support for TTL Security Check feature is enabled, BGP will accept incoming IP packets with a TTL value that is equal to or greater than the expected TTL value. Packets that are not accepted are discarded.
  - The example configuration sets the expected incoming TTL value to at least 253, which is 255 minus the TTL value of 2, and this is the minimum TTL value expected from the BGP peer. The local router will accept the peering session from the 10.1.1.1 neighbor only if it is one or two hops away.
### Command or Action | Purpose
---|---
**Step 6** | Exits router configuration mode and enters privileged EXEC mode.
**end** | 
**Example:**
```
Device(config-router)# end
```
**Step 7** | (Optional) Displays the contents of the currently running configuration file.
**show running-config** | 
**Example:**
```
Device# show running-config | begin bgp
```
**Step 8** | (Optional) Displays information about the TCP and BGP connections to neighbors.
**show ip bgp neighbors** **[ip-address]** | 
**Example:**
```
Device# show ip bgp neighbors 10.4.9.5
```

### Examples

The configuration of the BGP Support for TTL Security Check feature can be verified with the `show running-config` and `show ip bgp neighbors` commands. This feature is configured locally on each peer, so there is no remote configuration to verify.

The following is sample output from the `show running-config` command. The output shows that neighbor 10.1.1.1 is configured to establish or maintain the neighbor session only if the expected TTL count in the incoming IP packet is 253 or 254.

```
Router# show running-config
| begin bgp

router bgp 65000
  no synchronization
  bgp log-neighbor-changes
  neighbor 10.1.1.1 remote-as 55000
  neighbor 10.1.1.1 ttl-security hops 2
  no auto-summary
```
The following is sample output from the `show ip bgp neighbors` command. The output shows that the local router will accept packets from the 10.1.1.1 neighbor if it is no more than 2 hops away. The configuration of this feature is displayed in the address family section of the output. The relevant line is shown in bold in the output.

```shell
Router# show ip bgp neighbors 10.1.1.1
BGP neighbor is 10.1.1.1, remote AS 55000, external link
BGP version 4, remote router ID 10.2.2.22
BGP state = Established, up for 00:59:21
Last read 00:00:21, hold time is 180, keepalive interval is 60 seconds
Neighbor capabilities:
  Route refresh: advertised and received(new)
  Address family IPv4 Unicast: advertised and received
Message statistics:
  InQ depth is 0
  OutQ depth is 0
  Sent         Rcvd
  Opens:       2             2
  Notifications: 0           0
  Updates:     0             0
  Keepalives:  226           227
  Route Refresh: 0           0
  Total:       228           229
Default minimum time between advertisement runs is 5 seconds
For address family: IPv4 Unicast
BGP table version 1, neighbor version 1/0
Output queue sizes : 0 self, 0 replicated
Index 1, Offset 0, Mask 0x2
Member of update-group 1
Prefix activity: Sent Rcvd
  Prefixes Current:       0     0
  Prefixes Total:         0     0
  Implicit Withdraw:      n/a    0
  Explicit Withdraw:      n/a    0
  Used as bestpath:       n/a    0
  Used as multipath:      n/a    0
  Outbound Inbound
Local Policy Denied Prefixes: 0
Total: 0
Number of NLRIs in the update sent: max 0, min 0
Connections established 2; dropped 1
Last reset 00:59:50, due to User reset
External BGP neighbor may be up to 2 hops away.
Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Local host: 10.2.2.22, Local port: 179
Foreign host: 10.1.1.1, Foreign port: 11001
Enqueued packets for retransmit: 0, input: 0 mis-ordered: 0 (0 bytes)
Event Timers (current time is 0xCC28EC):
  Timer      Starts  Wakeups  Next
  Retrans   63       0        0x0
  TimeWait  0        0        0x0
  AckHold  62       50       0x0
  SendWnd  0        0        0x0
  KeepAlive 0        0        0x0
  GiveUp   0        0        0x0
  PmtuAger 0        0        0x0
  DeadWait 0        0        0x0
iss: 712702676  snduna: 712703881  sdnxtn: 712703881  sndwnd: 15180
```

### Configuring BGP Neighbor Session Options

<table>
<thead>
<tr>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>TTL Security Check</td>
</tr>
<tr>
<td>Session Options</td>
</tr>
</tbody>
</table>

**Configuring the TTL Security Check for BGP Neighbor Sessions**

...
Configuring BGP Support for TCP Path MTU Discovery per Session

This section contains the following tasks:

Disabling TCP Path MTU Discovery Globally for All BGP Sessions

Perform this task to disable TCP path MTU discovery for all BGP sessions. TCP path MTU discovery is enabled by default when you configure BGP sessions, but we recommend that you enter the `show ip bgp neighbors` command to ensure that TCP path MTU discovery is enabled.

Before you begin

This task assumes that you have previously configured BGP neighbors with active TCP connections.

SUMMARY STEPS

1. `enable`
2. `show ip bgp neighbors [ip-address]`
3. `configure terminal`
4. `router bgp autonomous-system-number`
5. `no bgp transport path-mtu-discovery`
6. `end`
7. `show ip bgp neighbors [ip-address]`

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td><strong>Step 2</strong></td>
</tr>
<tr>
<td><code>enable</code></td>
<td><code>show ip bgp neighbors [ip-address]</code></td>
</tr>
<tr>
<td>Example:</td>
<td>Example:</td>
</tr>
<tr>
<td>Device&gt; enable</td>
<td>Device# show ip bgp neighbors</td>
</tr>
</tbody>
</table>

Enables privileged EXEC mode.

- Enter your password if prompted.

(Optional) Displays information about the TCP and BGP connections to neighbors.

- Use this command to determine whether BGP neighbors have TCP path MTU discovery enabled.

**Note** Only the syntax applicable to this task is used in this example. For more details, see the *Cisco IOS IP Routing: BGP Command Reference*.
### Purpose

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 3</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode to create or configure a BGP routing process.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# router bgp 50000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> no bgp transport path-mtu-discovery</td>
<td>Disables TCP path MTU discovery for all BGP sessions.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router)# no bgp transport path-mtu-discovery</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> end</td>
<td>Exits router configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router)# end</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong> show ip bgp neighbors [ip-address]</td>
<td>(Optional) Displays information about the TCP and BGP connection to neighbors.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device# show ip bgp neighbors</td>
<td></td>
</tr>
</tbody>
</table>

#### Examples

The following sample output from the `show ip bgp neighbors` command shows that TCP path MTU discovery is enabled for BGP neighbors. Two entries in the output—Transport(tcp) path-mtu-discovery is enabled and path mtu capable—show that TCP path MTU discovery is enabled.

```
Router# show ip bgp neighbors

BGP neighbor is 172.16.1.2, remote AS 45000, internal link
   BGP version 4, remote router ID 172.16.1.99
   .
   .
   For address family: IPv4 Unicast
   BGP table version 5, neighbor version 5/0
   .
   .
```

**Note** Only the syntax applicable to this task is used in this example. For more details, see the *Cisco IOS IP Routing: BGP Command Reference*. 
Address tracking is enabled, the RIB does have a route to 172.16.1.2
Address tracking requires at least a /24 route to the peer
Connections established 3; dropped 2
Last reset 00:00:35, due to Router ID changed
Transport(tcp) path-mtu-discovery is enabled

SRTT: 146 ms, RTTO: 1283 ms, RTV: 1137 ms, KRTT: 0 ms
minRTT: 8 ms, maxRTT: 300 ms, ACK hold: 200 ms
Flags: higher precedence, retransmission timeout, nagle, path mtu capable

The following is sample output from the show ip bgp neighbors command after the no bgp transport path-mtu-discovery command has been entered. Note that the path mtu entries are missing.

Router# show ip bgp neighbors
BGP neighbor is 172.16.1.2, remote AS 45000, internal link
  BGP version 4, remote router ID 172.16.1.99

  For address family: IPv4 Unicast
  BGP table version 5, neighbor version 5/0

  Address tracking is enabled, the RIB does have a route to 172.16.1.2
  Address tracking requires at least a /24 route to the peer
  Connections established 3; dropped 2
  Last reset 00:00:35, due to Router ID changed

  SRTT: 146 ms, RTTO: 1283 ms, RTV: 1137 ms, KRTT: 0 ms
  minRTT: 8 ms, maxRTT: 300 ms, ACK hold: 200 ms
  Flags: higher precedence, retransmission timeout, nagle

Disabling TCP Path MTU Discovery for a Single BGP Neighbor

Perform this task to establish a peering session with an internal BGP (iBGP) neighbor and then disable TCP path MTU discovery for the BGP neighbor session. The neighbor transport command can be used in router configuration mode or address family configuration mode.

Before you begin
This task assumes that you know that TCP path MTU discovery is enabled by default for all your BGP neighbors.

SUMMARY STEPS

1.  enable
2.  configure  terminal
3.  router bgp  autonomous-system-number
4.  address-family  [ipv4  mdt | multicast | unicast [vrf  vrf-name] | vrf vrf-name]  [vpnv4  [unicast]]
5.  neighbor  [ip-address]  [peer-group-name]  remote-as  autonomous-system-number
6.  neighbor  [ip-address]  [peer-group-name]  activate
7. `no neighbor {ip-address|peer-group-name} transport {connection-mode | path-mtu-discovery}`
8. `end`
9. `show ip bgp neighbors`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><code>enable</code></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device&gt; enable</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><code>configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device# configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td><code>router bgp autonomous-system-number</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config)# router bgp 45000</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>Enters address family configuration mode to configure BGP peers to accept address-family-specific configurations.</td>
</tr>
<tr>
<td>`address-family {ipv4 [mdt</td>
<td>multicast</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config-router)# address-family ipv4 unicast</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>Adds the IP address or peer group name of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local router.</td>
</tr>
<tr>
<td>`neighbor {ip-address</td>
<td>peer-group-name} remote-as autonomous-system-number`</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config-router-af)# neighbor 192.168.1.1 remote-as 45000</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>Activates the neighbor under the IPv4 address family.</td>
</tr>
<tr>
<td>`neighbor {ip-address</td>
<td>peer-group-name} activate`</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config-router-af)# neighbor 172.16.1.1 activate</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>Disables TCP path MTU discovery for a single BGP neighbor.</td>
</tr>
<tr>
<td>`no neighbor {ip-address</td>
<td>peer-group-name} transport {connection-mode</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config-router-af)# no neighbor 172.16.1.1 transport path-mtu-discovery</code></td>
<td></td>
</tr>
</tbody>
</table>
### Disabling TCP Path MTU Discovery for a Single BGP Neighbor

<table>
<thead>
<tr>
<th>Step 8</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>end</em></td>
<td>Exits address family configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config-router-af)# end</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 9</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>show ip bgp neighbors</em></td>
<td>(Optional) Displays information about the TCP and BGP connections to neighbors.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device# show ip bgp neighbors</td>
<td></td>
</tr>
</tbody>
</table>

### Examples

The following sample output shows that TCP path MTU discovery has been disabled for BGP neighbor 172.16.1.1 but that it is still enabled for BGP neighbor 192.168.2.2. Two entries in the output—Transport(tcp) path-mtu-discovery is enabled and pathmtucapable—show that TCP path MTU discovery is enabled.

```
Router# show ip bgp neighbors
BGP neighbor is 172.16.1.1, remote AS 45000, internal link
  BGP version 4, remote router ID 172.17.1.99
  Address tracking is enabled, the RIB does have a route to 172.16.1.1
  Address tracking requires at least a /24 route to the peer
  Connections established 1; dropped 0
  Last reset never
  SRTT: 165 ms, RTTO: 1172 ms, RTV: 1007 ms, KRTT: 0 ms
  minRTT: 20 ms, maxRTT: 300 ms, ACK hold: 200 ms
  Flags: higher precedence, retransmission timeout, nagle
  ...
BGP neighbor is 192.168.2.2, remote AS 50000, external link
  BGP version 4, remote router ID 10.2.2.99
  Address tracking is enabled, the RIB does have a route to 192.168.2.2
  Address tracking requires at least a /24 route to the peer
  ...
```
Connections established 2; dropped 1
Last reset 00:05:11, due to User reset
Transport(tcp) path-mtu-discovery is enabled

SRTT: 210 ms, RTTO: 904 ms, RTV: 694 ms, KRTT: 0 ms
minRTT: 20 ms, maxRTT: 300 ms, ACK hold: 200 ms
Flags: higher precedence, retransmission timeout, nagle, path mtu capable

Enabling TCP Path MTU Discovery Globally for All BGP Sessions

Perform this task to enable TCP path MTU discovery for all BGP sessions. TCP path MTU discovery is enabled by default when you configure BGP sessions, but if the BGP Support for TCP Path MTU Discovery per Session feature has been disabled, you can use this task to reenable it. To verify that TCP path MTU discovery is enabled, use the `show ip bgp neighbors` command.

Before you begin

This task assumes that you have previously configured BGP neighbors with active TCP connections.

SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. bgp transport path-mtu-discovery
5. end
6. show ip bgp neighbors

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode to create or configure a BGP routing process.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config)# router bgp 45000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> bgp transport path-mtu-discovery</td>
<td>Enables TCP path MTU discovery for all BGP sessions.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
</tbody>
</table>
### Configuring BGP Neighbor Session Options

#### Enabling TCP Path MTU Discovery Globally for All BGP Sessions

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device(config-router)# bgp transport path-mtu-discovery</td>
<td>Exits router configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config-router)# end</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>(Optional) Displays information about the TCP and BGP connections to neighbors.</td>
</tr>
<tr>
<td>show ip bgp neighbors</td>
<td>- In this example, the output from this command will show that all neighbors have TCP path MTU discovery enabled.</td>
</tr>
<tr>
<td>Device# show ip bgp neighbors</td>
<td></td>
</tr>
</tbody>
</table>

#### Examples

The following sample output from the `show ip bgp neighbors` command shows that TCP path MTU discovery is enabled for BGP neighbors. Two entries in the output—Transport(tcp) path-mtu-discovery is enabled and pathmtucapable—show that TCP path MTU discovery is enabled.

```
Router# show ip bgp neighbors
BGP neighbor is 172.16.1.2, remote AS 45000, internal link
    BGP version 4, remote router ID 172.16.1.99
    ...
    For address family: IPv4 Unicast
        BGP table version 5, neighbor version 5/0
        ...
        Address tracking is enabled, the RIB does have a route to 172.16.1.2
        Address tracking requires at least a /24 route to the peer
        Connections established 3; dropped 2
        Last reset 00:00:35, due to Router ID changed
        Transport(tcp) path-mtu-discovery is enabled
        ...
        SRTT: 146 ms, RTTO: 1283 ms, RTV: 1137 ms, KRTT: 0 ms
        minRTT: 8 ms, maxRTT: 300 ms, ACK hold: 200 ms
        Flags: higher precedence, retransmission timeout, nagle, path mtu capable
```
Enabling TCP Path MTU Discovery for a Single BGP Neighbor

Perform this task to establish a peering session with an eBGP neighbor and then enable TCP path MTU discovery for the BGP neighbor session. The `neighbor transport` command can be used in router configuration mode or address family configuration mode.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `address-family {ipv4 [mdt | multicast | unicast [vrf vrf-name] | vrf vrf-name] | vpnv4 [unicast]}
5. `neighbor {ip-address| peer-group-name} remote-as autonomous-system-number`
6. `neighbor {ip-address| peer-group-name} activate`
7. `neighbor {ip-address| peer-group-name} transport {connection-mode | path-mtu-discovery}`
8. `end`
9. `show ip bgp neighbors [ip-address]`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example: Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td>Example: Device(config)# router bgp 45000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> address-family {ipv4 [mdt</td>
<td>multicast</td>
</tr>
<tr>
<td>Example: Device(config-router)# address-family ipv4 unicast</td>
<td>• The example creates an IPv4 unicast address family session.</td>
</tr>
<tr>
<td><strong>Step 5</strong> neighbor {ip-address</td>
<td>peer-group-name} remote-as autonomous-system-number</td>
</tr>
<tr>
<td>Example: Device(config-router-af)# neighbor 192.168.2.2 remote-as 50000</td>
<td></td>
</tr>
</tbody>
</table>
### Command or Action

**Step 6**

```plaintext
neighbor {ip-address|peer-group-name} activate
Example:
Device(config-router-af)# neighbor 192.168.2.2 activate
```

**Purpose**

Activates the neighbor under the IPv4 address family.

**Step 7**

```plaintext
neighbor {ip-address|peer-group-name}
transport {connection-mode | path-mtu-discovery}
Example:
Device(config-router-af)# neighbor 192.168.2.2 transport path-mtu-discovery
```

**Purpose**

Enables TCP path MTU discovery for a single BGP neighbor.

**Step 8**

```plaintext
end
Example:
Device(config-router-af)# end
```

**Purpose**

Exits address family configuration mode and returns to privileged EXEC mode.

**Step 9**

```plaintext
show ip bgp neighbors [ip-address]
Example:
Device# show ip bgp neighbors 192.168.2.2
```

**Purpose**

(Optional) Displays information about the TCP and BGP connections to neighbors.

**Note** Only the syntax applicable to this task is used in this example. For more details, see the *Cisco IOS IP Routing: BGP Command Reference*.

### Examples

The following sample output from the `show ip bgp neighbors` command shows that TCP path MTU discovery is enabled for the BGP neighbor at 192.168.2.2. Two entries in the output—Transport(tcp) path-mtu-discovery is enabled and path-mtu capable—show that TCP path MTU discovery is enabled.

```
Router# show ip bgp neighbors 192.168.2.2
BGP neighbor is 192.168.2.2, remote AS 50000, external link
   BGP version 4, remote router ID 10.2.2.99
   .
   .
For address family: IPv4 Unicast
   BGP table version 4, neighbor version 4/0
   .
   .
   Address tracking is enabled, the RIB does have a route to 192.168.2.2
   Address tracking requires at least a /24 route to the peer
   Connections established 2; dropped 1
   Last reset 00:05:11, due to User reset
   Transport(tcp) path-mtu-discovery is enabled
   .
   .
   SRTT: 210 ms, RTTO: 904 ms, RTV: 694 ms, KRTT: 0 ms
```
Configuration Examples for BGP Neighbor Session Options

Example: Configuring Fast Session Deactivation for a BGP Neighbor

In the following example, the BGP routing process is configured on device A and device B to monitor and use fast peering session deactivation for the neighbor session between the two devices. Although fast peering session deactivation is not required at both devices in the neighbor session, it will help the BGP networks in both autonomous systems to converge faster if the neighbor session is deactivated.

Device A

```
router bgp 40000
 neighbor 192.168.1.1 remote-as 45000
 neighbor 192.168.1.1 fall-over
end
```

Device B

```
router bgp 45000
 neighbor 192.168.1.2 remote-as 40000
 neighbor 192.168.1.2 fall-over
end
```

Example: Configuring Selective Address Tracking for Fast Session Deactivation

The following example shows how to configure the BGP peering session to be reset if a route with a prefix of /28 or a more specific route to a peer destination is no longer available:

```
router bgp 45000
 neighbor 192.168.1.2 remote-as 40000
 neighbor 192.168.1.2 fall-over route-map CHECK-NBR
exit
ip prefix-list FILTER28 seq 5 permit 0.0.0.0/0 ge 28
route-map CHECK-NBR permit 10
 match ip address prefix-list FILTER28
end
```

Example: Configuring BFD for a BGP IPv6 Neighbor

The following example configures FastEthernet interface 0/1 with the IPv6 address 2001:DB8:4:1::1. Bidirectional Forwarding Detection (BFD) is configured for the BGP neighbor at 2001:DB8:5:1::2. BFD will track forwarding path failure of the BGP neighbor and provide faster reconvergence time for BGP after a forwarding path failure.

```
ipv6 unicast-routing
ipv6 cef
```
interface fastethernet 0/1
ipv6 address 2001:DB8:4:1::1/64
bfd interval 500 min_rx 500 multiplier 3
no shutdown
exit
router bgp 65000
no bgp default ipv4-unicast
address-family ipv6 unicast
neighbor 2001:DB8:5:1::2 remote-as 65001
neighbor 2001:DB8:5:1::2 fall-over bfd
end

Example: Configuring the TTL-Security Check

The example configurations in this section show how to configure the BGP Support for TTL Security Check feature.

The following example uses the trace command to determine the hop count to an eBGP peer. The hop count number is displayed in the output for each networking device that IP packets traverse to reach the specified neighbor. In the following example, the hop count for the 10.1.1.1 neighbor is 1.

Router# trace ip 10.1.1.1
Type escape sequence to abort.
Tracing the route to 10.1.1.1
  1 10.1.1.1 0 msec * 0 msec

The following example sets the hop count to 2 for the 10.1.1.1 neighbor. Because the hop-count argument is set to 2, BGP will accept only IP packets with a TTL count in the header that is equal to or greater than 253.

Router(config-router)# neighbor 10.1.1.1 ttl-security hops 2

Examples: Configuring BGP Support for TCP Path MTU Discovery per Session

This section contains the following configuration examples:

Example: Disabling TCP Path MTU Discovery Globally for All BGP Sessions

The following example shows how to disable TCP path MTU discovery for all BGP neighbor sessions. Use the show ip bgp neighbors command to verify that TCP path MTU discovery has been disabled.

enable
configure terminal
router bgp 45000
  no bgp transport path-mtu-discovery
end
show ip bgp neighbors

Example: Disabling TCP Path MTU Discovery for a Single BGP Neighbor

The following example shows how to disable TCP path MTU discovery for an eBGP neighbor at 192.168.2.2:

enable
configure terminal
router bgp 45000
  neighbor 192.168.2.2 remote-as 50000
  neighbor 192.168.2.2 activate
Example: Enabling TCP Path MTU Discovery Globally for All BGP Sessions

The following example shows how to enable TCP path MTU discovery for all BGP neighbor sessions. Use the show ip bgp neighbors command to verify that TCP path MTU discovery has been enabled.

```
no neighbor 192.168.2.2 transport path-mtu-discovery
end
show ip bgp neighbors 192.168.2.2
```

Example: Enabling TCP Path MTU Discovery for a Single BGP Neighbor

The following example shows how to enable TCP path MTU discovery for an eBGP neighbor at 192.168.2.2. Use the show ip bgp neighbors command to verify that TCP path MTU discovery has been enabled.

```
enable
configure terminal
router bgp 45000
   neighbor 192.168.2.2 remote-as 50000
   neighbor 192.168.2.2 activate
   neighbor 192.168.2.2 transport path-mtu-discovery
end
show ip bgp neighbors 192.168.2.2
```

Where to Go Next

For information about advertising the bandwidth of an autonomous system exit link as an extended community, refer to the “BGP Link Bandwidth” module.

Additional References

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<tr>
<td>BGP commands: complete command syntax, command mode, defaults, command history, usage guidelines, and examples</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
<tr>
<td>Overview of Cisco BGP conceptual information with links to all the individual BGP modules</td>
<td>“Cisco BGP Overview” module</td>
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<tr>
<td>Conceptual and configuration details for basic BGP tasks</td>
<td>“Configuring a Basic BGP Network” module</td>
</tr>
<tr>
<td>Related Topic</td>
<td>Document Title</td>
</tr>
<tr>
<td>------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------</td>
</tr>
<tr>
<td>Conceptual and configuration details for advanced BGP tasks</td>
<td>“Configuring Advanced BGP Features” module</td>
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<tr>
<td>Bidirectional Forwarding Detection configuration tasks</td>
<td>IP Routing: BFD Configuration Guide</td>
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</tbody>
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**Standards**

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<td>MDT SAFI</td>
<td>MDT SAFI</td>
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**MIBs**

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<tr>
<th>MIB</th>
<th>MIBs Link</th>
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</thead>
<tbody>
<tr>
<td>CISCO-BGP4-MIB</td>
<td>To locate and download MIBs for selected platforms, Cisco IOS XE software releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
</tr>
</tbody>
</table>

**RFCs**

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<tr>
<th>RFC</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFC 1191</td>
<td>Path MTU Discovery</td>
</tr>
<tr>
<td>RFC 1771</td>
<td>A Border Gateway Protocol 4 (BGP-4)</td>
</tr>
<tr>
<td>RFC 1772</td>
<td>Application of the Border Gateway Protocol in the Internet</td>
</tr>
<tr>
<td>RFC 1773</td>
<td>Experience with the BGP Protocol</td>
</tr>
<tr>
<td>RFC 1774</td>
<td>BGP-4 Protocol Analysis</td>
</tr>
<tr>
<td>RFC 1930</td>
<td>Guidelines for Creation, Selection, and Registration of an Autonomous System (AS)</td>
</tr>
<tr>
<td>RFC 2858</td>
<td>Multiprotocol Extensions for BGP-4</td>
</tr>
<tr>
<td>RFC 2918</td>
<td>Route Refresh Capability for BGP-4</td>
</tr>
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</table>
Technical Assistance

<table>
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<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

Feature Information for Configuring BGP Neighbor Session Options

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP Support for TCP Path MTU Discovery per Session</td>
<td>12.2(33)SRA</td>
<td>BGP support for TCP path maximum transmission unit (MTU) discovery introduced the ability for BGP to automatically discover the best TCP path MTU for each BGP session. The TCP path MTU is enabled by default for all BGP neighbor sessions, but you can disable, and subsequently enable, the TCP path MTU globally for all BGP sessions or for an individual BGP neighbor session. The following commands were introduced or modified by this feature: <code>bgp transport</code>, <code>neighbor transport</code>, <code>show ip bgp neighbors</code>.</td>
</tr>
<tr>
<td></td>
<td>12.2(31)SB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12.2(33)SXH</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12.4(20)T</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15.0(1)S</td>
<td></td>
</tr>
<tr>
<td>BGP Support for TTL Security Check</td>
<td>12.0(27)S</td>
<td>The BGP Support for TTL Security Check feature introduced a lightweight security mechanism to protect external Border Gateway Protocol (eBGP) peering sessions from CPU utilization-based attacks using forged IP packets. Enabling this feature prevents attempts to hijack the eBGP peering session by a host on a network segment that is not part of either BGP network or by a host on a network segment that is not between the eBGP peers. The following commands were introduced or modified by this feature: <code>neighbor ttl-security</code>, <code>show ip bgp neighbors</code>.</td>
</tr>
<tr>
<td></td>
<td>12.3(7)T</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12.2(25)S</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12.2(18)SXE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15.0(1)S</td>
<td></td>
</tr>
</tbody>
</table>
### Feature Information

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bidirectional Forwarding Detection (BFD)</td>
<td>15.1(2)S, 15.2(3)T, 15.2(4)S</td>
<td>Bidirectional Forwarding Detection (BFD) can be used to track fast forwarding path failure of BGP neighbors that use an IPv6 address. The following command was modified by this feature: <code>neighbor fall-over</code>. In Cisco IOS Release 15.2(4)S, support was added for the Cisco 7200 series router.</td>
</tr>
</tbody>
</table>
CHAPTER 17

BGP Neighbor Policy

The BGP Neighbor Policy feature introduces new keywords to two existing commands to display information about local and inherited policies. When BGP neighbors use multiple levels of peer templates, it can be difficult to determine which policies are applied to the neighbor. Inherited policies are policies that the neighbor inherits from a peer group or a peer policy template.

- Finding Feature Information, on page 399
- Information About BGP Neighbor Policy, on page 399
- How to Display BGP Neighbor Policy Information, on page 400
- Additional References, on page 400
- Feature Information for BGP Neighbor Policy, on page 401

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About BGP Neighbor Policy

Benefit of BGP Neighbor Policy Feature

The BGP Neighbor Policy feature introduces new keywords to the show ip bgp neighbors policy command and the show ip bgp template peer-policy command to display information about local and inherited policies. When BGP neighbors use multiple levels of peer templates, it can be difficult to determine which policies are applied to the neighbor. Inherited policies are policies that the neighbor inherits from a peer group or a peer policy template.
How to Display BGP Neighbor Policy Information

Displaying BGP Neighbor Policy Information

SUMMARY STEPS

1. enable
2. show ip bgp neighbors { ip-address | ipv6-address } policy [ detail]
3. show ip bgp template peer-policy [ policy-template-name [ detail] ]

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Example: Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Displays the policies applied to the specified neighbor.</td>
</tr>
<tr>
<td>show ip bgp neighbors { ip-address</td>
<td>ipv6-address } policy [ detail]</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Displays the locally configured peer policy templates.</td>
</tr>
<tr>
<td>show ip bgp template peer-policy [ policy-template-name [ detail] ]</td>
<td>Example: Device# show ip bgp template peer-policy</td>
</tr>
</tbody>
</table>

Additional References

Related Documents

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<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
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Feature Information for BGP Neighbor Policy

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Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 33: Feature Information for BGP Neighbor Policy

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP Neighbor Policy</td>
<td>12.2(33)SB</td>
<td>The BGP Neighbor Policy feature introduces new keywords to two existing commands to display information about local and inherited policies. When BGP neighbors use multiple levels of peer templates, it can be difficult to determine which policies are applied to the neighbor. Inherited policies are policies that the neighbor inherits from a peer-group or a peer-policy template. The following commands were modified: show ip bgp neighbors, and show ip bgp template peer-policy.</td>
</tr>
</tbody>
</table>
BGP Dynamic Neighbors

BGP dynamic neighbor support allows BGP peering to a group of remote neighbors that are defined by a range of IP addresses. Each range can be configured as a subnet IP address. BGP dynamic neighbors are configured using a range of IP addresses and BGP peer groups.

- Finding Feature Information, on page 403
- Information About BGP Dynamic Neighbors, on page 403
- How to Configure BGP Dynamic Neighbors, on page 404
- Configuration Examples for BGP Dynamic Neighbors, on page 413
- Additional References, on page 416
- Feature Information for BGP Dynamic Neighbors, on page 416

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About BGP Dynamic Neighbors

BGP Dynamic Neighbors

Support for the BGP Dynamic Neighbors feature was introduced in Cisco IOS Release 12.2(33)SXH on the Cisco Catalyst 6500 series switches. BGP dynamic neighbor support allows BGP peering to a group of remote neighbors that are defined by a range of IP addresses. Each range can be configured as a subnet IP address. BGP dynamic neighbors are configured using a range of IP addresses and BGP peer groups.

In Cisco IOS XE Denali 16.3 release, support for BGP dynamic neighbors was extended to IPv6 BGP peering with VRF support.

After a subnet range is configured for a BGP peer group and a TCP session is initiated by another router for an IP address in the subnet range, a new BGP neighbor is dynamically created as a member of that group.
After the initial configuration of subnet ranges and activation of the peer group (referred to as a *listen range group*), dynamic BGP neighbor creation does not require any further CLI configuration on the initial router. Other routers can establish a BGP session with the initial router, but the initial router need not establish a BGP session to other routers if the IP address of the remote peer used for the BGP session is not within the configured range.

To support the BGP Dynamic Neighbors feature, the output for the `show ip bgp neighbors`, `show ip bgp peer-group`, and `show ip bgp summary` commands was updated to display information about dynamic neighbors.

A dynamic BGP neighbor will inherit any configuration for the peer group. In larger BGP networks, implementing BGP dynamic neighbors can reduce the amount and complexity of CLI configuration and save CPU and memory usage. Only IPv4 peering is supported.

### How to Configure BGP Dynamic Neighbors

#### Implementing BGP Dynamic Neighbors Using Subnet Ranges

In Cisco IOS Release 12.2(33)SXH, support for BGP dynamic neighbors was introduced. Perform this task to implement the dynamic creation of BGP neighbors using subnet ranges.

In this task, a BGP peer group is created on Router B in the figure below, a global limit is set on the number of dynamic BGP neighbors, and a subnet range is associated with a peer group. Configuring the subnet range enables the dynamic BGP neighbor process. The peer group is added to the BGP neighbor table of the local router, and an alternate autonomous system number is also configured. The peer group is activated under the IPv4 address family.

The next step is to move to another router—Router E in the figure below—where a BGP session is started and the neighbor router, Router B, is configured as a remote BGP peer. The peering configuration opens a TCP session and triggers Router B to create a dynamic BGP neighbor because the IP address that starts the TCP session (192.168.3.2) is within the configured subnet range for dynamic BGP peers. The task moves back to the first router, Router B, to run three `show` commands that have been modified to display dynamic BGP peer information.
Before you begin

This task requires Cisco IOS Release 12.2(33)SXH, or a later release, to be running.

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This task supports only IPv4 BGP peering.

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**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `bgp log-neighbor-changes`
5. `neighbor peer-group-name peer-group`
6. `bgp listen [limit max-number]`
7. `bgp listen [limit max-number | range network length peer-group peer-group-name]`
8. `neighbor {ip-address | ipv6-address | peer-group-name} ebgp-multihop [ttl]`
9. `neighbor peer-group-name remote-as autonomous-system-number [alternate-as autonomous-system-number...]`
10. `address-family ipv4 [mdt | multicast | unicast [vrf vrf-name]]`
11. `neighbor {ip-address | peer-group-name} activate`
12. `end`
13. Move to another router that has an interface within the subnet range for the BGP peer group configured in this task.
14. `enable`
15. `configure terminal`
16. `router bgp autonomous-system-number`
### DETAILED STEPS

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<thead>
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<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>DeviceB&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>DeviceB&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
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</tr>
<tr>
<td>DeviceB# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
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</tr>
<tr>
<td>DeviceB(config)# router bgp 45000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> bgp log-neighbor-changes</td>
<td>(Optional) Enables logging of BGP neighbor status changes (up or down) and neighbor resets.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>DeviceB(config-router)# bgp log-neighbor-changes</td>
<td>Use this command for troubleshooting network connectivity problems and measuring network stability. Unexpected neighbor resets might indicate high error rates or high packet loss in the network and should be investigated.</td>
</tr>
<tr>
<td><strong>Step 5</strong> neighbor peer-group-name peer-group</td>
<td>Creates a BGP peer group.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>DeviceB(config-router)# neighbor group192 peer-group</td>
<td>In this example, a peer group named group192 is created. This group will be used as a listen range group.</td>
</tr>
<tr>
<td><strong>Step 6</strong> bgp listen [limit max-number]</td>
<td>Sets a global limit of BGP dynamic subnet range neighbors.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>DeviceB(config-router)# bgp listen limit 200</td>
<td>Use the optional limit keyword and max-number argument to define the maximum number of BGP dynamic subnet range neighbors that can be created.</td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td>Only the syntax applicable to this task is used in this example. For the complete syntax, see Step 7.</td>
</tr>
</tbody>
</table>
### Purpose
Associates a subnet range with a BGP peer group and activates the BGP dynamic neighbors feature.

- Use the optional limit keyword and max-number argument to define the maximum number of BGP dynamic neighbors that can be created.
- Use the optional range keyword and network/length argument to define a prefix range to be associated with the specified peer group.
- In this example, the prefix range 192.168.0.0/16 is associated with the listen range group named group192.

### Command or Action

**Step 7**

```plaintext
bgp listen [limit max-number | range network/length peer-group peer-group-name]
```

**Example:**

```
DeviceB(config-router)# bgp listen range 192.168.0.0/16 peer-group group192
```

### Purpose
Accepts and attempts BGP connections to external peers residing on networks that are not directly connected.

### Command or Action

**Step 8**

```plaintext
neighbor {ip-address | ipv6-address | peer-group-name} ebgp-multihop [ttl]
```

**Example:**

```
DeviceB(config-router)# neighbor group192 ebgp-multihop 255
```

### Purpose
Adds the IP address or peer group name of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local router.

- Use the optional alternate-as keyword and autonomous-system-number argument to identify up to five alternate autonomous system numbers for listen range neighbors.
- In this example, the peer group named group192 is configured with two possible autonomous system numbers.

**Note**

The alternate-as keyword is used only with the listen range peer groups, not with individual BGP neighbors.

### Command or Action

**Step 9**

```plaintext
neighbor peer-group-name remote-as autonomous-system-number [alternate-as autonomous-system-number...]
```

**Example:**

```
DeviceB(config-router)# neighbor group192 remote-as 40000 alternate-as 50000
```

### Command or Action

**Step 10**

```plaintext
address-family ipv4 [mdt | multicast | unicast [vrf vrf-name]]
```

**Example:**

```
DeviceB(config-router)# address-family ipv4 unicast
```

### Purpose
Enters address family configuration mode to configure BGP peers to accept address-family-specific configurations.

### Command or Action

**Step 11**

```plaintext
neighbor {ip-address | peer-group-name} activate
```

**Example:**

```
DeviceB(config-router-af)# neighbor group192 activate
```

### Purpose
Activates the neighbor or listen range peer group for the configured address family.

- In this example, the neighbor 172.16.1.1 is activated for the IPv4 address family.
<table>
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<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 12</strong> end</td>
<td>Exits address family configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Step 13</strong> Move to another router that has an interface within the subnet range for the BGP peer group configured in this task.</td>
<td>—</td>
</tr>
<tr>
<td><strong>Step 14</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Step 15</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Step 16</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td><strong>Step 17</strong> neighbor {ip-address</td>
<td>peer-group-name} remote-as autonomous-system-number [alternate-as autonomous-system-number...]</td>
</tr>
<tr>
<td><strong>Step 18</strong> Return to the first router.</td>
<td>—</td>
</tr>
<tr>
<td><strong>Step 19</strong> show ip bgp summary</td>
<td>(Optional) Displays the BGP path, prefix, and attribute information for all connections to BGP neighbors.</td>
</tr>
<tr>
<td><strong>Step 20</strong> show ip bgp peer-group [peer-group-name] [summary]</td>
<td>(Optional) Displays information about BGP peer groups.</td>
</tr>
</tbody>
</table>
### Purpose

Command or Action

DeviceB# show ip bgp peer-group group192

Step 21 show ip bgp neighbors [ip-address]

Example:

DeviceB# show ip bgp neighbors 192.168.3.2

(Optional) Displays information about BGP and TCP connections to neighbors.

- In this example, information is displayed about the dynamically created neighbor at 192.168.3.2. The IP address of this BGP neighbor can be found in the output of either the `show ip bgp summary` or the `show ip bgp peer-group` command.

Note: Only the syntax applicable to this task is used in this example. For more details, see the Cisco IOS IP Routing: BGP Command Reference.

### Examples

The following output examples were taken from Router B in the figure above after the appropriate configuration steps in this task were completed on both Router B and Router E.

The following output from the `show ip bgp summary` command shows that the BGP neighbor 192.168.3.2 was dynamically created and is a member of the listen range group, group192. The output also shows that the IP prefix range of 192.168.0.0/16 is defined for the listen range named group192.

```
Router# show ip bgp summary
BGP router identifier 192.168.3.1, local AS number 45000
BGP table version is 1, main routing table version 1
Neighbor  V  AS  MsgRcvd  MsgSent  TblVer  InQ  OutQ  Up/Down  State/PfxRcd
*192.168.3.2  4  50000  2  2  0  0  0 00:00:37  0
* Dynamically created based on a listen range command
Dynamically created neighbors: 1/(200 max), Subnet ranges: 1
BGP peergroup group192 listen range group members:
192.168.0.0/16
```

The following output from the `show ip bgp peer-group` command shows information about the listen range group, group192 that was configured in this task:

```
Router# show ip bgp peer-group group192
BGP peer-group is group192, remote AS 40000
BGP peergroup group192 listen range group members:
192.168.0.0/16
BGP version 4
Default minimum time between advertisement runs is 30 seconds
For address family: IPv4 Unicast
BGP neighbor is group192, peer-group external, members:
*192.168.3.2
Index 0, Offset 0, Mask 0x0
Update messages formatted 0, replicated 0
Number of NLRIs in the update sent: max 0, min 0
```
The following sample output from the `show ip bgp neighbors` command shows that the neighbor 192.168.3.2 is a member of the peer group, group192, and belongs to the subnet range group 192.168.0.0/16, which shows that this peer was dynamically created:

```
Router# show ip bgp neighbors 192.168.3.2
BGP neighbor is *192.168.3.2, remote AS 50000, external link
Member of peer-group group192 for session parameters
Belongs to the subnet range group: 192.168.0.0/16
BGP version 4, remote router ID 192.168.3.2
BGP state = Established, up for 00:06:35
Last read 00:00:33, last write 00:00:25, hold time is 180, keepalive intervals
Neighbor capabilities:
    Route refresh: advertised and received(new)
Address family IPv4 Unicast: advertised and received
Message statistics:
    InQ depth is 0
    OutQ depth is 0
    Sent     Rcvd
    Opens:  1     1
    Notifications:  0     0
    Updates: 0     0
    Keepalives: 7     7
    Route Refresh: 0     0
    Total:  8     8
Default minimum time between advertisement runs is 30 seconds
For address family: IPv4 Unicast
    BGP table version 1, neighbor version 1/0
Output queue size : 0
Index 1, Offset 0, Mask 0x2
1 update-group member
  group192 peer-group member
```

**Configuring BGP IPv6 Dynamic Neighbor Support with VRF Support**

In Cisco IOS XE Denali 16.3 release, support for BGP dynamic neighbors was extended to IPv6 BGP peering.

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**Note**

You can also configure BGP IPv6 dynamic neighbors without VRF support.

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**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `bgp listen [limit max-number | range network | length peer-group peer-group-name]`
5. `address-family [ipv4 | ipv6] [mdt | multicast | unicast [vrf vrf-name]]`
6. `bgp listen [limit max-number]`
7. `neighbor peer-group-name peer-group`
8. `neighbor peer-group-name remote-as autonomous-system-number [alternate-as autonomous-system-number...]`
BGP Dynamic Neighbors

9. address-family [ipv4 | ipv6] [mdt | multicast | unicast [vrf vrf-name]]
10. neighbor {ip-address | peer-group-name} activate
11. end

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>- Enter your password if prompted.</td>
</tr>
<tr>
<td></td>
<td>- The configuration is entered on router B.</td>
</tr>
<tr>
<td>Step 2 configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Step 3 router bgp autonomous-system-number</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Step 4 bgp listen [limit max-number</td>
<td>range network / length peer-group peer-group-name]</td>
</tr>
<tr>
<td>Example:</td>
<td>- Use the optional limit keyword and max-number argument to define the maximum number of BGP dynamic neighbors that can be created.</td>
</tr>
<tr>
<td></td>
<td>- Use the optional range keyword and network / length argument to define a prefix range to be associated with the specified peer group.</td>
</tr>
<tr>
<td></td>
<td>- In this example, the prefix range 2001::0/64 is associated with the listen range group named group192.</td>
</tr>
<tr>
<td>Step 5 address-family [ipv4</td>
<td>ipv6] [mdt</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Step 6 bgp listen [limit max-number]</td>
<td>Specifies the maximum number of prefixes in VRF address family.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Step 7 neighbor peer-group-name peer-group</td>
<td>Creates a BGP peer group.</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Example:</td>
<td>- In this example, a peer group named group192 is created. This group will be used as a listen range group.</td>
</tr>
<tr>
<td>Step 8</td>
<td>Adds the IP address or peer group name of the neighbor in the specified autonomous system to the IPv6 BGP neighbor table.</td>
</tr>
<tr>
<td>neighbor peer-group-name remote-as autonomous-system-number [alternate-as autonomous-system-number...]</td>
<td>- Use the optional alternate-as keyword and autonomous-system-number argument to identify up to five alternate autonomous system numbers for listen range neighbors.</td>
</tr>
<tr>
<td>Example:</td>
<td>- In this example, the peer group named group192 is configured with two possible autonomous system numbers.</td>
</tr>
<tr>
<td>Step 9</td>
<td>Enable IPv4 address family for this peer-group.</td>
</tr>
<tr>
<td>address-family [ipv4</td>
<td>ipv6] [mdt</td>
</tr>
<tr>
<td>Example:</td>
<td>- Exits address family configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td>Step 10</td>
<td>- Dynamically created based on a listen range command</td>
</tr>
<tr>
<td>neighbor {ip-address</td>
<td>peer-group-name} activate</td>
</tr>
</tbody>
</table>

### Verifying BGP IPv6 Dynamic Neighbor Configuration

Use the `show bgp ipv6 unicast summary` command to verify the BGP IPv6 unicast address family configuration in global routing table:

```mermaid
Device# show bgp ipv6 unicast summary
BGP router identifier 192.168.3.1, local AS number 45000
BGP table version is 1, main routing table version 1
Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd
*2001::1 4 50000 2 2 0 0 00:00:37 0
* Dynamically created based on a listen range command
Configuration Examples for BGP Dynamic Neighbors

Example: Implementing BGP Dynamic Neighbors Using Subnet Ranges

In the following example, two BGP peer groups are created on Router B in the figure below, a global limit is set on the number of dynamic BGP neighbors, and a subnet range is associated with a peer group. Configuring the subnet range enables the dynamic BGP neighbor process. The peer groups are added to the BGP neighbor table of the local router, and an alternate autonomous system number is also configured for one of the peer groups, group192. The subnet range peer groups and a standard BGP peer are then activated under the IPv4 address family.

The configuration moves to another router—Router A in the figure below—where a BGP session is started and the neighbor router, Router B, is configured as a remote BGP peer. The peering configuration opens a TCP session and triggers Router B to create a dynamic BGP neighbor because the IP address that starts the TCP session (192.168.1.2) is within the configured subnet range for dynamic BGP peers.

A third router—Router E in the figure below—also starts a BGP peering session with Router B. Router E is in the autonomous system 50000, which is the configured alternate autonomous system. Router B responds to the resulting TCP session by creating another dynamic BGP peer.

This example concludes with the output of the **show ip bgp summary** command entered on Router B.
Figure 37: BGP Dynamic Neighbor Topology

Router B

enable
configure terminal
router bgp 45000
   bgp log-neighbor-changes
   bgp listen limit 200
   bgp listen range 172.21.0.0/16 peer-group group172
   bgp listen range 192.168.0.0/16 peer-group group192
   neighbor group172 peer-group
   neighbor group172 remote-as 45000
   neighbor group192 peer-group
   neighbor group192 remote-as 40000 alternate-as 50000
   neighbor 172.16.1.2 remote-as 45000
   address-family ipv4 unicast
   neighbor group172 activate
   neighbor group192 activate
   neighbor 172.16.1.2 activate
end

Router A

enable
configure terminal
router bgp 40000
   neighbor 192.168.1.1 remote-as 45000
   exit

Router E

enable
configure terminal
router bgp 50000
neighbor 192.168.3.1 remote-as 45000
exit

After both Router A and Router E are configured, the `show ip bgp summary` command is run on Router B. The output displays the regular BGP neighbor, 172.16.1.2, and the two BGP neighbors that were created dynamically when Router A and Router E initiated TCP sessions for BGP peering to Router B. The output also shows information about the configured listen range subnet groups.

**Example: Configuring BGP IPv6 Dynamic Neighbor Support with VRF Support**

```
enable
configure terminal
router bgp 55000
bgp listen range 2001::0/64 peer-group group182
  address-family ipv6 unicast vrf vrf2
bgp listen limit 600
neighbor group182 peer-group
neighbor group182 remote-as 103 alternate-as 104
address-family ipv4 unicast vrf vrf2
neighbor group182 activate
end
```

```
Configuring BGP IPv6 Dynamic Neighbor Support without VRF Support
```

```
enable
configure terminal
router bgp 100
bgp listen range 2001::0/64 peer-group group192
bgp listen limit 500
neighbor group192 peer-group
neighbor group192 remote-as 101 alternate-as 102
address family ipv6 unicast
neighbor group192 activate
address family ipv4 unicast
neighbor group192 activate
end
```
Additional References

Related Documents

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<td>Cisco IOS Master Command List, All Releases</td>
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<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
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Standards and RFCs

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<td>Route Refresh Capability for BGP-4</td>
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Technical Assistance

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<th>Link</th>
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<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
<tr>
<td>download documentation, software, and tools. Use these resources to install</td>
<td></td>
</tr>
<tr>
<td>and configure the software and to troubleshoot and resolve technical</td>
<td></td>
</tr>
<tr>
<td>issues with Cisco products and technologies. Access to most tools on the</td>
<td></td>
</tr>
<tr>
<td>Cisco Support and Documentation website requires a Cisco.com user ID and</td>
<td></td>
</tr>
<tr>
<td>password.</td>
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</tr>
</tbody>
</table>

Feature Information for BGP Dynamic Neighbors

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.
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<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP Dynamic Neighbors</td>
<td>Cisco IOS XE Release 3.1S</td>
<td>BGP dynamic neighbor support allows BGP peering to a group of remote neighbors that are defined by a range of IP addresses. Each range can be configured as a subnet IP address. BGP dynamic neighbors are configured using a range of IP addresses and BGP peer groups. After a subnet range is configured for a BGP peer group and a TCP session is initiated for an IP address in the subnet range, a new BGP neighbor is dynamically created as a member of that group. The new BGP neighbor will inherit any configuration for the peer group. The following commands were introduced or modified by this feature: <code>bgp listen</code>, <code>debug ip bgp range</code>, <code>neighbor remote-as</code>, <code>show ip bgp neighbors</code>, <code>show ip bgp peer-group</code>, and <code>show ip bgp summary</code>.</td>
</tr>
<tr>
<td>BGP IPv6 Dynamic Neighbor Support</td>
<td>Cisco IOS XE Denali 16.3.1</td>
<td>In Cisco IOS XE Denali 16.3 release, support for BGP dynamic neighbors was extended to IPv6 BGP peering with support for VRF. The following commands were introduced or modified by this feature: <code>bgp listen</code>, <code>debug ip bgp range</code>, <code>neighbor remote-as</code>, <code>show bgp neighbors</code>, <code>show bgp summary</code>, <code>show bgp vpng6 unicast vrf neighbors</code>, <code>show bgp vpng6 unicast vrf peer-group</code>, <code>show bgp vpng6 unicast vrf summary</code>.</td>
</tr>
</tbody>
</table>
CHAPTER 19

BGP Support for Next-Hop Address Tracking

The BGP Support for Next-Hop Address Tracking feature is enabled by default when a supporting Cisco software image is installed. BGP next-hop address tracking is event driven. BGP prefixes are automatically tracked as peering sessions are established. Next-hop changes are rapidly reported to the BGP routing process as they are updated in the RIB. This optimization improves overall BGP convergence by reducing the response time to next-hop changes for routes installed in the RIB. When a bestpath calculation is run in between BGP scanner cycles, only next-hop changes are tracked and processed.

- Finding Feature Information, on page 419
- Information About BGP Support for Next-Hop Address Tracking, on page 419
- How to Configure BGP Support for Next-Hop Address Tracking, on page 421
- Configuration Examples for BGP Support for Next-Hop Address Tracking, on page 431
- Additional References, on page 432
- Feature Information for BGP Support for Next-Hop Address Tracking, on page 433

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About BGP Support for Next-Hop Address Tracking

BGP Next-Hop Address Tracking

The BGP next-hop address tracking feature is enabled by default when a supporting Cisco software image is installed. BGP next-hop address tracking is event driven. BGP prefixes are automatically tracked as peering sessions are established. Next-hop changes are rapidly reported to the BGP routing process as they are updated in the RIB. This optimization improves overall BGP convergence by reducing the response time to next-hop changes for routes installed in the RIB. When a best-path calculation is run in between BGP scanner cycles, only next-hop changes are tracked and processed.
BGP Next-Hop Dampening Penalties

If the penalty threshold value is higher than 950, then the delay is calculated as the reuse time using the dampening calculations. The dampening calculations use the following parameters:

- Penalty
- Half-life time
- Reuse time
- max-suppress-time

The values for the dampening parameters used are a max-suppress-time of 60 seconds, the half-life of 8 seconds, and the reuse-limit of 100.

For example, if the original penalty of 1600 is added, then after 16 seconds it becomes 800, and after 40 seconds, the penalty becomes 100. Hence, for the route update penalty of 1600, a delay of 40 seconds is used to schedule the BGP scanner.

These parameters (penalty threshold and any of the dampening parameters) cannot be modified.

Default BGP Scanner Behavior

BGP monitors the next hop of installed routes to verify next-hop reachability and to select, install, and validate the BGP best path. By default, the BGP scanner is used to poll the RIB for this information every 60 seconds. During the 60 second time period between scan cycles, Interior Gateway Protocol (IGP) instability or other network failures can cause black holes and routing loops to temporarily form.

BGP Next_Hop Attribute

The Next_Hop attribute identifies the next-hop IP address to be used as the BGP next hop to the destination. The device makes a recursive lookup to find the BGP next hop in the routing table. In external BGP (eBGP), the next hop is the IP address of the peer that sent the update. Internal BGP (iBGP) sets the next-hop address to the IP address of the peer that advertised the prefix for routes that originate internally. When any routes to iBGP that are learned from eBGP are advertised, the Next_Hop attribute is unchanged.

A BGP next-hop IP address must be reachable in order for the device to use a BGP route. Reachability information is usually provided by the IGP, and changes in the IGP can influence the forwarding of the next-hop address over a network backbone.

Selective BGP Next-Hop Route Filtering

BGP selective next-hop route filtering was implemented as part of the BGP Selective Address Tracking feature to support BGP next-hop address tracking. Selective next-hop route filtering uses a route map to selectively define routes to help resolve the BGP next hop.

The ability to use a route map with the `bgp next-hop` command allows the configuration of the length of a prefix that applies to the BGP Next_Hop attribute. The route map is used during the BGP bestpath calculation and is applied to the route in the routing table that covers the next-hop attribute for BGP prefixes. If the next-hop route fails the route map evaluation, the next-hop route is marked as unreachable. This command is per address family, so different route maps can be applied for next-hop routes in different address families.
Use route map on ASR series devices to set the next hop as BGP peer for the route and apply that route map in outbound direction towards the peer.

Note
Only `match ip address` and `match source-protocol` commands are supported in the route map. No `set` commands or other `match` commands are supported.

BGP Support for Fast Peering Session Deactivation

BGP Hold Timer
By default, the BGP hold timer is set to run every 180 seconds in Cisco software. This timer value is set as the default to protect the BGP routing process from instability that can be caused by peering sessions with other routing protocols. BGP devices typically carry large routing tables, so frequent session resets are not desirable.

BGP Fast Peering Session Deactivation
BGP fast peering session deactivation improves BGP convergence and response time to adjacency changes with BGP neighbors. This feature is event driven and configured on a per-neighbor basis. When this feature is enabled, BGP will monitor the peering session with the specified neighbor. Adjacency changes are detected and terminated peering sessions are deactivated in between the default or configured BGP scanning interval.

Selective Address Tracking for BGP Fast Session Deactivation
In Cisco IOS XE Release 2.1 and later releases, the BGP Selective Address Tracking feature introduced the use of a route map with BGP fast session deactivation. The `route-map` keyword and `map-name` argument are used with the `neighbor fall-over` BGP neighbor session command to determine if a peering session with a BGP neighbor should be reset when a route to the BGP peer changes. The route map is evaluated against the new route, and if a deny statement is returned, the peer session is reset. The route map is not used for session establishment.

Note
Only `match ip address` and `match source-protocol` commands are supported in the route map. No `set` commands or other `match` commands are supported.

How to Configure BGP Support for Next-Hop Address Tracking

Configuring BGP Next-Hop Address Tracking
The tasks in this section show how configure BGP next-hop address tracking. BGP next-hop address tracking significantly improves the response time of BGP to next-hop changes in the RIB. However, unstable Interior
Gateway Protocol (IGP) peers can introduce instability to BGP neighbor sessions. We recommend that you aggressively dampen unstable IGP peering sessions to reduce the possible impact to BGP. For more details about configuring route dampening, see “Configuring BGP Route Dampening.”

Configuring BGP Selective Next-Hop Route Filtering

Perform this task to configure selective next-hop route filtering using a route map to filter potential next-hop routes. This task uses prefix lists and route maps to match IP addresses or source protocols and can be used to avoid aggregate addresses and BGP prefixes being considered as next-hop routes. Only **match ip address** and **match source-protocol** commands are supported in the route map. No **set** commands or other **match** commands are supported.

For more examples of how to use the **bgp nexthop** command, see the “Examples: Configuring BGP Selective Next-Hop Route Filtering” section in this module.

**SUMMARY STEPS**

1. **enable**
2. **configure terminal**
3. **router bgp autonomous-system-number**
4. **address-family ipv4 [unicast | multicast | vrf vrf-name]**
5. **bgp nexthop route-map map-name**
6. **exit**
7. **exit**
8. **ip prefix-list list-name [seq seq-value] {deny network/length | permit network/length} [ge ge-value] [le le-value]**
9. **route-map map-name [permit | deny] [sequence-number]**
10. **match ip address prefix-list prefix-list-name [prefix-list-name...]**
11. **exit**
12. **route-map map-name [permit | deny] [sequence-number]**
13. **end**
14. **show ip bgp [network] [network-mask]**

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td><strong>enable</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device&gt; enable</td>
<td>- Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td><strong>configure terminal</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td><strong>router bgp autonomous-system-number</strong></td>
<td>Enters router configuration mode and creates a BGP routing process.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td><code>Device(config)# router bgp 45000</code></td>
<td>Specifies the IPv4 address family and enters address family configuration mode.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>Sends an address-family command.</td>
<td></td>
</tr>
<tr>
<td>`address-family ipv4 [unicast</td>
<td>multicast</td>
<td>vrf vrf-name]`</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Sends an address-family command.</td>
<td></td>
</tr>
<tr>
<td><code>Device(config-router)# address-family ipv4 unicast</code></td>
<td>Sends an address-family command.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>Configures the BGP next-hop route map.</td>
<td></td>
</tr>
<tr>
<td><code>bgp nexthop route-map map-name</code></td>
<td>Uses a route map to selectively define routes.</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Uses a route map to selectively define routes.</td>
<td></td>
</tr>
<tr>
<td><code>Device(config-router-af)# bgp nexthop route-map CHECK-NEXTHOP</code></td>
<td>Uses a route map to selectively define routes.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>Exits address family configuration mode.</td>
<td></td>
</tr>
<tr>
<td><code>exit</code></td>
<td>Exits address family configuration mode.</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Exits address family configuration mode.</td>
<td></td>
</tr>
<tr>
<td><code>Device(config-router-af)# exit</code></td>
<td>Exits address family configuration mode.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>Exits router configuration mode.</td>
<td></td>
</tr>
<tr>
<td><code>exit</code></td>
<td>Exits router configuration mode.</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Exits router configuration mode.</td>
<td></td>
</tr>
<tr>
<td><code>Device(config-router)# exit</code></td>
<td>Exits router configuration mode.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td>Creates a prefix list.</td>
<td></td>
</tr>
<tr>
<td>`ip prefix-list list-name [seq seq-value] {deny network length</td>
<td>permit network length} [ge ge-value] [le le-value]`</td>
<td>Creates a prefix list.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Creates a prefix list.</td>
<td></td>
</tr>
<tr>
<td><code>Device(config)# ip prefix-list FILTER25 seq 5 permit 0.0.0.0/0 le 25</code></td>
<td>Creates a prefix list.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 9</strong></td>
<td>Configures a route map.</td>
<td></td>
</tr>
<tr>
<td>`route-map map-name [permit</td>
<td>deny] [sequence-number]`</td>
<td>Configures a route map.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Configures a route map.</td>
<td></td>
</tr>
<tr>
<td><code>Device(config)# route-map CHECK-NEXTHOP</code></td>
<td>Configures a route map.</td>
<td></td>
</tr>
</tbody>
</table>
### Purpose

**Command or Action**

```
Device(config)# route-map CHECK-NEXTHOP deny 10
```

**Purpose**

address match in the following **match** command, the IP address will be denied.

<table>
<thead>
<tr>
<th>Step 10</th>
<th><strong>match ip address prefix-list</strong> prefix-list-name [prefix-list-name...]</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config-route-map)# match ip address prefix-list FILTER25</td>
</tr>
</tbody>
</table>

Matches the IP addresses in the specified prefix list.

- Use the **prefix-list-name** argument to specify the name of a prefix list. The ellipsis means that more than one prefix list can be specified.

**Note** Only the syntax applicable to this task is used in this example. For more details, see the *Cisco IOS IP Routing: BGP Command Reference*.

<table>
<thead>
<tr>
<th>Step 11</th>
<th><strong>exit</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config-route-map)# exit</td>
</tr>
</tbody>
</table>

Exits route map configuration mode and enters global configuration mode.

| Step 12 | **route-map** map-name [permit | deny] [sequence-number] |
|---------|---------------------------------------------------------------|
| **Example:** | Device(config)# route-map CHECK-NEXTHOP permit 20 |

Configures a route map and enters route map configuration mode.

- In this example, all other IP addresses are permitted by route map CHECK-NEXTHOP.

<table>
<thead>
<tr>
<th>Step 13</th>
<th><strong>end</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config-route-map)# end</td>
</tr>
</tbody>
</table>

Exits route map configuration mode and enters privileged EXEC mode.

<table>
<thead>
<tr>
<th>Step 14</th>
<th><strong>show ip bgp</strong> [network] [network-mask]</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Device# show ip bgp</td>
</tr>
</tbody>
</table>

Displays the entries in the BGP routing table.

- Enter this command to view the next-hop addresses for each route.

**Note** Only the syntax applicable to this task is used in this example. For more details, see the *Cisco IOS IP Routing: BGP Command Reference*.
Adjusting the Delay Interval for BGP Next-Hop Address Tracking

Perform this task to adjust the delay interval between routing table walks for BGP next-hop address tracking.

You can increase the performance of this feature by tuning the delay interval between full routing table walks to match the tuning parameters for the Interior Gateway protocol (IGP). The default delay interval is 5 seconds. This value is optimal for a fast-tuned IGP. In the case of an IGP that converges more slowly, you can change the delay interval to 20 seconds or more, depending on the IGP convergence time.

BGP next-hop address tracking significantly improves the response time of BGP to next-hop changes in the RIB. However, unstable Interior Gateway Protocol (IGP) peers can introduce instability to BGP neighbor sessions. We recommend that you aggressively dampen unstable IGP peering sessions to reduce the possible impact to BGP.

SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. address-family ipv4 [[mdt] | multicast | tunnel | unicast [vrf vrf-name] | vrf vrf-name] | vpnv4 [unicast]]
5. bgp nexthop trigger delay delay-timer
6. end

DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td></td>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>router bgp autonomous-system-number</td>
<td>Enters router configuration mode to create or configure a BGP routing process.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config)# router bgp 64512</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>address-family ipv4 [[mdt]</td>
<td>multicast</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>• The example creates an IPv4 unicast address family session.</td>
</tr>
<tr>
<td></td>
<td>Device(config-router)# address-family ipv4 unicast</td>
<td></td>
</tr>
</tbody>
</table>
### BGP Support for Next-Hop Address Tracking

#### Disabling BGP Next-Hop Address Tracking

Perform this task to disable BGP next-hop address tracking. BGP next-hop address tracking is enabled by default under the IPv4 and VPNv4 address families. Beginning with Cisco IOS Release 12.2(33)SB6, BGP next-hop address tracking is also enabled by default under the VPNv6 address family whenever the next hop is an IPv4 address mapped to an IPv6 next-hop address.

Disabling next hop address tracking may be useful if you the network has unstable IGP peers and route dampening is not resolving the stability issues. To reenable BGP next-hop address tracking, use the `bgp nexthop` command with the `trigger` and `enable` keywords.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `address-family ipv4 [[mdt | multicast | tunnel | unicast [vrf vrf-name] | vrf vrf-name] | vpnv4 [unicast] | vpnv6 [unicast]]`
5. `no bgp nexthop trigger enable`
6. `end`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> <code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>Device&gt; enable</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> <code>configure terminal</code></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
</tbody>
</table>
### Command or Action

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device&gt; configure terminal</td>
<td>Enters router configuration mod to create or configure a BGP routing process.</td>
</tr>
</tbody>
</table>

**Step 3**

**router bgp** *autonomous-system-number*

**Example:**

Device(config)# router bgp 64512

Enter address family configuration mode to configure BGP peers to accept address family-specific configurations.

- The example creates an IPv4 unicast address family session.

**Step 4**

**address-family** ipv4 [[mdt | multicast | tunnel | unicast [vrf vrf-name] | vrf vrf-name] | vpnv4 [unicast] | vpnv6 [unicast]]

**Example:**

Device(config-router)# address-family ipv4 unicast

**Step 5**

**no bgp nexthop trigger enable**

**Example:**

Device(config-router-af)# no bgp nexthop trigger enable

Disables BGP next-hop address tracking.

- Next-hop address tracking is enabled by default for IPv4 and VPNv4 address family sessions.
- The example disables next-hop address tracking.

**Step 6**

**end**

**Example:**

Device(config-router-af)# end

Exits address-family configuration mode, and enters Privileged EXEC mode.

---

### Configuring Fast Session Deactivation

The tasks in this section show how to configure BGP next-hop address tracking. BGP next-hop address tracking significantly improves the response time of BGP to next-hop changes in the RIB. However, unstable Interior Gateway Protocol (IGP) peers can introduce instability to BGP neighbor sessions. We recommend that you aggressively dampen unstable IGP peering sessions to reduce the possible impact to BGP. For more details about route dampening, see the "Configuring Internal BGP Features" module.

### Configuring Fast Session Deactivation for a BGP Neighbor

Perform this task to establish a peering session with a BGP neighbor and then configure the peering session for fast session deactivation to improve the network convergence time if the peering session is deactivated.

Enabling fast session deactivation for a BGP neighbor can significantly improve BGP convergence time. However, unstable IGP peers can still introduce instability to BGP neighbor sessions. We recommend that you aggressively dampen unstable IGP peering sessions to reduce the possible impact to BGP.

### SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router bgp** *autonomous-system-number*
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example: Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode to create or configure a BGP routing process.</td>
</tr>
<tr>
<td>Example: Device(config)# router bgp 50000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> address-family ipv4 [mdt</td>
<td>multicast</td>
</tr>
<tr>
<td>Example: Device(config-router)# address-family ipv4 unicast</td>
<td>• The example creates an IPv4 unicast address family session.</td>
</tr>
<tr>
<td><strong>Step 5</strong> neighbor ip-address remote-as autonomous-system-number</td>
<td>Establishes a peering session with a BGP neighbor.</td>
</tr>
<tr>
<td>Example: Device(config-router-af)# neighbor 10.0.0.1 remote-as 50000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> neighbor ip-address fall-over</td>
<td>Configures the BGP peering to use fast session deactivation.</td>
</tr>
<tr>
<td>Example: Device(config-router-af)# neighbor 10.0.0.1 fall-over</td>
<td>• BGP will remove all routes learned through this peer if the session is deactivated.</td>
</tr>
<tr>
<td><strong>Step 7</strong> end</td>
<td>Exits configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Device(config-router-af)# end</td>
<td></td>
</tr>
</tbody>
</table>
## Configuring Selective Address Tracking for Fast Session Deactivation

Perform this task to configure selective address tracking for fast session deactivation. The optional `route-map` keyword and `map-name` argument of the `neighbor fall-over` command are used to determine if a peering session with a BGP neighbor should be deactivated (reset) when a route to the BGP peer changes. The route map is evaluated against the new route, and if a deny statement is returned, the peer session is reset.

**Note**

Only `match ip address` and `match source-protocol` commands are supported in the route map. No `set` commands or other `match` commands are supported.

### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `neighbor {ip-address|peer-group-name} remote-as autonomous-system-number`
5. `neighbor ip-address fall-over [route-map map-name]`
6. `exit`
7. `ip prefix-list list-name [seq seq-value] [deny network / length] [permit network / length] [ge ge-value] [le le-value]`
8. `route-map map-name [permit | deny] [sequence-number]`
9. `match ip address prefix-list prefix-list-name [prefix-list-name...]`
10. `end`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device&gt; enable</td>
<td>- Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# router bgp 45000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> neighbor {ip-address</td>
<td>peer-group-name} remote-as autonomous-system-number</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Step</td>
<td>Command or Action</td>
</tr>
<tr>
<td>------</td>
<td>------------------</td>
</tr>
</tbody>
</table>
| 5    | **neighbor** ip-address fall-over [route-map map-name] | Applies a route map when a route to the BGP changes.  
- In this example, the route map named CHECK-NBR is applied when the route to neighbor 192.168.1.2 changes. |
| 6    | **exit** | Exits router configuration mode and enters global configuration mode. |
| 7    | **ip prefix-list list-name** [seq seq-value]{deny network length | Creates a prefix list for BGP next-hop route filtering.  
- Selective next-hop route filtering supports prefix length matching or source protocol matching on a per-address-family basis.  
- The example creates a prefix list named FILTER28 that permits routes only if the mask length is greater than or equal to 28.  

**Example:**  
Device(config)# ip prefix-list FILTER28 seq 5  
permit 0.0.0.0/0 ge 28 |
| 8    | **route-map map-name** [permit | Configures a route map and enters route-map configuration mode.  
- In this example, a route map named CHECK-NBR is created. If there is an IP address match in the following **match** command, the IP address will be permitted. |
| 9    | match ip address prefix-list prefix-list-name | Matches the IP addresses in the specified prefix list.  
- Use the **prefix-list-name** argument to specify the name of a prefix list. The ellipsis means that more than one prefix list can be specified.  

**Note** Only the syntax applicable to this task is used in this example. For more details, see the *Cisco IOS IP Routing: BGP Command Reference*. |
| 10   | **end** | Exits configuration mode and returns to privileged EXEC mode. |
Configuration Examples for BGP Support for Next-Hop Address Tracking

Example: Enabling and Disabling BGP Next-Hop Address Tracking

In the following example, next-hop address tracking is disabled under the IPv4 address family session:

```conf
router bgp 50000
    address-family ipv4 unicast
    no bgp nexthop trigger enable
```

Example: Adjusting the Delay Interval for BGP Next-Hop Address Tracking

In the following example, the delay interval for next-hop tracking is configured to occur every 20 seconds under the IPv4 address family session:

```conf
router bgp 50000
    address-family ipv4 unicast
    bgp nexthop trigger delay 20
```

Examples: Configuring BGP Selective Next-Hop Route Filtering

The following example shows how to configure BGP selective next-hop route filtering to avoid using a BGP prefix as the next-hop route. If the most specific route that covers the next hop is a BGP route, then the BGP route will be marked as unreachable. The next hop must be an IGP or static route.

```conf
router bgp 45000
    address-family ipv4 unicast
    bgp nexthop route-map CHECK-BGP
    exit
    exit
    route-map CHECK-BGP deny 10
    match source-protocol bgp 1
    exit
    route-map CHECK-BGP permit 20
    end
```

The following example shows how to configure BGP selective next-hop route filtering to avoid using a BGP prefix as the next-hop route and to ensure that the prefix is more specific than /25.

```conf
router bgp 45000
    address-family ipv4 unicast
    bgp nexthop route-map CHECK-BGP25
    exit
    exit
    ip prefix-list FILTER25 seq 5 permit 0.0.0.0/0 le 25
    route-map CHECK-BGP25 deny 10
    match ip address prefix-list FILTER25
    exit
    route-map CHECK-BGP25 deny 20
    match source-protocol bgp 1
```
Example: Configuring Fast Session Deactivation for a BGP Neighbor

In the following example, the BGP routing process is configured on device A and device B to monitor and use fast peering session deactivation for the neighbor session between the two devices. Although fast peering session deactivation is not required at both devices in the neighbor session, it will help the BGP networks in both autonomous systems to converge faster if the neighbor session is deactivated.

**Device A**

```plaintext
router bgp 40000
  neighbor 192.168.1.1 remote-as 45000
  neighbor 192.168.1.1 fall-over
end
```

**Device B**

```plaintext
router bgp 45000
  neighbor 192.168.1.2 remote-as 40000
  neighbor 192.168.1.2 fall-over
end
```

Example: Configuring Selective Address Tracking for Fast Session Deactivation

The following example shows how to configure the BGP peering session to be reset if a route with a prefix of /28 or a more specific route to a peer destination is no longer available:

```plaintext
router bgp 45000
  neighbor 192.168.1.2 remote-as 40000
  neighbor 192.168.1.2 fall-over route-map CHECK-NBR
  exit
  ip prefix-list FILTER28 seq 5 permit 0.0.0.0/0 ge 28
  route-map CHECK-NBR permit 10
    match ip address prefix-list FILTER28
end
```

Additional References

**Related Documents**

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
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<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
</tbody>
</table>
Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
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<tr>
<td>The Cisco Support and Documentation website provides online resources to</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
<tr>
<td>download documentation, software, and tools. Use these resources to install</td>
<td></td>
</tr>
<tr>
<td>and configure the software and to troubleshoot and resolve technical</td>
<td></td>
</tr>
<tr>
<td>issues with Cisco products and technologies. Access to most tools on the</td>
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<td>Cisco Support and Documentation website requires a Cisco.com user ID and</td>
<td></td>
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<tr>
<td>password.</td>
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</table>

Feature Information for BGP Support for Next-Hop Address Tracking

Table 35: Feature Information for BGP Support for Next-Hop Address Tracking

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP Support for Next-Hop Address Tracking</td>
<td>Cisco IOS XE Release 2.1</td>
<td>The BGP Support for Next-Hop Address Tracking feature is enabled by default when a supporting Cisco IOS software image is installed. BGP next-hop address tracking is event driven. BGP prefixes are automatically tracked as peering sessions are established. Next-hop changes are rapidly reported to the BGP routing process as they are updated in the RIB. This optimization improves overall BGP convergence by reducing the response time to next-hop changes for routes installed in the RIB. When a bestpath calculation is run in between BGP scanner cycles, only next-hop changes are tracked and processed. This feature was introduced on the Cisco ASR 1000 Series Routers. The following command was introduced in this feature: <code>bgp nexthop</code>.</td>
</tr>
<tr>
<td>Feature Name</td>
<td>Releases</td>
<td>Feature Information</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>-------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>BGP Selective Address Tracking</td>
<td>12.2(31)SB</td>
<td>The BGP Selective Address Tracking feature introduces the use of a route map for next-hop route filtering and fast session deactivation. Selective next-hop filtering uses a route map to selectively define routes to help resolve the BGP next hop, or a route map can be used to determine if a peering session with a BGP neighbor should be reset when a route to the BGP peer changes. This feature was introduced on the Cisco ASR 1000 Series Routers. The following commands were modified by this feature: <code>bgp nexthop</code>, <code>neighbor fall-over</code>.</td>
</tr>
<tr>
<td></td>
<td>12.2(33)SRB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cisco IOS XE Release 2.1</td>
<td></td>
</tr>
<tr>
<td>BGP Support for Fast Peering Session Deactivation</td>
<td>12.2(33)SRA</td>
<td>The BGP Support for Fast Peering Session Deactivation feature introduced an event-driven notification system that allows a Border Gateway Protocol (BGP) process to monitor BGP peering sessions on a per-neighbor basis. This feature improves the response time of BGP to adjacency changes by allowing BGP to detect an adjacency change and deactivate the terminated session in between standard BGP scanning intervals. Enabling this feature improves overall BGP convergence. This feature was introduced on the Cisco ASR 1000 Series Routers. The following command was modified by this feature: <code>neighbor fall-over</code>.</td>
</tr>
<tr>
<td></td>
<td>12.2(31)SB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cisco IOS XE Release 2.1</td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER 20

BGP Restart Neighbor Session After Max-Prefix Limit Reached

The BGP Restart Session After Max-Prefix Limit Reached feature adds the `restart` keyword to the `neighbor maximum-prefix` command. This allows a network operator to configure the time interval at which a peering session is reestablished by a device when the number of prefixes that have been received from a peer has exceeded the maximum prefix limit.

- Finding Feature Information, on page 435
- Information About BGP Neighbor Session Restart After Max-Prefix Limit Reached, on page 435
- How to Configure a Device to Reestablish a Neighbor Session After the Maximum Prefix Limit Has Been Exceeded, on page 437
- Configuration Example for BGP Restart Neighbor Session After Max-Prefix Limit Reached, on page 441
- Additional References for BGP Restart Neighbor Session After Max-Prefix Limit Reached, on page 441
- Feature Information for BGP Restart Neighbor Session after Max-Prefix Limit, on page 442

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About BGP Neighbor Session Restart After Max-Prefix Limit Reached

Prefix Limits and BGP Peering Sessions

Use the `neighbor maximum-prefix` command to limit the maximum number of prefixes that a device running BGP can receive from a peer. When the device receives too many prefixes from a peer and the maximum-prefix
limit is exceeded, the peering session is disabled or brought down. The session stays down until the network operator manually brings the session back up by entering the `clear ip bgp` command, which clears stored prefixes.

**BGP Neighbor Session Restart with the Maximum Prefix Limit**

The `restart` keyword was added to the `neighbor maximum-prefix` command so that a network operator can configure a device to automatically reestablish a BGP neighbor peering session when the peering session has been disabled or brought down. The time interval at which peering can be reestablished automatically is configurable. The `restart-interval` for the `restart` keyword is specified in minutes; range is from 1 to 65,535 minutes.

**Subcodes for BGP Cease Notification**

Border Gateway Protocol (BGP) imposes maximum limits on the maximum number of prefixes that are accepted from a peer for a given address family. This limitation safeguards the device from resource depletion caused by misconfiguration, either locally or on the remote neighbor. To prevent a peer from flooding BGP with advertisements, a limit is placed on the number of prefixes that are accepted from a peer for each supported address family. The default limits can be overridden through configuration of the `maximum-prefix` limit command for the peer for the appropriate address family.

The following subcodes are supported for the BGP cease notification message:

- Maximum number of prefixes reached
- Administrative shutdown
- Peer de-configured
- Administrative reset

A cease notification message is sent to the neighbor and the peering with the neighbor is terminated when the number of prefixes received from the peer for a given address family exceeds the maximum limit (either set by default or configured by the user) for that address family. It is possible that the maximum number of prefixes for a neighbor for a given address family has been configured after the peering with the neighbor has been established and a certain number of prefixes have already been received from the neighbor for that address family. A cease notification message is sent to the neighbor and peering with the neighbor is terminated immediately after the configuration if the configured maximum number of prefixes is fewer than the number of prefixes that have already been received from the neighbor for the address family.
How to Configure a Device to Reestablish a Neighbor Session After the Maximum Prefix Limit Has Been Exceeded

Configuring a Router to Reestablish a Neighbor Session After the Maximum Prefix Limit Reached

Perform this task to configure the time interval at which a BGP neighbor session is reestablished by a device when the number of prefixes that have been received from a BGP peer has exceeded the maximum prefix limit.

The network operator can configure a device running BGP to automatically reestablish a neighbor session that has been brought down because the configured maximum-prefix limit has been exceeded. No intervention from the network operator is required when this feature is enabled.

Note
This task attempts to reestablish a disabled BGP neighbor session at the configured time interval that is specified by the network operator. However, the configuration of the restart timer alone cannot change or correct a peer that is sending an excessive number of prefixes. The network operator will need to reconfigure the maximum-prefix limit or reduce the number of prefixes that are sent from the peer. A peer that is configured to send too many prefixes can cause instability in the network, where an excessive number of prefixes are rapidly advertised and withdrawn. In this case, the **warning-only** keyword of the `neighbor maximum-prefix` command can be configured to disable the restart capability while the network operator corrects the underlying problem.

### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `neighbor {ip-address | ipv6-address | peer-group-name} peer-group`
5. `neighbor {ip-address | ipv6-address | peer-group-name} peer-group peer-group-name`
6. `neighbor {ip-address | ipv6-address | peer-group-name} remote-as autonomous-system-number [alternate-as autonomous-system-number...]
7. `neighbor {ip-address | ipv6-address | peer-group-name} remote-as autonomous-system-number [alternate-as autonomous-system-number...]
8. `neighbor {ip-address | ipv6-address | peer-group-name} maximum-prefix maximum [threshold] [restart minutes] [warning-only]`
9. `end`
10. `show ip bgp neighbors ip-address`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
</tbody>
</table>
### Command or Action

<table>
<thead>
<tr>
<th>Step 2</th>
<th>configure terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td>Device# configure terminal</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Purpose</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Enter your password if prompted.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 3</th>
<th>router bgp autonomous-system-number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td>Device(config)# router bgp 101</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Purpose</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Enters router configuration mode and creates a BGP routing process.</td>
<td></td>
</tr>
</tbody>
</table>

| Step 4 | neighbor {ip-address | ipv6-address | peer-group-name} peer-group  |
|--------|--------------------------------|
| Example: | Device(config-router)# neighbor internal peer-group |

<table>
<thead>
<tr>
<th>Purpose</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Creates a BGP or multiprotocol BGP peer group.</td>
<td></td>
</tr>
</tbody>
</table>

| Step 5 | neighbor {ip-address | ipv6-address | peer-group-name} peer-group peer-group-name  |
|--------|--------------------------------|
| Example: | Device(config-router)# neighbor 10.4.9.5 peer-group internal |

<table>
<thead>
<tr>
<th>Purpose</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Configures a BGP neighbor to member of a peer group.</td>
<td></td>
</tr>
</tbody>
</table>

| Step 6 | neighbor {ip-address | ipv6-address | peer-group-name} remote-as autonomous-system-number [ alternate-as autonomous-system-number... ]  |
|--------|--------------------------------|
| Example: | Device(config-router)# neighbor internal remote-as 100 |

<table>
<thead>
<tr>
<th>Purpose</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Adds a peer group to the BGP or multiprotocol BGP neighbor table.</td>
<td></td>
</tr>
</tbody>
</table>

| Step 7 | neighbor {ip-address | ipv6-address | peer-group-name} remote-as autonomous-system-number [ alternate-as autonomous-system-number... ]  |
|--------|--------------------------------|
| Example: | Device(config-router)# neighbor 10.4.9.5 remote-as 100 |

<table>
<thead>
<tr>
<th>Purpose</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Adds an entry to the BGP or multiprotocol BGP neighbor table.</td>
<td></td>
</tr>
</tbody>
</table>

| Step 8 | neighbor {ip-address | ipv6-address | } maximum-prefix maximum [threshold] [restart minutes] [warning-only]  |
|--------|--------------------------------|
| Example: |  |

<table>
<thead>
<tr>
<th>Purpose</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Configures the maximum-prefix limit on a router that is running BGP.</td>
<td></td>
</tr>
</tbody>
</table>

- Use the restart keyword and minutes argument to configure the router to automatically reestablish a neighbor session that has been disabled because the
### Command or Action

<table>
<thead>
<tr>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device(config-router)# neighbor 10.4.9.5 maximum-prefix 1000 90 restart 60</td>
</tr>
<tr>
<td>• Use the warning-only keyword to configure the device to disable the restart capability to allow you to adjust a peer that is sending too many prefixes.</td>
</tr>
<tr>
<td>Note: If the minutes argument is not configured, the disabled session will stay down after the maximum-prefix limit is exceeded. This is the default behavior.</td>
</tr>
</tbody>
</table>

### Step 9

#### end

**Example:**

Device(config-router)# end

**Purpose:** Exits router configuration mode and enters privileged EXEC mode.

### Step 10

#### show ip bgp neighbors ip-address

**Example:**

Device# show ip bgp neighbors 10.4.9.5

**Purpose:** (Optional) Displays information about the TCP and BGP connections to neighbors.

• In this example, the output from this command will display the maximum prefix limit for the specified neighbor and the configured restart timer value.

### Examples

The following sample output from the `show ip bgp neighbors` command verifies that a device has been configured to automatically reestablish disabled neighbor sessions. The output shows that the maximum prefix limit for neighbor 10.4.9.5 is set to 1000 prefixes, the restart threshold is set to 90 percent, and the restart interval is set at 60 minutes.

Device# show ip bgp neighbors 10.4.9.5

BGP neighbor is 10.4.9.5, remote AS 101, internal link  
BGP version 4, remote router ID 10.4.9.5  
BGP state = Established, up for 2w2d  
Last read 00:00:14, hold time is 180, keepalive interval is 60 seconds  
Neighbor capabilities:  
  Route refresh: advertised and received(new)  
  Address family IPv4 Unicast: advertised and received  
Message statistics:  
  InQ depth is 0  
  OutQ depth is 0  
  Sent  |  Rcvd  
  Opens:  |  1  |  1  
  Notifications: |  0  |  0  
  Updates: |  0  |  0  
  Keepalives: |  23095  |  23095  
  Route Refresh: |  0  |  0  
  Total: |  23096  |  23096  
Default minimum time between advertisement runs is 5 seconds
For address family: IPv4 Unicast
BGP table version 1, neighbor versions 1/0 1/0
Output queue sizes : 0 self, 0 replicated
Index 2, Offset 0, Mask 0x4
Member of update-group 2

Prefix activity: Sent Rcvd
Prefixes Current: 0 0
Prefixes Total: 0 0
Implicit Withdraw: 0 0
Explicit Withdraw: 0 0
Used as bestpath: n/a 0
Used as multipath: n/a 0
Outbound Inbound
Local Policy Denied Prefixes: ------- -------
Total: 0 0

Maximum prefixes allowed 1000
Threshold for warning message 90%, restart interval 60 min
Number of NLRIs in the update sent: max 0, min 0
Connections established 1; dropped 0
Last reset never
Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Local host: 10.4.9.21, Local port: 179
Foreign host: 10.4.9.5, Foreign port: 11871
Enqueued packets for retransmit: 0, input: 0 mis-ordered: 0 (0 bytes)
Event Timers (current time is 0x5296BD2C):
Timer Starts Wakeups Next
Retrans 23098 0 0x0
TimeWait 0 0 0x0
AckHold 23096 22692 0x0
SendWnd 0 0 0x0
KeepAlive 0 0 0x0
GiveUp 0 0 0x0
PmtuAger 0 0 0x0
DeadWait 0 0 0x0
iss: 1900546793 snduna: 1900985663 sndnxt: 1900985663 sndwnd: 14959
irs: 2894590641 rcvnx: 2895029492 rcvwnd: 14978 delrcw: 1406
SRTT: 300 ms, RTTO: 607 ms, RTV: 3 ms, KRTT: 0 ms
minRTT: 0 ms, maxRTT: 316 ms, ACK hold: 200 ms
Flags: passive open, nagle, gen tcbs
Datagrams (max data segment is 1460 bytes):
Rcvd: 46021 (out of order: 0), with data: 23096, total data bytes: 438850
Sent: 46095 (retransmit: 0, fastretransmit: 0), with data: 23097, total data by9

Troubleshooting Tips

Use the clear ip bgp command to reset a BGP connection using BGP soft reconfiguration. This command can be used to clear stored prefixes to prevent a device that is running BGP from exceeding the maximum-prefix limit.

Display of the following error messages can indicate an underlying problem that is causing the neighbor session to become disabled. You should check the values configured for the neighbor maximum-prefix command and the configuration of any peers that are sending an excessive number of prefixes. The following sample error messages are similar to the error messages that may be displayed:

00:01:14:%BGP-5-ADJCHANGE:neighbor 10.10.10.2 Up
00:01:14:%BGP-4-MAXPPX:No. of unicast prefix received from 10.10.10.2 reaches 5, max 6
00:01:14:%BGP-3-MAXPPXXCEED:No.of unicast prefix received from 10.10.10.2:7 exceed limit
The `bgp dampening` command can be used to configure the dampening of a flapping route or interface when a peer is sending too many prefixes and causing network instability. Use this command only when troubleshooting or tuning a device that is sending an excessive number of prefixes. For more details about BGP route dampening, see the “Configuring Advanced BGP Features” module.

### Configuration Example for BGP Restart Neighbor Session After Max-Prefix Limit Reached

**Example: Configuring a Router to Reestablish a Neighbor Session After the Maximum Prefix Limit Reached**

The following example sets the maximum number of prefixes allowed from the neighbor at 192.168.6.6 to 2000 and configures the device to reestablish a peering session after 30 minutes if one has been disabled:

```
Device(config)# router bgp 101
Device(config-router)# neighbor internal peer-group
Device(config-router)# neighbor 10.4.9.5 peer-group internal
Device(config-router)# neighbor internal remote-as 100
Device(config-router)# neighbor 10.4.9.5 remote-as 100
Device(config-router)# neighbor 10.4.9.5 maximum-prefix 2000 90 restart 30
Device(config-router)# end
```

### Additional References for BGP Restart Neighbor Session After Max-Prefix Limit Reached

#### Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
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<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
</tbody>
</table>

#### Standards and RFCs

<table>
<thead>
<tr>
<th>Standard/RFC</th>
<th>Title</th>
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<tbody>
<tr>
<td>RFC 2918</td>
<td>Route Refresh Capability for BGP-4</td>
</tr>
<tr>
<td>RFC 4486</td>
<td>Subcodes for BGP Cease Notification Message</td>
</tr>
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Technical Assistance

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<th>Description</th>
<th>Link</th>
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<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

Feature Information for BGP Restart Neighbor Session after Max-Prefix Limit

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to [http://www.cisco.com/go/cfn](http://www.cisco.com/go/cfn). An account on Cisco.com is not required.

**Table 36: Feature Information for BGP Restart Session After Max-Prefix Limit**

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP Restart Session After Max-Prefix Limit</td>
<td>Cisco IOS XE Release 2.1</td>
<td>The BGP Restart Session After Max-Prefix Limit Reached feature adds the <code>restart</code> keyword to the <code>neighbor maximum-prefix</code> command. This allows a network operator to configure the time interval at which a peering session is reestablished by a device when the number of prefixes that have been received from a peer has exceeded the maximum prefix limit. This feature was introduced on the Cisco ASR 1000 Series Aggregation Services Routers. The following commands were modified: <code>neighbor maximum-prefix</code> and <code>show ip bgp neighbors</code>.</td>
</tr>
<tr>
<td>BGP—Subcodes for BGP Cease Notification</td>
<td>Cisco IOS XE Release 3.13S</td>
<td>Support for subcodes for BGP cease notification has been added.</td>
</tr>
</tbody>
</table>
CHAPTER 21

BGP Support for Dual AS Configuration for Network AS Migrations

The BGP Support for Dual AS Configuration for Network AS Migrations feature extended the functionality of the BGP Local-AS feature by providing additional autonomous system path customization configuration options. The configuration of this feature is transparent to customer peering sessions, allowing the provider to merge two autonomous systems without interrupting customer peering arrangements. Customer peering sessions can later be updated during a maintenance window or during other scheduled downtime.

- Finding Feature Information, on page 443
- Information About BGP Support for Dual AS Configuration for Network AS Migrations, on page 443
- How to Configure BGP Support for Dual AS Configuration for Network AS Migrations, on page 445
- Configuration Examples for Dual-AS Peering for Network Migration, on page 447
- Additional References, on page 449
- Feature Information for BGP Support for Dual AS Configuration for Network AS Migrations, on page 449

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About BGP Support for Dual AS Configuration for Network AS Migrations

Autonomous System Migration for BGP Networks

Autonomous system migration can be necessary when a telecommunications or Internet service provider purchases another network. It is desirable for the provider to be able to integrate the second autonomous
system without disrupting existing customer peering arrangements. The amount of configuration required in
the customer networks can make this a cumbersome task that is difficult to complete without disrupting service.

**Dual Autonomous System Support for BGP Network Autonomous System Migration**

In Cisco IOS Release 12.0(29)S, 12.3(14)T, 12.2(33)SXH, and later releases, support was added for dual BGP
autonomous system configuration to allow a secondary autonomous system to merge under a primary
autonomous system, without disrupting customer peering sessions. The configuration of this feature is
transparent to customer networks. Dual BGP autonomous system configuration allows a router to appear, to
external peers, as a member of secondary autonomous system during the autonomous system migration. This
feature allows the network operator to merge the autonomous systems and then later migrate customers to
new configurations during normal service windows without disrupting existing peering arrangements.

The `neighbor local-as` command is used to customize the `AS_PATH` attribute by adding and removing
autonomous system numbers for routes received from eBGP neighbors. This feature allows a router to appear
to external peers as a member of another autonomous system for the purpose of autonomous system number
migration. This feature simplifies this process of changing the autonomous system number in a BGP network
by allowing the network operator to merge a secondary autonomous system into a primary autonomous system
and then later update the customer configurations during normal service windows without disrupting existing
peering arrangements.

**BGP Autonomous System Migration Support for Confederations, Individual Peering Sessions, and Peer
Groupings**

This feature supports confederations, individual peering sessions, and configurations applied through peer
groups and peer templates. If this feature is applied to group peers, the individual peers cannot be customized.

**Ingress Filtering During BGP Autonomous System Migration**

Autonomous system path customization increases the possibility that routing loops can be created if such
customization is misconfigured. The larger the number of customer peerings, the greater the risk. You can
minimize this possibility by applying policies on the ingress interfaces to block the autonomous system number
that is in transition or routes that have no `local-as` configuration.

**Caution**

BGP prepends the autonomous system number from each BGP network that a route traverses to maintain
network reachability information and to prevent routing loops. This feature should be configured only for
autonomous system migration and should be deconfigured after the transition has been completed. This
procedure should be attempted only by an experienced network operator, as routing loops can be created with
improper configuration.

**BGP Network Migration to 4-Byte Autonomous System Numbers**

The BGP Support for 4-Byte ASN feature introduced support for 4-byte autonomous system numbers. Because
of increased demand for autonomous system numbers, in January 2009 the IANA started to allocate 4-byte
autonomous system numbers in the range from 65536 to 4294967295.

The Cisco implementation of 4-byte autonomous system numbers supports RFC 4893. RFC 4893 was developed
to allow BGP to support a gradual transition from 2-byte autonomous system numbers to 4-byte autonomous
system numbers. A new reserved (private) autonomous system number, 23456, was created by RFC 4893 and this number cannot be configured as an autonomous system number in the Cisco IOS CLI.

Migrating your BGP network to 4-byte autonomous system numbers requires some planning. If you are upgrading to an image that supports 4-byte autonomous system numbers, you can still use 2-byte autonomous system numbers. The show command output and regular expression match are not changed and remain in asplain (decimal value) format for 2-byte autonomous system numbers regardless of the format configured for 4-byte autonomous system numbers.

To ensure a smooth transition, we recommend that all BGP speakers within an autonomous system that is identified using a 4-byte autonomous system number be upgraded to support 4-byte autonomous system numbers.

For details about steps to perform to upgrade a BGP network to full 4-byte autonomous system support, see the Migration Guide for Explaining 4-Byte Autonomous System white paper.

How to Configure BGP Support for Dual AS Configuration for Network AS Migrations

Configuring Dual AS Peering for Network Migration

Perform this task to configure a BGP peer router to appear to external peers as a member of another autonomous system for the purpose of autonomous system number migration. When the BGP peer is configured with dual autonomous system numbers then the network operator can merge a secondary autonomous system into a primary autonomous system and update the customer configuration during a future service window without disrupting existing peering arrangements.

The show ip bgp and show ip bgp neighbors commands can be used to verify autonomous system number for entries in the routing table and the status of this feature.

Note

• The BGP Support for Dual AS Configuration for Network AS Migrations feature can be configured for only true eBGP peering sessions. This feature cannot be configured for two peers in different subautonomous systems of a confederation.
• The BGP Support for Dual AS Configuration for Network AS Migrations feature can be configured for individual peering sessions and configurations applied through peer groups and peer templates. If this command is applied to a peer group, the peers cannot be individually customized.

SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. neighbor ip-address remote-as autonomous-system-number
5. neighbor ip-address local-as [autonomous-system-number [no-prepend [replace-as [dual-as]]]]
6. neighbor ip-address remove-private-as
7. end
8. **show ip bgp** `[network] [network-mask] [longer-prefixes] [prefix-list prefix-list-name | route-map route-map-name] [shorter-prefixes mask-length]

9. **show ip bgp neighbors** `[neighbor-address] [received-routes | routes | advertised-routes | paths regexp | dampened-routes | received prefix-filter]

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| Step 1 | **enable**<br>**Example:**<br>Router> enable | Enables privileged EXEC mode.  
  * Enter your password if prompted. |
| Step 2 | **configure terminal**<br>**Example:**<br>Router# configure terminal | Enters global configuration mode. |
| Step 3 | **router bgp** `autonomous-system-number`<br>**Example:**<br>Router(config)# router bgp 40000 | Enters router configuration mode, and creates a BGP routing process. |
| Step 4 | **neighbor** `ip-address remote-as autonomous-system-number`<br>**Example:**<br>Router(config-router)# neighbor 10.0.0.1 remote-as 45000 | Establishes a peering session with a BGP neighbor. |
| Step 5 | **neighbor** `ip-address local-as [autonomous-system-number [no-prepend [replace-as [dual-as]]]]`<br>**Example:**<br>Router(config-router)# neighbor 10.0.0.1 local-as 50000 no-prepend replace-as dual-as | Customizes the AS_PATH attribute for routes received from an eBGP neighbor.  
  * The **replace-as** keyword is used to prepend only the local autonomous system number (as configured with the `ip-address` argument) to the AS_PATH attribute. The autonomous system number from the local BGP routing process is not prepended.  
  * The **dual-as** keyword is used to configure the eBGP neighbor to establish a peering session using the real autonomous-system number (from the local BGP routing process) or by using the autonomous system number configured with the `ip-address` argument (local-as).  
  * The example configures the peering session with the 10.0.0.1 neighbor to accept the real autonomous system number and the local-as number. |
### Command or Action

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 6</td>
<td><code>neighbor ip-address remove-private-as</code></td>
<td>(Optional) Removes private autonomous system numbers from outbound routing updates.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong> <code>Router(config-router)# neighbor 10.0.0.1 remove-private-as</code></td>
<td>• This command can be used with the <code>replace-as</code> functionality to remove the private autonomous system number and replace it with an external autonomous system number.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Private autonomous system numbers (64512 to 65535) are automatically removed from the AS_PATH attribute when this command is configured.</td>
</tr>
<tr>
<td>Step 7</td>
<td><code>end</code></td>
<td>Exits router configuration mode and enters privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong> <code>Router(config-router)# end</code></td>
<td></td>
</tr>
<tr>
<td>Step 8</td>
<td>`show ip bgp [network] [network-mask] [longer-prefixes] [prefix-list prefix-list-name</td>
<td>Displays entries in the BGP routing table.</td>
</tr>
<tr>
<td></td>
<td>[route-map route-map-name] [shorter-prefixes mask-length]`</td>
<td>• The output can be used to verify if the real autonomous system number or local-as number is configured.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong> <code>Router# show ip bgp</code></td>
<td></td>
</tr>
<tr>
<td>Step 9</td>
<td>`show ip bgp neighbors [neighbor-address] [received-routes</td>
<td>routes</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong> <code>Router# show ip bgp neighbors</code></td>
<td>• The output will display <code>local AS</code>, <code>no-prepend</code>, <code>replace-as</code>, and <code>dual-as</code> with the corresponding autonomous system number when these options are configured.</td>
</tr>
</tbody>
</table>

### Configuration Examples for Dual-AS Peering for Network Migration

#### Example: Dual AS Configuration

The following examples show how this feature is used to merge two autonomous systems without interrupting peering arrangements with the customer network. The `neighbor local-as` command is configured to allow Router 1 to maintain peering sessions through autonomous system 40000 and autonomous system 45000. Router 2 is a customer router that runs a BGP routing process in autonomous system 50000 and is configured to peer with autonomous-system 45000.
Router 1 in Autonomous System 40000 (Provider Network)

```plaintext
interface Serial3/0
  ip address 10.3.3.11 255.255.255.0
  
  router bgp 40000
  no synchronization
  bgp router-id 10.0.0.11
  neighbor 10.3.3.33 remote-as 50000
  neighbor 10.3.3.33 local-as 45000 no-prepend replace-as dual-as
```

Router 1 in Autonomous System 45000 (Provider Network)

```plaintext
interface Serial3/0
  ip address 10.3.3.11 255.255.255.0
  
  router bgp 45000
  bgp router-id 10.0.0.11
  neighbor 10.3.3.33 remote-as 50000
```

Router 2 in Autonomous System 50000 (Customer Network)

```plaintext
interface Serial3/0
  ip address 10.3.3.33 255.255.255.0
  
  router bgp 50000
  bgp router-id 10.0.0.3
  neighbor 10.3.3.11 remote-as 45000
```

After the transition is complete, the configuration on router 50000 can be updated to peer with autonomous system 40000 during a normal maintenance window or during other scheduled downtime:

```plaintext
neighbor 10.3.3.11 remote-as 100
```

Example: Dual AS Confederation Configuration

The following example can be used in place of the Router 1 configuration in the "Example: Dual AS Configuration" example. The only difference between these configurations is that Router 1 is configured to be part of a confederation.

```plaintext
interface Serial3/0/0
  ip address 10.3.3.11 255.255.255.0
  
  router bgp 65534
  no synchronization
  bgp confederation identifier 100
  bgp router-id 10.0.0.11
  neighbor 10.3.3.33 remote-as 50000
  neighbor 10.3.3.33 local-as 45000 no-prepend replace-as dual-as
```

Example: Replace an AS with Another AS in Routing Updates

The following example strips private autonomous system 64512 from outbound routing updates for the 10.3.3.33 neighbor and replaces it with autonomous system 50000:
router bgp 64512
neighbor 10.3.3.33 local-as 50000 no-prepend replace-as

Additional References

Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
<tr>
<td>download documentation, software, and tools. Use these resources to install</td>
<td></td>
</tr>
<tr>
<td>and configure the software and to troubleshoot and resolve technical</td>
<td></td>
</tr>
<tr>
<td>issues with Cisco products and technologies. Access to most tools on the</td>
<td></td>
</tr>
<tr>
<td>Cisco Support and Documentation website requires a Cisco.com user ID and</td>
<td></td>
</tr>
<tr>
<td>password.</td>
<td></td>
</tr>
</tbody>
</table>

Feature Information for BGP Support for Dual AS Configuration for Network AS Migrations

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.
Table 37: Feature Information for BGP Support for Dual AS Configuration for Network AS Migrations

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP Support for Dual AS Configuration for Network AS Migrations</td>
<td>12.2(33)SRA Cisco IOS XE Release 2.1</td>
<td>The BGP Support for Dual AS Configuration for Network AS Migrations feature extended the functionality of the BGP Local-AS feature by providing additional autonomous system path customization configuration options. The configuration of this feature is transparent to customer peering sessions, allowing the provider to merge two autonomous systems without interrupting customer peering arrangements. Customer peering sessions can later be updated during a maintenance window or during other scheduled downtime. This feature was introduced on the Cisco ASR 1000 Series Routers. The following command was modified by this feature: <code>neighbor local-as</code>.</td>
</tr>
</tbody>
</table>
Configuring Internal BGP Features

This module describes how to configure internal Border Gateway Protocol (BGP) features. Internal BGP (iBGP) refers to running BGP on networking devices within one autonomous system. BGP is an interdomain routing protocol designed to provide loop-free routing between separate routing domains (autonomous systems) that contain independent routing policies. Many companies now have large internal networks, and there are many issues involved in scaling the existing internal routing protocols to match the increasing traffic demands while maintaining network efficiency.

- Finding Feature Information, on page 451
- Information About Internal BGP Features, on page 451
- How to Configure Internal BGP Features, on page 457
- Configuration Examples for Internal BGP Features, on page 469
- Additional References for Internal BGP Features, on page 472
- Feature Information for Configuring Internal BGP Features, on page 473

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

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Information About Internal BGP Features

BGP Routing Domain Confederation

One way to reduce the internal BGP (iBGP) mesh is to divide an autonomous system into multiple subautonomous systems and group them into a single confederation. To the outside world, the confederation looks like a single autonomous system. Each autonomous system is fully meshed within itself and has a few connections to other autonomous systems in the same confederation. Even though the peers in different autonomous systems have external BGP (eBGP) sessions, they exchange routing information as if they were iBGP peers. Specifically, the next hop, Multi Exit Discriminator (MED) attribute, and local preference...
information are preserved. This feature allows you to retain a single Interior Gateway Protocol (IGP) for all of the autonomous systems.

To configure a BGP confederation, you must specify a confederation identifier. To the outside world, the group of autonomous systems will look like a single autonomous system with the confederation identifier as the autonomous system number.

**BGP Route Reflector**

BGP requires that all iBGP speakers be fully meshed. However, this requirement does not scale well when there are many iBGP speakers. Instead of configuring a confederation, another way to reduce the iBGP mesh is to configure a route reflector.

The figure below illustrates a simple iBGP configuration with three iBGP speakers (Routers A, B, and C). Without route reflectors, when Router A receives a route from an external neighbor, it must advertise it to both routers B and C. Routers B and C do not readvertise the iBGP learned route to other iBGP speakers because the routers do not pass on routes learned from internal neighbors to other internal neighbors, thus preventing a routing information loop.

*Figure 38: Three Fully Meshed iBGP Speakers*

With route reflectors, all iBGP speakers need not be fully meshed because there is a method to pass learned routes to neighbors. In this model, an iBGP peer is configured to be a route reflector responsible for passing iBGP learned routes to a set of iBGP neighbors. In the figure below, Router B is configured as a route reflector. When the route reflector receives routes advertised from Router A, it advertises them to Router C, and vice versa. This scheme eliminates the need for the iBGP session between Routers A and C.
The internal peers of the route reflector are divided into two groups: client peers and all the other routers in the autonomous system (nonclient peers). A route reflector reflects routes between these two groups. The route reflector and its client peers form a **cluster**. The nonclient peers must be fully meshed with each other, but the client peers need not be fully meshed. The clients in the cluster do not communicate with iBGP speakers outside their cluster.

The figure below illustrates a more complex route reflector scheme. Router A is the route reflector in a cluster with routers B, C, and D. Routers E, F, and G are fully meshed, nonclient routers.
When the route reflector receives an advertised route, depending on the neighbor, it takes the following actions:

- A route from an external BGP speaker is advertised to all clients and nonclient peers.
- A route from a nonclient peer is advertised to all clients.
- A route from a client is advertised to all clients and nonclient peers. Hence, the clients need not be fully meshed.

Along with route reflector-aware BGP speakers, it is possible to have BGP speakers that do not understand the concept of route reflectors. They can be members of either client or nonclient groups allowing an easy and gradual migration from the old BGP model to the route reflector model. Initially, you could create a single cluster with a route reflector and a few clients. All the other iBGP speakers could be nonclient peers to the route reflector and then more clusters could be created gradually.

An autonomous system can have multiple route reflectors. A route reflector treats other route reflectors just like other iBGP speakers. A route reflector can be configured to have other route reflectors in a client group or nonclient group. In a simple configuration, the backbone could be divided into many clusters. Each route reflector would be configured with other route reflectors as nonclient peers (thus, all the route reflectors will be fully meshed). The clients are configured to maintain iBGP sessions with only the route reflector in their cluster.

Usually a cluster of clients will have a single route reflector. In that case, the cluster is identified by the router ID of the route reflector. To increase redundancy and avoid a single point of failure, a cluster might have more than one route reflector. In this case, all route reflectors in the cluster must be configured with the 4-byte cluster ID so that a route reflector can recognize updates from route reflectors in the same cluster. All the
route reflectors serving a cluster should be fully meshed and all of them should have identical sets of client and nonclient peers.

**Route Reflector Mechanisms to Avoid Routing Loops**

As the iBGP learned routes are reflected, routing information may loop. The route reflector model has the following mechanisms to avoid routing loops:

- **Originator ID** is an optional, nontransitive BGP attribute. It is a 4-byte attribute created by a route reflector. The attribute carries the router ID of the originator of the route in the local autonomous system. Therefore, if a misconfiguration causes routing information to come back to the originator, the information is ignored.

- **Cluster-list** is an optional, nontransitive BGP attribute. It is a sequence of cluster IDs that the route has passed. When a route reflector reflects a route from its clients to nonclient peers, and vice versa, it appends the local cluster ID to the cluster list. If the cluster list is empty, a new cluster list is created. Using this attribute, a route reflector can identify if routing information is looped back to the same cluster due to misconfiguration. If the local cluster ID is found in the cluster list, the advertisement is ignored.

- The use of `set` clauses in outbound route maps can modify attributes and possibly create routing loops. To avoid this behavior, most `set` clauses of outbound route maps are ignored for routes reflected to iBGP peers. The only `set` clause of an outbound route map that is acted upon is the `set ip next-hop` clause.

**BGP Outbound Route Map on Route Reflector to Set IP Next Hop for iBGP Peer**

The BGP Outbound Route Map on Route Reflectors to Set IP Next Hop for iBGP Peer feature allows a route reflector to modify the next hop attribute for a reflected route.

The use of `set` clauses in outbound route maps can modify attributes and possibly create routing loops. To avoid this behavior, most `set` clauses of outbound route maps are ignored for routes reflected to iBGP peers. The only `set` clause of an outbound route map on a route reflector (RR) that is acted upon is the `set ip next-hop` clause. The `set ip next-hop` clause is applied to reflected routes.

Configuring an RR with an outbound route map allows a network administrator to modify the next hop attribute for a reflected route. By configuring a route map with the `set ip next-hop` clause, the administrator puts the RR into the forwarding path, and can configure iBGP multipath load sharing to achieve load balancing. That is, the RR can distribute outgoing packets among multiple egress points. See the “Configuring iBGP Multipath Load Sharing” module.

---

**Caution**

Incorrectly setting BGP attributes for reflected routes can cause inconsistent routing, routing loops, or a loss of connectivity. Setting BGP attributes for reflected routes should be attempted only by someone who has a good understanding of the design implications.

**BGP Route Dampening**

Route dampening is a BGP feature designed to minimize the propagation of flapping routes across an internetwork. A route is considered to be flapping when its availability alternates repeatedly.

For example, consider a network with three BGP autonomous systems: autonomous system 1, autonomous system 2, and autonomous system 3. Suppose the route to network A in autonomous system 1 flaps (it becomes unavailable). Under circumstances without route dampening, the eBGP neighbor of autonomous system 1 to...
autonomous system 2 sends a withdraw message to autonomous system 2. The border router in autonomous system 2, in turn, propagates the withdraw message to autonomous system 3. When the route to network A reappears, autonomous system 1 sends an advertisement message to autonomous system 2, which sends it to autonomous system 3. If the route to network A repeatedly becomes unavailable, then available, many withdrawal and advertisement messages are sent. This is a problem in an internetwork connected to the Internet because a route flap in the Internet backbone usually involves many routes.

**Note**
No penalty is applied to a BGP peer reset when route dampening is enabled. Although the reset withdraws the route, no penalty is applied in this instance, even if route flap dampening is enabled.

**Route Dampening Minimizes Route Flapping**

The route dampening feature minimizes the flapping problem as follows. Suppose again that the route to network A flaps. The router in autonomous system 2 (where route dampening is enabled) assigns network A a penalty of 1000 and moves it to history state. The router in autonomous system 2 continues to advertise the status of the route to neighbors. The penalties are cumulative. When the route flaps so often that the penalty exceeds a configurable suppress limit, the router stops advertising the route to network A, regardless of how many times it flaps. Thus, the route is dampened.

The penalty placed on network A is decayed until the reuse limit is reached, upon which the route is once again advertised. At half of the reuse limit, the dampening information for the route to network A is removed.

**BGP Route Dampening Terms**

The following terms are used when describing route dampening:

- **Flap**—A route whose availability alternates repeatedly.
- **History state**—After a route flaps once, it is assigned a penalty and put into history state, meaning the router does not have the best path, based on historical information.
- **Penalty**—Each time a route flaps, the router configured for route dampening in another autonomous system assigns the route a penalty of 1000. Penalties are cumulative. The penalty for the route is stored in the BGP routing table until the penalty exceeds the suppress limit. At that point, the route state changes from history to damp.
- **Damp state**—In this state, the route has flapped so often that the router will not advertise this route to BGP neighbors.
- **Suppress limit**—A route is suppressed when its penalty exceeds this limit. The default value is 2000.
- **Half-life**—Once the route has been assigned a penalty, the penalty is decreased by half after the half-life period (which is 15 minutes by default). The process of reducing the penalty happens every 5 seconds.
- **Reuse limit**—As the penalty for a flapping route decreases and falls below this reuse limit, the route is unsuppressed. That is, the route is added back to the BGP table and once again used for forwarding. The default reuse limit is 750. The process of unsuppressing routes occurs at 10-second increments. Every 10 seconds, the router finds out which routes are now unsuppressed and advertises them to the world.
- **Maximum suppress limit**—This value is the maximum amount of time a route can be suppressed. The default value is four times the half-life.
The routes external to an autonomous system learned via iBGP are not dampened. This policy prevents the iBGP peers from having a higher penalty for routes external to the autonomous system.

**BGP Route Map Next Hop Self**

The BGP Route Map Next Hop Self feature provides a way to override the settings for bgp next-hop unchanged and bgp next-hop unchanged allpath selectively. These settings are global for an address family. For some routes, this may not be appropriate. For example, static routes may need to be redistributed with a next hop of self, but connected routes and routes learned via Interior Border Gateway Protocol (IBGP) or Exterior Border Gateway Protocol (EBGP) may continue to be redistributed with an unchanged next hop.

The BGP route map next hop self functionality modifies the existing route map infrastructure to configure a new ip next-hop self setting, which overrides the bgp next-hop unchanged and bgp next-hop unchanged allpaths settings.

The ip next-hop self setting is applicable only to VPNv4 and VPNv6 address families. Routes distributed by protocols other than BGP are not affected.

You configure a new bgp route-map priority setting to inform BGP that the route map will take priority over the settings for bgp next-hop unchanged and bgp next-hop unchanged allpath. The bgp route-map priority setting only impacts BGP. The bgp route-map priority setting has no impact unless you configure the bgp next-hop unchanged or bgp next-hop unchanged allpaths settings.

**How to Configure Internal BGP Features**

**Configuring a Routing Domain Confederation**

To configure a BGP confederation, you must specify a confederation identifier. To the outside world, the group of autonomous systems will look like a single autonomous system with the confederation identifier as the autonomous system number. To configure a BGP confederation identifier, use the following command in router configuration mode:

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Router(config-router)# bgp confederation identifier as-number</td>
<td>Configures a BGP confederation.</td>
</tr>
</tbody>
</table>

In order to treat the neighbors from other autonomous systems within the confederation as special eBGP peers, use the following command in router configuration mode:

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Router(config-router)# bgp confederation peers as-number [as-number]</td>
<td>Specifies the autonomous systems that belong to the confederation.</td>
</tr>
</tbody>
</table>

For an alternative way to reduce the iBGP mesh, see "Configuring a Route Reflector, on page 458."
## Configuring a Route Reflector

To configure a route reflector and its clients, use the following command in router configuration mode:

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>`Router(config-router)# neighbor {ip-address</td>
<td>peer-group-name} route-reflector-client`</td>
</tr>
</tbody>
</table>

If the cluster has more than one route reflector, configure the cluster ID by using the following command in router configuration mode:

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>Router(config-router)# bgp cluster-id cluster-id</code></td>
<td>Configures the cluster ID.</td>
</tr>
</tbody>
</table>

Use the `show ip bgp` command to display the originator ID and the cluster-list attributes.

By default, the clients of a route reflector are not required to be fully meshed and the routes from a client are reflected to other clients. However, if the clients are fully meshed, the route reflector need not reflect routes to clients.

To disable client-to-client route reflection, use the `no bgp client-to-client reflection` command in router configuration mode:

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>Router(config-router)# no bgp client-to-client reflection</code></td>
<td>Disables client-to-client route reflection.</td>
</tr>
</tbody>
</table>

## Configuring a Route Reflector Using a Route Map to a Set Next Hop for an iBGP Peer

Perform this task on an RR to set a next hop for an iBGP peer. One reason to perform this task is when you want to make the RR the next hop for routes, so that you can configure iBGP load sharing. Create a route map that sets the next hop to be the RR’s address, which will be advertised to the RR clients. The route map is applied only to outbound routes from the router to which the route map is applied.

**Caution**

Incorrectly setting BGP attributes for reflected routes can cause inconsistent routing, routing loops, or a loss of connectivity. Setting BGP attributes for reflected routes should only be attempted by someone who has a good understanding of the design implications.
Do not use the `neighbor next-hop-self` command to modify the next hop attribute for an RR. Using the `neighbor next-hop-self` command on the RR will modify next hop attributes only for non-reflected routes and not the intended routes that are being reflected from the RR clients. To modify the next hop attribute when reflecting a route, use an outbound route map.

This task configures the RR (Router 2) in the scenario illustrated in the figure below. In this case, Router 1 is the iBGP peer whose routes’ next hop is being set. Without a route map, outbound routes from Router 1 would go to next hop Router 3. Instead, setting the next hop to the RR’s address will cause routes from Router 1 to go to the RR, and thus allow the RR to perform load balancing among Routers 3, 4, and 5.

*Figure 41: Route Reflector Using a Route Map to a Set Next Hop for an iBGP Peer*

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `route-map map-tag`
4. `set ip next-hop ip-address`
5. `exit`
6. `router bgp as-number`
7. `address-family ipv4`
8. `maximum-paths ibgp number`
9. `neighbor ip-address remote-as as-number`
10. `neighbor ip-address activate`
11. `neighbor ip-address route-reflector-client`
12. `neighbor ip-address route-map map-name out`
13. Repeat Steps 12 through 14 for the other RR clients.
14. `end`
15. `show ip bgp neighbors`
## DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** | **enable** | Enables privileged EXEC mode.  
  * Enter your password if prompted. |
| **Example:** | | |
| | `Router>` enable | |
| | **Step 2** | Enters global configuration mode. |
| | **configure terminal** | |
| **Example:** | | |
| | `Router# configure terminal` | |
| | **Step 3** | Enters route map configuration mode to configure a route map.  
  * The route map is created to set the next hop for the route reflector client. |
| | **route-map map-tag** | |
| **Example:** | | |
| | `Router(config)# route-map rr-out` | |
| | **Step 4** | Specifies that for routes that are advertised where this route map is applied, the next-hop attribute is set to this IPv4 address.  
  * For this task, we want to set the next hop to be the address of the RR. |
<p>| | <strong>set ip next-hop ip-address</strong> | |
| <strong>Example:</strong> | | |
| | <code>Router(config-route-map)# set ip next-hop 10.2.0.1</code> | |
| | <strong>Step 5</strong> | Exits route-map configuration mode and enters global configuration mode. |
| | <strong>exit</strong> | |
| <strong>Example:</strong> | | |
| | <code>Router(config-route-map)# exit</code> | |
| | <strong>Step 6</strong> | Enters router configuration mode and creates a BGP routing process. |
| | <strong>router bgp as-number</strong> | |
| <strong>Example:</strong> | | |
| | <code>Router(config)# router bgp 100</code> | |
| | <strong>Step 7</strong> | Enters address family configuration mode to configure BGP peers to accept address family specific configurations. |
| | <strong>address-family ipv4</strong> | |
| <strong>Example:</strong> | | |
| | <code>Router(config-router-af)# address-family ipv4</code> | |
| | <strong>Step 8</strong> | Controls the maximum number of parallel iBGP routes that can be installed in the routing table. |
| | <strong>maximum-paths ibgp number</strong> | |
| <strong>Example:</strong> | | |
| | <code>Router(config-router)# maximum-paths ibgp 5</code> | |
| | <strong>Step 9</strong> | Adds an entry to the BGP neighbor table. |
| | <strong>neighbor ip-address remote-as as-number</strong> | |
| <strong>Example:</strong> | | |</p>
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Router(config-router-af)# neighbor 10.1.0.1 remote-as 100</td>
<td></td>
</tr>
<tr>
<td><strong>Step 10</strong> neighbor ip-address activate</td>
<td>Enables the exchange of information with the peer.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router(config-router-af)# neighbor 10.1.0.1 activate</td>
<td></td>
</tr>
<tr>
<td><strong>Step 11</strong> neighbor ip-address route-reflector-client</td>
<td>Configures the local router as a BGP route reflector, and configures the specified neighbor as a route-reflector client.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router(config-router-af)# neighbor 10.1.0.1 route-reflector-client</td>
<td></td>
</tr>
<tr>
<td><strong>Step 12</strong> neighbor ip-address route-map map-name out</td>
<td>Applies the route map to outgoing routes from this neighbor.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>• Reference the route map you created in Step 3.</td>
</tr>
<tr>
<td>Router(config-router-af)# neighbor 10.1.0.1 route-map rr-out out</td>
<td></td>
</tr>
<tr>
<td><strong>Step 13</strong> Repeat Steps 12 through 14 for the other RR clients.</td>
<td>You will not be applying a route map to the other RR clients.</td>
</tr>
<tr>
<td><strong>Step 14</strong> end</td>
<td>Exits address family configuration mode and enters privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router(config-router-af)# end</td>
<td></td>
</tr>
<tr>
<td><strong>Step 15</strong> show ip bgp neighbors</td>
<td>(Optional) Displays information about the BGP neighbors, including their status as RR clients, and information about the route map configured.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router# show ip bgp neighbors</td>
<td></td>
</tr>
</tbody>
</table>

### Adjusting BGP Timers

BGP uses certain timers to control periodic activities such as the sending of keepalive messages and the interval after not receiving a keepalive message after which the Cisco software declares a peer dead. By default, the keepalive timer is 60 seconds, and the hold-time timer is 180 seconds. You can adjust these timers. When a connection is started, BGP will negotiate the hold time with the neighbor. The smaller of the two hold times will be chosen. The keepalive timer is then set based on the negotiated hold time and the configured keepalive time.

To adjust BGP timers for all neighbors, use the following command in router configuration mode:

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device(config-router)# timers bgp keepalive holdtime</td>
<td>Adjusts BGP timers for all neighbors.</td>
</tr>
</tbody>
</table>
To adjust BGP keepalive and hold-time timers for a specific neighbor, use the following command in router configuration mode:

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device(config-router)# neighbor [ip-address | peer-group-name] timers keepalive holdtime</td>
<td>Sets the keepalive and hold-time timers (in seconds) for the specified peer or peer group.</td>
</tr>
</tbody>
</table>

**Note**

The timers configured for a specific neighbor or peer group override the timers configured for all BGP neighbors using the `timers bgp` router configuration command.

To clear the timers for a BGP neighbor or peer group, use the `no` form of the `neighbor timers` command.

### Configuring the Router to Consider a Missing MED as the Worst Path

To configure the router to consider a path with a missing MED attribute as the worst path, use the following command in router configuration mode:

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Router(config-router)# bgp bestpath med missing-as-worst</td>
<td>Configures the router to consider a missing MED as having a value of infinity, making the path without a MED value the least desirable path.</td>
</tr>
</tbody>
</table>

### Configuring the Router to Consider the MED to Choose a Path from Subautonomous System Paths

To configure the router to consider the MED value in choosing a path, use the following command in router configuration mode:

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Router(config-router)# bgp bestpath med confed</td>
<td>Configures the router to consider the MED in choosing a path from among those advertised by different subautonomous systems within a confederation.</td>
</tr>
</tbody>
</table>

The comparison between MEDs is made only if there are no external autonomous systems in the path (an external autonomous system is an autonomous system that is not within the confederation). If there is an external autonomous system in the path, then the external MED is passed transparently through the confederation, and the comparison is not made.

The following example compares route A with these paths:

- path= 65000 65004, med=2
- path= 65001 65004, med=3
- path= 65002 65004, med=4
- path= 65003 1, med=1
In this case, path 1 would be chosen if the `bgp bestpath med confed router configuration` command is enabled. The fourth path has a lower MED, but it is not involved in the MED comparison because there is an external autonomous system in this path.

### Configuring the Router to Use the MED to Choose a Path in a Confederation

To configure the router to use the MED to choose the best path from among paths advertised by a single subautonomous system within a confederation, use the following command in router configuration mode:

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>Router(config-router)# bgp deterministic med</code></td>
<td>Configures the router to compare the MED variable when choosing among routes advertised by different peers in the same autonomous system.</td>
</tr>
</tbody>
</table>

**Note**

If the `bgp always-compare-med` router configuration command is enabled, all paths are fully comparable, including those from other autonomous systems in the confederation, even if the `bgp deterministic med` command is also enabled.

### Enabling and Configuring BGP Route Dampening

Perform this task to enable and configure BGP route dampening.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp as-number`
4. `address-family ipv4 [unicast | multicast | vrf vrf-name]`
5. `bgp dampening [half-life reuse suppress max-suppress-time] [route-map map-name]`
6. `end`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><code>enable</code></td>
<td>Enter your password if prompted.</td>
</tr>
<tr>
<td><code>Example:</code></td>
<td></td>
</tr>
<tr>
<td><code>Router&gt; enable</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><code>configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><code>Example:</code></td>
<td></td>
</tr>
<tr>
<td><code>Router# configure terminal</code></td>
<td></td>
</tr>
</tbody>
</table>
### Configuring Internal BGP Features

#### Monitoring and Maintaining BGP Route Dampening

You can monitor the flaps of all the paths that are flapping. The statistics will be deleted once the route is not suppressed and is stable for at least one half-life. To display flap statistics, use the following commands as needed:

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Router# <code>show ip bgp dampening flap-statistics</code></td>
<td>Displays BGP flap statistics for all paths.</td>
</tr>
<tr>
<td>Router# <code>show ip bgp dampening flap-statistics regexp regexp</code></td>
<td>Displays BGP flap statistics for all paths that match the regular expression.</td>
</tr>
</tbody>
</table>

---

**Purpose**

**Command or Action**

### Step 3

**router bgp as-number**  
**Example:**  

`Router(config)# router bgp 45000`

Enters router configuration mode and creates a BGP routing process.

### Step 4

**address-family ipv4 [unicast | multicast | vrf vrf-name]**  
**Example:**  

```
Router(config-router)# address-family ipv4 unicast
```

Specifies the IPv4 address family and enters address family configuration mode.

- The `unicast` keyword specifies the IPv4 unicast address family. By default, the router is placed in address family configuration mode for the IPv4 unicast address family if the `unicast` keyword is not specified with the `address-family ipv4` command.
- The `multicast` keyword specifies IPv4 multicast address prefixes.
- The `vrf` keyword and `vrf-name` arguments specify the name of the VRF instance to associate with subsequent IPv4 address family configuration mode commands.

### Step 5

**bgp dampening [half-life reuse suppress max-suppress-time] [route-map map-name]**  
**Example:**  

```
Router(config-router-af)# bgp dampening 30 1500 10000 120
```

Enables BGP route dampening and changes the default values of route dampening factors.

- The `half-life`, `reuse`, `suppress`, and `max-suppress-time` arguments are all position dependent; if one argument is entered then all the arguments must be entered.
- Use the `route-map` keyword and `map-name` argument to control where BGP route dampening is enabled.

### Step 6

**end**  
**Example:**  

```
Router(config-router-af)# end
```

Exits address family configuration mode and enters privileged EXEC mode.

---

**Monitoring and Maintaining BGP Route Dampening**

You can monitor the flaps of all the paths that are flapping. The statistics will be deleted once the route is not suppressed and is stable for at least one half-life. To display flap statistics, use the following commands as needed:
### Purpose

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| Router# `show ip bgp dampening flap-statistics`  
  `filter-list access-list list` | Displays BGP flap statistics for all paths that pass the filter. |
| Router# `show ip bgp dampening flap-statistics`  
  `ip-address mask` | Displays BGP flap statistics for a single entry. |
| Router# `show ip bgp dampening flap-statistics`  
  `ip-address mask longer-prefix` | Displays BGP flap statistics for more specific entries. |

To clear BGP flap statistics (thus making it less likely that the route will be dampened), use the following commands as needed:

### Command

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Router# <code>clear ip bgp flap-statistics</code></td>
<td>Clears BGP flap statistics for all routes.</td>
</tr>
<tr>
<td>Router# <code>clear ip bgp flap-statistics regexp regexp</code></td>
<td>Clears BGP flap statistics for all paths that match the regular expression.</td>
</tr>
<tr>
<td>Router# <code>clear ip bgp flap-statistics filter-list list</code></td>
<td>Clears BGP flap statistics for all paths that pass the filter.</td>
</tr>
<tr>
<td>Router# <code>clear ip bgp flap-statistics ip-address mask</code></td>
<td>Clears BGP flap statistics for a single entry.</td>
</tr>
<tr>
<td>Router# <code>clear ip bgp flap-statistics ip-address mask longer-prefix</code></td>
<td>Clears BGP flap statistics for all paths from a neighbor.</td>
</tr>
</tbody>
</table>

---

**Note**

The flap statistics for a route are also cleared when a BGP peer is reset. Although the reset withdraws the route, there is no penalty applied in this instance, even if route flap dampening is enabled.

Once a route is dampened, you can display BGP route dampening information, including the time remaining before the dampened routes will be unsuppressed. To display the information, use the following command:

### Command

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Router# <code>show ip bgp dampening dampened-paths</code></td>
<td>Displays the dampened routes, including the time remaining before they will be unsuppressed.</td>
</tr>
</tbody>
</table>

You can clear BGP route dampening information and unsuppress any suppressed routes by using the following command:
### Purpose

Clears route dampening information and unsuppresses the suppressed routes.

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>Router# clear ip bgp dampened-paths [ip-address network-mask]</code></td>
<td>Clears route dampening information and unsuppresses the suppressed routes.</td>
</tr>
</tbody>
</table>

### Configuring BGP Route Map next-hop self

Perform this task to modify the existing route map by adding the ip next-hop self setting and overriding the bgp next-hop unchanged and bgp next-hop unchanged allpaths settings.

#### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `route-map map-tag permit sequence-number`
4. `match source-protocol source-protocol`
5. `set ip next-hop self`
6. `exit`
7. `route-map map-tag permit sequence-number`
8. `match route-type internal`
9. `match route-type external`
10. `match source-protocol source-protocol`
11. `exit`
12. `router bgp autonomous-system-number`
13. `neighbor ip-address remote-as autonomous-system-number`
14. `address-family vpnv4`
15. `neighbor ip-address activate`
16. `neighbor ip-address next-hop unchanged allpaths`
17. `neighbor ip-address route-map map-name out`
18. `exit`
19. `address-family ipv4 [unicast | multicast | vrf vrf-name]`
20. `bgp route-map priority`
21. `redistribute protocol`
22. `redistribute protocol`
23. `exit-address-family`
24. `end`

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>Device&gt; enable</code></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Enter your password if prompted.</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
<td></td>
</tr>
<tr>
<td>Example: Device# configure terminal</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> route-map map-tag permit sequence-number</td>
<td>Defines conditions for redistributing routes from one routing protocol to another routing protocol and enters route-map configuration mode.</td>
<td></td>
</tr>
<tr>
<td>Example: Device(config)# route-map static-nexthop-rewrite permit 10</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> match source-protocol source-protocol</td>
<td>Matches Enhanced Interior Gateway Routing Protocol (EIGRP) external routes based on a source protocol.</td>
<td></td>
</tr>
<tr>
<td>Example: Device(config-route-map)# match source-protocol static</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> set ip next-hop self</td>
<td>Configure local routes (for BGP only) with next hop of self.</td>
<td></td>
</tr>
<tr>
<td>Example: Device(config-route-map)# set ip next-hop self</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> exit</td>
<td>Exits route-map configuration mode and enters global configuration mode.</td>
<td></td>
</tr>
<tr>
<td>Example: Device(config-route-map)# exit</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong> route-map map-tag permit sequence-number</td>
<td>Defines conditions for redistributing routes from one routing protocol to another routing protocol and enters route-map configuration mode.</td>
<td></td>
</tr>
<tr>
<td>Example: Device(config)# route-map static-nexthop-rewrite permit 20</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong> match route-type internal</td>
<td>Redistributes routes of the specified type.</td>
<td></td>
</tr>
<tr>
<td>Example: Device(config-route-map)# match route-type internal</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 9</strong> match route-type external</td>
<td>Redistributes routes of the specified type.</td>
<td></td>
</tr>
<tr>
<td>Example: Device(config-route-map)# match route-type external</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 10</strong> match source-protocol source-protocol</td>
<td>Matches Enhanced Interior Gateway Routing Protocol (EIGRP) external routes based on a source protocol.</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td>Device(config-route-map)# match source-protocol connected</td>
<td>Exits route-map configuration mode and enters global configuration mode.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 11</strong> exit</td>
<td>Enters router configuration mode and creates a BGP routing process.</td>
<td></td>
</tr>
<tr>
<td>Example: Device(config-route-map)# exit</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 12</strong> router bgp autonomous-system-number</td>
<td>Adds an entry to the BGP or multiprotocol BGP neighbor table.</td>
<td></td>
</tr>
<tr>
<td>Example: Device(config)# router bgp 45000</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 13</strong> neighbor ip-address remote-as autonomous-system-number</td>
<td>Specifies the VPNv4 address family and enters address family configuration mode.</td>
<td></td>
</tr>
<tr>
<td>Example: Device(config-router)# neighbor 172.16.232.50 remote-as 65001</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 14</strong> address-family vpnv4</td>
<td>Enables the exchange of information with a Border Gateway Protocol (BGP) neighbor.</td>
<td></td>
</tr>
<tr>
<td>Example: Device(config-router)# address-family vpnv4</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 15</strong> neighbor ip-address activate</td>
<td>Enables an external EBGP peer that is configured as multihop to propagate the next hop unchanged.</td>
<td></td>
</tr>
<tr>
<td>Example: Device(config-router-af)# neighbor 172.16.232.50 activate</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 16</strong> neighbor ip-address next-hop unchanged allpaths</td>
<td>Applies a route map to an outgoing route.</td>
<td></td>
</tr>
<tr>
<td>Example: Device(config-router-af)# neighbor 172.16.232.50 next-hop unchanged allpaths</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 17</strong> neighbor ip-address route-map map-name out</td>
<td>Exits address family configuration mode and enters router configuration mode.</td>
<td></td>
</tr>
<tr>
<td>Example: Device(config-router-af)# neighbor 172.16.232.50 route-map static-nexthop-rewrite out</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 18</strong> exit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Example: Device(config-router-af)# exit</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Configuration Examples for Internal BGP Features

#### Example: BGP Confederation Configurations with Route Maps

This section contains an example of the use of a BGP confederation configuration that includes BGP communities and route maps. For more examples of how to configure a BGP confederation, see the “Example: BGP Confederation” section in this module.

This example shows how BGP community attributes are used with a BGP confederation configuration to filter routes.

In this example, the route map named `set-community` is applied to the outbound updates to neighbor 172.16.232.50 and the local-as community attribute is used to filter the routes. The routes that pass access list 1 have the special community attribute value local-as. The remaining routes are advertised normally.

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 19</strong></td>
<td><strong>Purpose</strong></td>
</tr>
<tr>
<td>address-family ipv4 [unicast</td>
<td>multiset] vrf vrf-name</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config-router)# address-family ipv4 unicast vrf inside</td>
<td></td>
</tr>
<tr>
<td><strong>Step 20</strong></td>
<td><strong>Purpose</strong></td>
</tr>
<tr>
<td>bgp route-map priority</td>
<td>Configures the route map priority for the local BGP routing process.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config-router-af)# bgp route-map priority</td>
<td></td>
</tr>
<tr>
<td><strong>Step 21</strong></td>
<td><strong>Purpose</strong></td>
</tr>
<tr>
<td>redistribute protocol</td>
<td>Redistributes routes from one routing domain into another routing domain.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config-router-af)# redistribute static</td>
<td></td>
</tr>
<tr>
<td><strong>Step 22</strong></td>
<td><strong>Purpose</strong></td>
</tr>
<tr>
<td>redistribute protocol</td>
<td>Redistributes routes from one routing domain into another routing domain.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config-router-af)# redistribute connected</td>
<td></td>
</tr>
<tr>
<td><strong>Step 23</strong></td>
<td><strong>Purpose</strong></td>
</tr>
<tr>
<td>exit-address-family</td>
<td>Exits address family configuration mode and enters router configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config-router-af)# exit address-family</td>
<td></td>
</tr>
<tr>
<td><strong>Step 24</strong></td>
<td><strong>Purpose</strong></td>
</tr>
<tr>
<td>end</td>
<td>Exits router configuration mode and enters privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config-router)# end</td>
<td></td>
</tr>
</tbody>
</table>
special community value automatically prevents the advertisement of those routes by the BGP speakers outside autonomous system 200.

```
router bgp 65000
    network 10.0.1.0 route-map set-community
    bgp confederation identifier 200
    bgp confederation peers 65001
    neighbor 172.16.232.50 remote-as 100
    neighbor 172.16.233.2 remote-as 65001
    !
    route-map set-community permit 10
    match ip address 1
    set community local-as
```

### Example: BGP Confederation

The following is a sample configuration that shows several peers in a confederation. The confederation consists of three internal autonomous systems with autonomous system numbers 6001, 6002, and 6003. To the BGP speakers outside the confederation, the confederation looks like a normal autonomous system with autonomous system number 500 (specified via the `bgp confederation identifier` router configuration command).

In a BGP speaker in autonomous system 6001, the `bgp confederation peers` router configuration command marks the peers from autonomous systems 6002 and 6003 as special eBGP peers. Hence peers 172.16.232.55 and 172.16.232.56 will get the local preference, next hop, and MED unmodified in the updates. The router at 10.16.69.1 is a normal eBGP speaker and the updates received by it from this peer will be just like a normal eBGP update from a peer in autonomous system 6001.

```
router bgp 6001
    bgp confederation identifier 500
    bgp confederation peers 6002 6003
    neighbor 172.16.232.55 remote-as 6002
    neighbor 172.16.232.56 remote-as 6003
    neighbor 10.16.69.1 remote-as 777
```

In a BGP speaker in autonomous system 6002, the peers from autonomous systems 6001 and 6003 are configured as special eBGP peers. 10.70.70.1 is a normal iBGP peer and 10.99.99.2 is a normal eBGP peer from autonomous system 700.

```
router bgp 6002
    bgp confederation identifier 500
    bgp confederation peers 6001 6003
    neighbor 10.70.70.1 remote-as 6002
    neighbor 172.16.232.57 remote-as 6001
    neighbor 172.16.232.56 remote-as 6003
    neighbor 10.99.99.2 remote-as 700
```

In a BGP speaker in autonomous system 6003, the peers from autonomous systems 6001 and 6002 are configured as special eBGP peers. 10.200.200.200 is a normal eBGP peer from autonomous system 701.

```
router bgp 6003
    bgp confederation identifier 500
    bgp confederation peers 6001 6002
    neighbor 172.16.232.57 remote-as 6001
    neighbor 172.16.232.55 remote-as 6002
    neighbor 10.200.200.200 remote-as 701
```
The following is a part of the configuration from the BGP speaker 10.200.200.205 from autonomous system 701 in the same example. Neighbor 172.16.232.56 is configured as a normal eBGP speaker from autonomous system 500. The internal division of the autonomous system into multiple autonomous systems is not known to the peers external to the confederation.

```
router bgp 701
    neighbor 172.16.232.56 remote-as 500
    neighbor 10.200.200.205 remote-as 701
```

**Example: Route Reflector Using a Route Map to Set a Next Hop for an iBGP Peer**

The following example is based on the figure above. Router 2 is the route reflector for the clients: Routers 1, 3, 4, and 5. Router 1 is connected to Router 3, but you don’t want Router 1 to forward traffic destined to AS 200 to use Router 3 as the next hop (and therefore use the direct link with Router 3); you want to direct the traffic to the RR, which can load share among Routers 3, 4, and 5.

This example configures the RR, Router 2. A route map named rr-out is applied to Router 1; the route map sets the next hop to be the RR at 10.2.0.1. When Router 1 sees that the next hop is the RR address, Router 1 forwards the routes to the RR. When the RR receives packets, it will automatically load share among the iBGP paths. A maximum of five iBGP paths are allowed.

```
Router 2

route-map rr-out
    set ip next-hop 10.2.0.1

interface gigabitethernet 0/0
    ip address 10.2.0.1 255.255.0.0
router bgp 100
    address-family ipv4 unicast
    maximum-paths ibgp 5
    neighbor 10.1.0.1 remote-as 100
    neighbor 10.1.0.1 activate
    neighbor 10.1.0.1 route-reflector-client
    neighbor 10.1.0.1 route-map rr-out out

    neighbor 10.3.0.1 remote-as 100
    neighbor 10.3.0.1 activate
    neighbor 10.3.0.1 route-reflector-client

    neighbor 10.4.0.1 remote-as 100
    neighbor 10.4.0.1 activate
    neighbor 10.4.0.1 route-reflector-client

    neighbor 10.5.0.1 remote-as 100
    neighbor 10.5.0.1 activate
    neighbor 10.5.0.1 route-reflector-client
end
```

**Example: Configuring BGP Route Map next-hop self**

This section contains an example of how to configure BGP Route Map next-hop self.
In this example, a route map is configured that matches the networks where you wish to override settings for bgp next-hop unchanged and bgp next-hop unchanged allpath. Subsequently, next-hop self is configured. After this, the bgp route map priority is configured for the specified address family so that the previously specified route map takes priority over the settings for bgp next-hop unchanged and bgp next-hop unchanged allpath. This configuration results in static routes being redistributed with a next hop of self, but connected routes and routes learned via IBGP or EBGP continue to be redistributed with an unchanged next hop.

```
route-map static-nexthop-rewrite permit 10
match source-protocol static
set ip next-hop self
route-map static-nexthop-rewrite permit 20
match route-type internal
match route-type external
match source-protocol connected
!
router bgp 65000
neighbor 172.16.232.50 remote-as 65001
address-family vpnv4
  neighbor 172.16.232.50 activate
  neighbor 172.16.232.50 next-hop unchanged allpaths
  neighbor 172.16.232.50 route-map static-nexthop-rewrite out
exit-address-family
address-family ipv4 unicast vrf inside
  bgp route-map priority
  redistribute static
  redistribute connected
exit-address-family
end
```

### Additional References for Internal BGP Features

#### Related Documents

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<tr>
<th>Related Topic</th>
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<td>Cisco IOS Master Commands List, All Releases</td>
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<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
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<tr>
<td>BGP overview</td>
<td>“Cisco BGP Overview” module</td>
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<td>Basic BGP configuration tasks</td>
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<td>iBGP multipath load sharing</td>
<td>“iBGP Multipath Load Sharing” module</td>
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<td>Connecting to a service provider</td>
<td>“Connecting to a Service Provider Using External BGP” module</td>
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<tr>
<td>Configuring features that apply to multiple IP routing protocols</td>
<td><em>IP Routing: Protocol-Independent Configuration Guide</em></td>
</tr>
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<tr>
<th>RFC</th>
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<tr>
<td>RFC 1772</td>
<td>Application of the Border Gateway Protocol in the Internet</td>
</tr>
<tr>
<td>RFC 1773</td>
<td>Experience with the BGP Protocol</td>
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<td>RFC 1774</td>
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<td>RFC 1930</td>
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<td>Multiprotocol Extensions for BGP-4</td>
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<td>RFC 2918</td>
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<td>Capabilities Advertisement with BGP-4</td>
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<tr>
<td>RFC 4271</td>
<td>A Border Gateway Protocol 4 (BGP-4)</td>
</tr>
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<td>RFC 4893</td>
<td>BGP Support for Four-octet AS Number Space</td>
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<td>Textual Representation of Autonomous system (AS) Numbers</td>
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<td>RFC 5398</td>
<td>Autonomous System (AS) Number Reservation for Documentation Use</td>
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Technical Assistance

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<tr>
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<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
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</tbody>
</table>

Feature Information for Configuring Internal BGP Features

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.
### Table 38: Feature Information for Configuring Internal BGP Features

<table>
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<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Configuration Information</th>
</tr>
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<tr>
<td>Configuring internal BGP features</td>
<td>10.3</td>
<td>All the features contained in this module are considered to be legacy features and will work in all trains release images. The following commands were introduced or modified by these features:&lt;br&gt;&lt;br&gt;• <code>bgp always-compare-med</code>&lt;br&gt;• <code>bgp bestpath med confed</code>&lt;br&gt;• <code>bgp bestpath med missing-as-worst</code>&lt;br&gt;• <code>bgp client-to-client reflection</code>&lt;br&gt;• <code>bgp cluster-id</code>&lt;br&gt;• <code>bgp confederation identifier</code>&lt;br&gt;• <code>bgp confederation peers</code>&lt;br&gt;• <code>bgp dampening</code>&lt;br&gt;• <code>bgp deterministic med</code>&lt;br&gt;• <code>clear ip bgp dampening</code>&lt;br&gt;• <code>clear ip bgp flap-statistics</code>&lt;br&gt;• <code>neighbor route-reflector-client</code>&lt;br&gt;• <code>neighbor timers</code>&lt;br&gt;• <code>show ip bgp</code>&lt;br&gt;• <code>show ip bgp dampening dampened-paths</code>&lt;br&gt;• <code>show ip bgp dampening flap-statistics</code>&lt;br&gt;• <code>timers bgp</code></td>
</tr>
<tr>
<td></td>
<td>12.0(7)T</td>
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<tr>
<td></td>
<td>12.0(32)S12</td>
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<tr>
<td></td>
<td>12.2(33)SRA</td>
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</tr>
<tr>
<td></td>
<td>12.2(33)SXH</td>
<td></td>
</tr>
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<td>12.0(16)ST</td>
<td>The BGP Outbound Route Map on Route Reflector to Set IP Next Hop feature allows a route reflector to modify the next hop attribute for a reflected route.</td>
</tr>
<tr>
<td></td>
<td>12.0(22)S</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td>12.2(14)S</td>
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<td></td>
<td>15.0(1)S</td>
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<tr>
<td>BGP Outbound Route Map on Route Reflector to Set IP Next Hop</td>
<td>12.0(16)ST</td>
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<td>12.0(22)S</td>
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<td></td>
<td>12.2</td>
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<td></td>
<td>12.2(14)S</td>
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</tr>
<tr>
<td></td>
<td>15.0(1)S</td>
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</tr>
</tbody>
</table>
CHAPTER 23

BGP VPLS Auto Discovery Support on Route Reflector

BGP Route Reflector was enhanced to be able to reflect BGP VPLS prefixes without having VPLS explicitly configured on the route reflector.

- Finding Feature Information, on page 475
- Information About BGP VPLS Auto Discovery Support on Route Reflector, on page 475
- Configuration Example for BGP VPLS Auto Discovery Support on Route Reflector, on page 476
- Additional References, on page 476
- Feature Information for BGP VPLS Auto Discovery Support on Route Reflector, on page 477

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About BGP VPLS Auto Discovery Support on Route Reflector

BGP VPLS Autodiscovery Support on Route Reflector

In Cisco IOS Release 12.2(33)SRE, BGP VPLS Autodiscovery Support on Route Reflector was introduced. On the Cisco 7600 and Cisco 7200 series routers, BGP Route Reflector was enhanced to be able to reflect BGP VPLS prefixes without having VPLS explicitly configured on the route reflector. The route reflector reflects the VPLS prefixes to other provider edge (PE) routers so that the PEs do not need to have a full mesh of BGP sessions. The network administrator configures only the BGP VPLS address family on the route reflector.
For an example of a route reflector configuration that can reflect VPLS prefixes, see the “Example: BGP VPLS Autodiscovery Support on Route Reflector” section. For more information about VPLS Autodiscovery, see the “VPLS Autodiscovery BGP Based” module in the MPLS Layer 2 VPNs Configuration Guide.

Restrictions for BGP VPLS Auto Discovery Support on Route Reflector

- VPLS BGP Auto Discovery with BGP Signaling in inter-AS Option C is not supported in IOS XE for route reflector.

Configuration Example for BGP VPLS Auto Discovery Support on Route Reflector

Example: BGP VPLS Autodiscovery Support on Route Reflector

In the following example, a host named PE-RR (indicating Provider Edge Route Reflector) is configured as a route reflector capable of reflecting VPLS prefixes. The VPLS address family is configured by `address-family l2vpn vpls` command.

```
hostname PE-RR
!
router bgp 1
  bgp router-id 1.1.1.3
  no bgp default route-target filter
  bgp log-neighbor-changes
  neighbor iBGP_PEERS peer-group
  neighbor iBGP_PEERS remote-as 1
  neighbor iBGP_PEERS update-source Loopback1
  neighbor 1.1.1.1 peer-group iBGP_PEERS
  neighbor 1.1.1.2 peer-group iBGP_PEERS
!
  address-family l2vpn vpls
    neighbor iBGP_PEERS send-community extended
    neighbor iBGP_PEERS route-reflector-client
    neighbor 1.1.1.1 peer-group iBGP_PEERS
    neighbor 1.1.1.2 peer-group iBGP_PEERS
  exit-address-family
!
```

Additional References

**Related Documents**

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</tr>
</tbody>
</table>

Feature Information for BGP VPLS Auto Discovery Support on Route Reflector

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<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
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<tr>
<td>BGP VPLS Auto Discovery Support on Route Reflector</td>
<td>12.2(33)SRE</td>
<td>BGP Route Reflector was enhanced to be able to reflect BGP VPLS prefixes without having VPLS explicitly configured on the route reflector.</td>
</tr>
<tr>
<td></td>
<td>Cisco IOS XE Release 2.5</td>
<td>This feature was introduced on the Cisco 7600 and Cisco 7200 series routers.</td>
</tr>
</tbody>
</table>
BGP FlowSpec Route-reflector Support

The BGP (Border Gateway Protocol) Flowspec (Flow Specification) Route Reflector feature enables service providers to control traffic flows in their network. This helps in filtering traffic and helps in taking action against distributed denial of service (DDoS) mitigation by dropping the DDoS traffic or diverting it to an analyzer.

BGP flow specification provides a mechanism to encode flow specification rules for traffic flows that can be distributed as BGP Network Layer Reachability Information (NLRI).

- Finding Feature Information, on page 479
- Restrictions for BGP FlowSpec Route-reflector Support, on page 479
- Information About BGP FlowSpec Route-reflector Support, on page 480
- How to Configure BGP FlowSpec Route-reflector Support, on page 481
- Configuration Examples for BGP FlowSpec Route-reflector Support, on page 487
- Additional References for BGP FlowSpec Route-reflector Support, on page 489
- Feature Information for BGP FlowSpec Route-reflector Support, on page 489

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Restrictions for BGP FlowSpec Route-reflector Support

- In Cisco IOS 15.5(S) release, BGP flow specification is supported only on a route reflector.
- Mixing of address family matches and actions is not supported in flow spec rules. For example, IPv4 matches cannot be combined with IPv6 actions and vice versa.
Information About BGP FlowSpec Route-reflector Support

Overview of Flowspec

Flowspec specifies procedures for the distribution of flow specification rules as Border Gateway Protocol Network Layer Reachability Information (BGP NLRI) that can be used in any application. It also defines application for the purpose of packet filtering in order to mitigate distributed denial of service attacks.

A flow specification rule consists of a matching part encoded in the BGP NLRI field and an action part encoded as BGP extended community as defined in the RFC 5575. A flow specification rule is a set of data (represented in an n-tuple) consisting of several matching criteria that can be applied to IP packet data. BGP flow specification rules are internally converted to equivalent Cisco Common Classification Policy Language (C3PL) representing corresponding match and action parameters.

In Cisco IOS 15.5(S) release, Flowspec supports following functions for the BGP route reflector:

- Flowspec rules defined in RFC 5575
- IPv6 extensions
- Redirect IP extensions
- BGP flowspec validation

Matching Criteria

The following table lists the various Flowspec tuples that are supported for BGP.

<table>
<thead>
<tr>
<th>BGP Flowspec NLRI Type</th>
<th>QoS Matching Field (IPv6)</th>
<th>QoS Matching Field (IPv4)</th>
<th>Input Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1</td>
<td>IPv6 destination address</td>
<td>IPv4 destination address</td>
<td>Prefix length</td>
</tr>
<tr>
<td>Type 2</td>
<td>IPv6 source address</td>
<td>IPv4 source address</td>
<td>Prefix length</td>
</tr>
<tr>
<td>Type 3</td>
<td>IPv6 next header</td>
<td>IPv4 protocol</td>
<td>Multi-value range</td>
</tr>
<tr>
<td>Type 4</td>
<td>IPv6 source or destination port</td>
<td>IPv4 source or destination port</td>
<td>Multi-value range</td>
</tr>
<tr>
<td>Type 5</td>
<td>IPv6 destination port</td>
<td>IPv4 destination port</td>
<td>Multi-value range</td>
</tr>
<tr>
<td>Type 6</td>
<td>IPv6 source port</td>
<td>IPv4 source port</td>
<td>Multi-value range</td>
</tr>
<tr>
<td>Type 7</td>
<td>IPv6 ICMP type</td>
<td>IPv4 ICMP type</td>
<td>Multi-value range</td>
</tr>
<tr>
<td>Type 8</td>
<td>IPv6 ICMP code</td>
<td>IPv4 ICMP code</td>
<td>Multi-value range</td>
</tr>
<tr>
<td>Type 9</td>
<td>IPv6 TCP flags</td>
<td>IPv4 TCP flags (2 bytes include reserved bits)</td>
<td>Bit mask</td>
</tr>
<tr>
<td>Type 10</td>
<td>IPv6 packet length</td>
<td>IPv4 packet length</td>
<td>Multi-value range</td>
</tr>
<tr>
<td>Type 11</td>
<td>IPv6 traffic class</td>
<td>IPv4 DSCP</td>
<td>Multi-value range</td>
</tr>
</tbody>
</table>
### How to Configure BGP FlowSpec Route-reflector Support

**Configuring BGP FlowSpec Route-reflector Support**

Perform this task to configure BGP FlowSpec on a route reflector. This task specifies only the IPv4 address family but, other address families are also supported for BGP flow specifications.

**Before you begin**

Configure a BGP route reflector.

**SUMMARY STEPS**

1. **enable**
2. **configure terminal**
3. **router bgp** `autonomous-system-number`
4. **neighbor** `ip-address` **remote-as** `autonomous-system-number`
5. **address-family** `{ipv4 | ipv6 | vpnv4 | vpnv6} flowspec`
6. **neighbor** `ip-address` **activate**
7. **neighbor** `ip-address` **route-reflector-client**
8. **end**

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp <code>autonomous-system-number</code></td>
<td>Enters router configuration mode for the BGP routing process.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# router bgp 1</td>
<td></td>
</tr>
</tbody>
</table>
### Disabling BGP FlowSpec Validation

Perform this task if you want to disable the BGP flow specification validations for eBGP peers. The validations are enabled by default.

To know more about BGP flow specification validations, see RFC 5575 (draft-ietf-idr-bgp-flowspec-oid-01-Revised Validation Procedure for BGP Flow Specifications).

#### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `address-family {ipv4 | ipv6 | vpnv4 | vpnv6} flowspec`
5. `neighbor ip-address validation off`

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 <code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
</tbody>
</table>

---

### BGP FlowSpec Route-reflector Support

<table>
<thead>
<tr>
<th>Step 4</th>
<th><code>neighbor ip-address remote-as autonomous-system-number</code></th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td><code>Device(config-router)# neighbor 10.1.1.1 remote-as 1</code></td>
<td>Adds an entry to the BGP or multiprotocol BGP neighbor table.</td>
</tr>
</tbody>
</table>

| Step 5 | `address-family {ipv4 | ipv6 | vpnv4 | vpnv6} flowspec` | Purpose |
|--------|----------------------------------------------------------|---------|
| Example: | `Device(config-router)# address-family ipv4 flowspec` | Specifies the address family and enters address family configuration mode. |
| - | Flowspec is supported on IPv4, IPv6, VPNv4 and VPNv6 address families. |

<table>
<thead>
<tr>
<th>Step 6</th>
<th><code>neighbor ip-address activate</code></th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td><code>Device(config-router-af)# neighbor 10.1.1.1 activate</code></td>
<td>Enables the exchange of information with a BGP neighbor.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 7</th>
<th><code>neighbor ip-address route-reflector-client</code></th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td><code>Device(config-router-af)# neighbor 10.1.1.1 route-reflector-client</code></td>
<td>Configures the router as a BGP route reflector and configures the specified neighbor as its client.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 8</th>
<th><code>end</code></th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td><code>Device(config-router-af)# end</code></td>
<td>(Optional) Exits address family configuration mode and returns to privileged EXEC mode.</td>
</tr>
</tbody>
</table>
### Command or Action

**Example:**

Device> enable

• Enter your password if prompted.

### Step 2

**configure terminal**

**Example:**

Device# configure terminal

Enters global configuration mode.

### Step 3

**router bgp autonomous-system-number**

**Example:**

Device(config)# router bgp 1

Enters router configuration mode for the BGP routing process.

### Step 4

**address-family {ipv4 | ipv6 | vpnv4 | vpnv6} flowspec**

**Example:**

Device(config-router)# address-family ipv4 flowspec

Specifies the address family and enters address family configuration mode.

• Flowspec is supported on IPv4, IPv6, VPNv4 and VPNv6 address families.

### Step 5

**neighbor ip-address validation off**

**Example:**

Device(config-router-af)# neighbor 10.1.1.1 validation off

Disables validation of flow specification for eBGP peers.

## Verifying BGP FlowSpec Route-reflector Support

The `show` commands can be entered in any order.

### Before you begin

Configure BGP FlowSec on a route reflector.

### SUMMARY STEPS

1. show bgp ipv4 flowspec
2. show bgp ipv4 flowspec detail
3. show bgp ipv4 flowspec summary
4. show bgp ipv6 flowspec
5. show bgp ipv6 flowspec detail
6. show bgp ipv6 flowspec summary
7. show bgp vpnv4 flowspec
8. show bgp vpnv4 flowspec all detail
9. show bgp vpnv6 flowspec
10. show bgp vpnv6 flowspec all detail
DETAILED STEPS

Step 1  show bgp ipv4 flowspec

This command displays the IPv4 flowspec routes.

Example:

```
Device# show bgp ipv4 flowspec

BGP table version is 3, local router ID is 10.10.10.2 Status codes: s suppressed, d damped, h history, * valid, > best, i - internal, r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter, best-external, a additional-path, c RIB-compressed, Origin codes: i - IGP, e - EGP, ? - incomplete RPKI validation codes: V valid, I invalid, N Not found

  Network  Next Hop  Metric  LocPrf Weight  Path
*>i Dest:2.2.2.0/24 10.0.101.1 100  0  0  i
*>i Dest:3.3.3.0/24 10.0.101.1 100  0  0  i
```

Step 2  show bgp ipv4 flowspec detail

This command displays the detailed information about IPv4 flowspec routes.

Example:

```
Device# show bgp ipv4 flowspec detail

BGP routing table entry for Dest:2.2.2.0/24, version 2
Paths: (1 available, best #1, table IPv4-Flowspec-BGP-Table)
Advertised to update-groups:
  1 Refresh Epoch 1
  Local, (Received from a RR-client)
    10.0.101.1 from 10.0.101.1 (10.0.101.1)
    Origin IGP, localpref 100, valid, internal, best
    Extended Community: FLOWSPEC Redirect-IP:0x000000000001
    rx pathid: 0, tx pathid: 0x0
BGP routing table entry for Dest:3.3.3.0/24, version 3
Paths: (1 available, best #1, table IPv4-Flowspec-BGP-Table)
Advertised to update-groups:
  1 Refresh Epoch 1
  Local, (Received from a RR-client)
    10.0.101.1 from 10.0.101.1 (10.0.101.1)
    Origin IGP, localpref 100, valid, internal, best
    rx pathid: 0, tx pathid: 0x0
```

Step 3  show bgp ipv4 flowspec summary

This command displays the IPv4 flowspec neighbors.

Example:

```
Device# show bgp ipv4 flowspec summary

BGP router identifier 10.10.10.2, local AS number 239 BGP table version is 3, main routing table version 3
2 network entries using 16608 bytes of memory
```


Step 4

**show bgp ipv6 flowspec**

This command displays the IPv6 flowspec routes.

**Example:**

```
Device# show bgp ipv6 flowspec
```

BGP table version is 2, local router ID is 10.10.10.2
Status codes: s suppressed, d damped, h history,
* valid, > best, i - internal, r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
x best-external, a additional-path, c RIB-compressed, Origin codes: i - IGP, e - EGP,
? - incomplete RPKI validation codes: V valid, I invalid, N Not found

<table>
<thead>
<tr>
<th>Network</th>
<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>* &gt;1 Dest:3::/0-24, Source:4::/0-24</td>
<td>FEC0::1001</td>
<td>100</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Step 5

**show bgp ipv6 flowspec detail**

This command displays the detailed information about IPv6 flowspec routes.

**Example:**

```
Device# show bgp ipv6 flowspec detail
```

BGP routing table entry for Dest:3::/0-24, Source:4::/0-24, version 2
Paths: (1 available, best #1, table Global-Flowspecv6-Table)
Advertised to update-groups:
2
Refresh Epoch 1
Local
    FEC0::1001 from FEC0::1001 (10.0.101.2)
    Origin IGP, localpref 100, valid, internal, best
    rx pathid: 0, tx pathid: 0x0

Step 6

**show bgp ipv6 flowspec summary**

This command displays the IPv6 flowspec neighbors.

**Example:**
Device# show bgp ipv6 flowspec summary

BGP router identifier 10.10.10.2, local AS number 239 BGP table version is 3, main routing table version 3
2 network entries using 16608 bytes of memory
2 path entries using 152 bytes of memory
2/2 BGP path/bestpath attribute entries using 304 bytes of memory
1 BGP AS-PATH entries using 24 bytes of memory
2 BGP extended community entries using 48 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 17136 total bytes of memory
BGP activity 18/0 prefixes, 18/0 paths, scan interval 15 secs

Neighbor State/PfxRcd  V  AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd
10.0.101.1 2 4 239 70 24 3 0 0 00:10:58
10.0.101.2 <2 4 239 0 0 1 0 0 never
Idle
10.0.101.3 4 240 0 0 1 0 0 never
Idle
10.10.10.1 4 239 19 23 3 0 0 00:10:53

Step 7 show bgp vpnv4 flowspec

This command displays the VPNv4 flowspec neighbors.

Example:
Device# show bgp vpnv4 flowspec

BGP table version is 2, local router ID is 10.10.10.2 Status codes: s suppressed, d damped, h history,
* valid, > best, i - internal,r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
x best-external, a additional-path, c RIB-compressed, Origin codes: i - IGP, e - BGP,
? - incomplete RPKI validation codes: V valid, I invalid, N Not found

Network Route Distinguisher: 200:200
Next Hop Metric LocPrf Weight Path
Dest:10.0.1.0/24 10.0.101.1 100 0 i

Step 8 show bgp vpnv4 flowspec all detail

This command displays the VPNv4 flowspec details.

Example:
Device# show bgp vpnv4 flowspec all detail

Route Distinguisher: 200:200
BGP routing table entry for 200:200:Dest:10.0.1.0/24, version 2
Paths: (1 available, best #1, table VPNv4-Flowspec-BGP-Table)
Advertised to update-groups:
3
Refresh Epoch 1
Local
10.0.101.1 (via default) from 10.0.101.1 (10.0.101.1)
Origin IGP, localpref 100, valid, internal, best
Extended Community: RT:100:100
rx pathid: 0, tx pathid: 0x0
Step 9  
**show bgp vpnv6 flowspec**

This command displays the VPNv6 flowspec neighbors.

**Example:**

```bash
Device# show bgp vpnv6 flowspec
```

<table>
<thead>
<tr>
<th>Network</th>
<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>*&gt;1</td>
<td>SPort:=20640</td>
<td>FEC0::1001</td>
<td>100</td>
<td>0</td>
<td>i</td>
</tr>
</tbody>
</table>

Step 10  
**show bgp vpnv6 flowspec all detail**

This command displays the VPNv6 flowspec details.

**Example:**

```bash
Device# show bgp vpnv6 flowspec all detail
```

**Configuration Examples for BGP FlowSpec Route-reflector Support**

**Example: BGP FlowSpec Route-reflector Support**

**Example: Configuring BGP FlowSpec on Route Reflector**

Configure BGP route reflector and inject flowspec in the route reflector.
Figure 42: BGP Route Reflector Topology

! Configure the topology

! Configure the interfaces on RR

RR> enable
RR# configure terminal
RR(config)# interface E0/0
RR(config-if)# ip address 10.0.0.1 255.224.0.0
RR(config-if)# no shutdown
RR(config-if)# exit
RR(config)# interface S2/0
RR(config-if)# ip address 10.32.0.1 255.224.0.0
RR(config-if)# no shutdown
RR(config-if)# exit
RR(config)# interface S3/0
RR(config-if)# ip address 10.64.0.1 255.224.0.0
RR(config-if)# no shutdown

! Configure RR as the route reflector with S2/0 (R1) and S2/0 (R2) as the neighbors

RR(config)# router bgp 333
RR(config-router)# no synchronization
RR(config-router)# network 10.0.0.0 mask 255.224.0.0
RR(config-router)# network 10.64.0.0 mask 255.224.0.0
RR(config-router)# network 10.32.0.0 mask 255.224.0.0
RR(config-router)# neighbor 10.64.0.2 remote-as 333
RR(config-router)# neighbor 10.32.0.2 remote-as 333

! Configure flowspec on route reflector

RR(config-router)# address-family ipv4 flowspec
RR(config-router-af)# neighbor 10.64.0.2 activate
RR(config-router-af)# neighbor 10.64.0.2 route-reflector-client
RR(config-router-af)# neighbor 10.32.0.2 activate
RR(config-router)# neighbor 10.32.0.2 route-reflector-client

! Verify the configuration

RR> show bgp ipv4 flowspec
Additional References for BGP FlowSpec Route-reflector Support

Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
</tbody>
</table>

Standards and RFCs

<table>
<thead>
<tr>
<th>Standard/RFC</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFC 5575</td>
<td>Dissemination of Flow Specification Rules</td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

Feature Information for BGP FlowSpec Route-reflector Support

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/efn. An account on Cisco.com is not required.
The BGP FlowSpec Route-reflector Support feature enables services providers to control traffic flows in their network and mitigate DDoS attack.

The following command was introduced by this feature:

```
address-family {ipv4 | ipv6 | vpnv4 | vpnv6} flowspec.
```

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP FlowSpec Route-reflector Support</td>
<td>15.5(1)S</td>
<td>The BGP FlowSpec Route-reflector Support feature enables services providers to control traffic flows in their network and mitigate DDoS attack. This feature was introduced on the Cisco ASR 1000 Series Routers. The following command was introduced by this feature: address-family {ipv4</td>
</tr>
<tr>
<td>BGP FlowSpec Route-reflector Support</td>
<td>Cisco IOS XE Release 3.14</td>
<td>The BGP FlowSpec Route-reflector Support feature enables services providers to control traffic flows in their network and mitigate DDoS attack. This feature was introduced on the Cisco ASR 1000 Series Routers. The following command was introduced by this feature: address-family {ipv4</td>
</tr>
</tbody>
</table>
BGP Flow Specification Client

The Border Gateway Protocol (BGP) flow specification client feature enables a device to perform the role of a BGP flow specification client and receive flow specification rules from a BGP flow specification controller. Flow specification rules contain a set of match criteria and actions (also called flows). The flows are configured on a controller (device), which advertises the flows to the client device, or specific interfaces on the client.

Attention

IOS XE software supports BGP flow specification client function and does not support BGP flow specification controller function.

• Finding Feature Information, on page 491
• Prerequisites for BGP Flow Specification Client, on page 491
• Restrictions for BGP Flow Specification Client, on page 492
• Information About BGP Flow Specification Client, on page 492
• How to Configure BGP Flow Specification Client, on page 494
• Configuration Examples for BGP Flow Specification Client, on page 499
• Additional References for BGP Flow Specification Client, on page 500
• Feature Information for BGP Flow Specification Client, on page 501

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for BGP Flow Specification Client

• Identify and configure flow specification rules on the controller.
Restrictions for BGP Flow Specification Client

- In Cisco IOS 15.5(S) release, BGP flow specification is supported only on a BGP flow specification client and route reflector.
- Mixing of address family matches and actions is not supported in flow specification rules. For example, IPv4 matches cannot be combined with IPv6 actions and vice versa.

Information About BGP Flow Specification Client

BGP Flow Specification Model

The BGP protocol is used for flow specifications due to unique advantages it offers. The three elements that are used to route flow specifications through BGP enabled devices are: controller, client, and route-reflector (which is optional). This document is specific to the client element function.

Though devices with the IOS XE software (such as ASR 1000, and so on) can perform BGP flow specification client role and not the controller role, a brief outline of the BGP flow specification process is given below for better understanding.

The BGP flow specification functionality allows you to rapidly deploy and propagate filtering and policing functionality among a large number of BGP peer devices to mitigate the effects of a distributed denial-of-service (DDoS) attack over your network.

The BGP flow specification model comprises of a client and a controller (route-reflector usage is optional). The controller is responsible for sending or injecting the flow specification NRLI entry. The client (acting as a BGP speaker) receives the NRLI and programs the hardware forwarding to act on the instruction from the controller. An illustration of this model is provided below.
In the above topology, the controller on the left-hand side injects the flow specification NRLI into the client on the right-hand side. The client receives the information, sends it to the flow specification manager component, configures the ePBR (Enhanced Policy Based Routing) infrastructure, which in turn programs the platform hardware of the device. This way, you can create rules to handle DDoS attacks on your network.

**Sample Flow Specification Client Configuration**

First, associate the device to a BGP autonomous system and enable flow specification policy mapping capability for various address families. Then, identify a neighbor (through its IP address) as a BGP peer and enable the capability to exchange information between the devices through the `neighbor activate` command. This way, flow specification information can be exchanged between the client, controller, and any other flow specification client device.

```text
! router bgp 100
  address-family ipv4 flowspec
    neighbor 10.1.1.1 activate!
```

**Matching Criteria and Actions**

The flow specification NLRI type consists of several optional sub-components. A specific packet is considered to match the flow specification when it matches the intersection (AND) of all the components present in the specification. The following are the supported component types or tuples that you can define:

<table>
<thead>
<tr>
<th>BGP Flowspec NLRI Type</th>
<th>QoS Matching Field (IPv6)</th>
<th>QoS Matching Field (IPv4)</th>
<th>Input Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1</td>
<td>IPv6 destination address</td>
<td>IPv4 destination address</td>
<td>Prefix length</td>
</tr>
<tr>
<td>Type 2</td>
<td>IPv6 source address</td>
<td>IPv4 source address</td>
<td>Prefix length</td>
</tr>
<tr>
<td>Type 3</td>
<td>IPv6 next header</td>
<td>IPv4 protocol</td>
<td>Multi-value range</td>
</tr>
</tbody>
</table>
### How to Configure BGP Flow Specification Client

#### Configuring a Device As a Flow Specification Client and Establishing a BGP Peer Relationship With Neighbor

The following task explains configuration of a device as a BGP flow specification client. A device interface within a VRF instance can also perform the role of a BGP flow specification client.

**Before you begin**

Before configuring a device as a flow specification client, it is a good practice to identify and configure the flow specification controller device (and a route reflector, if required). When flow specification rules are configured on the controller, the rules are remotely injected into the client and the matching criteria and corresponding actions are programmed into the platform hardware of the client.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp as-number`
4. `address-family {ipv4 | ipv6} flowspec`
5. `neighbor ip-address activate`
6. `exit`
7. `address-family {ipv4 | ipv6} flowspec vrf vrf-name`
8. `neighbor ip-address remote-as as-number`
9. `neighbor ip-address activate`

---

<table>
<thead>
<tr>
<th>BGP Flowspec NLRI Type</th>
<th>QoS Matching Field (IPv6)</th>
<th>QoS Matching Field (IPv4)</th>
<th>Input Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 4</td>
<td>IPv6 source or destination port</td>
<td>IPv4 source or destination port</td>
<td>Multi-value range</td>
</tr>
<tr>
<td>Type 5</td>
<td>IPv6 destination port</td>
<td>IPv4 destination port</td>
<td>Multi-value range</td>
</tr>
<tr>
<td>Type 6</td>
<td>IPv6 source port</td>
<td>IPv4 source port</td>
<td>Multi-value range</td>
</tr>
<tr>
<td>Type 7</td>
<td>IPv6 ICMP type</td>
<td>IPv4 ICMP type</td>
<td>Multi-value range</td>
</tr>
<tr>
<td>Type 8</td>
<td>IPv6 ICMP code</td>
<td>IPv4 ICMP code</td>
<td>Multi-value range</td>
</tr>
<tr>
<td>Type 9</td>
<td>IPv6 TCP flags</td>
<td>IPv4 TCP flags (2 bytes include reserved bits)</td>
<td>Bit mask</td>
</tr>
<tr>
<td>Type 10</td>
<td>IPv6 packet length</td>
<td>IPv4 packet length</td>
<td>Multi-value range</td>
</tr>
<tr>
<td>Type 11</td>
<td>IPv6 traffic class</td>
<td>IPv4 DSCP</td>
<td>Multi-value range</td>
</tr>
<tr>
<td>Type 12</td>
<td>Reserved</td>
<td>IPv4 fragment bits</td>
<td>Bit mask</td>
</tr>
</tbody>
</table>
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td></td>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>configure terminal</td>
<td>Enters global configuration mode</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>router bgp as-number</td>
<td>Specifies the autonomous system number and enters the BGP configuration mode, allowing you to configure the BGP routing process.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config)# router bgp 100</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>address-family {ipv4</td>
<td>ipv6} flowspec</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config-bgp)# address-family ipv4 flowspec</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>neighbor ip-address activate</td>
<td>Places the device in neighbor configuration mode for BGP routing and configures the neighbor IP address as a BGP peer. Enables the device to advertise (and receive information), including its IP address, to its BGP neighbor.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config-bgp-af)# neighbor 10.1.1.1 activate</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>exit</td>
<td>Exits BGP address family configuration mode and enters BGP configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config-bgp-af)# exit</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>address-family {ipv4</td>
<td>ipv6} flowspec vrf vrf-name</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config-bgp)# address-family ipv4 flowspec</td>
<td></td>
</tr>
<tr>
<td></td>
<td>vrf vrf1</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>neighbor ip-address remote-as as-number</td>
<td>Places the device in neighbor configuration mode for BGP routing and configures the neighbor (IP address) as a BGP peer. The remote-as keyword assigns the specified remote autonomous system number to the neighbor.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config-bgp-af)# neighbor 2001:DB8:1::1 remote-as 100</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>neighbor ip-address activate</td>
<td>Enables the device to advertise (and receive information), including its IP address, to its BGP neighbor.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config-bgp-af)# neighbor 2001:DB8:1::1 activate</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>exit</td>
<td>Exits BGP address family configuration mode and enters BGP configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
</tbody>
</table>
### Configuring a Flow Specification Policy On All Interfaces Of a Device

The following configuration task explains flow specification policy configuration on all interfaces of a device for the IPv4 and IPv6 address families, and on interfaces within a VRF instance.

#### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `flowspec`
4. `address-family ipv4`
5. `local-install interface-all`
6. `exit`
7. `address-family ipv6`
8. `local-install interface-all`
9. `exit`
10. `vrf vrf-name`
11. `address-family ipv4`
12. `local-install interface-all`
13. `exit`
14. `address-family ipv6`
15. `local-install interface-all`
16. `exit`

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device&gt; enable</td>
<td></td>
</tr>
</tbody>
</table>

| **Step 2** configure terminal            | Enters global configuration mode                                       |
| **Example:**                             |                                                                         |
| Device# configure terminal               |                                                                         |

| **Step 3** flowspec                      | Enters flowspec configuration mode.                                    |
| **Example:**                             |                                                                         |
| Device(config)# flowspec                 |                                                                         |

<p>| <strong>Step 4</strong> address-family ipv4           | Specifies the IPv4 address family and enters flow                     |
| <strong>Example:</strong>                             | specification address family configuration mode.                      |
| Device(config-flowspec)# address-family ipv4 |                                                                         |</p>
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 5</strong></td>
<td>local-install interface-all</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-flowspec-af)# local-install interface-all</td>
</tr>
<tr>
<td></td>
<td>Installs the flowspec policy on all interfaces.</td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>exit</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-flowspec-af)# exit</td>
</tr>
<tr>
<td></td>
<td>Exits flow specification address family configuration mode and enters flowspec configuration mode.</td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>address-family ipv6</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-flowspec)# address-family ipv6</td>
</tr>
<tr>
<td></td>
<td>Specifies the IPv6 address family and enters flow specification address family configuration mode.</td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td>local-install interface-all</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-flowspec-af)# local-install interface-all</td>
</tr>
<tr>
<td></td>
<td>Installs the flowspec policy on all interfaces.</td>
</tr>
<tr>
<td><strong>Step 9</strong></td>
<td>exit</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-flowspec-af)# exit</td>
</tr>
<tr>
<td></td>
<td>Exits flow specification address family configuration mode and enters flowspec configuration mode.</td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td>vrf vrf-name</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-flowspec)# vrf vrf10</td>
</tr>
<tr>
<td></td>
<td>Configures a VRF instance and enters flow specification VRF configuration mode.</td>
</tr>
<tr>
<td><strong>Step 11</strong></td>
<td>address-family ipv4</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-flowspec-vrf)# address-family ipv4</td>
</tr>
<tr>
<td></td>
<td>Specifies the IPv4 address family and enters VRF flow specification address family configuration mode.</td>
</tr>
<tr>
<td><strong>Step 12</strong></td>
<td>local-install interface-all</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-flowspec-vrf-af)# local-install interface-all</td>
</tr>
<tr>
<td></td>
<td>Installs the flowspec policy on all interfaces.</td>
</tr>
<tr>
<td><strong>Step 13</strong></td>
<td>exit</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-flowspec-vrf-af)# exit</td>
</tr>
<tr>
<td></td>
<td>Exits VRF flow specification address family configuration mode and enters VRF flow specification configuration mode.</td>
</tr>
<tr>
<td><strong>Step 14</strong></td>
<td>address-family ipv6</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-flowspec-vrf)# address-family ipv6</td>
</tr>
<tr>
<td></td>
<td>Specifies the IPv6 address family and enters VRF flow specification address family configuration mode.</td>
</tr>
<tr>
<td>Step 15</td>
<td>Command or Action</td>
</tr>
<tr>
<td>---------</td>
<td>------------------</td>
</tr>
<tr>
<td></td>
<td>local-install interface-all</td>
</tr>
</tbody>
</table>
|         | **Example:**  
|         | Device(config-flowspec-vrf-af)# local-install interface-all |         |

<table>
<thead>
<tr>
<th>Step 16</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>exit</td>
<td>Exits VRF flow specification address family configuration mode and enters VRF flow specification configuration mode.</td>
</tr>
</tbody>
</table>
|         | **Example:**  
|         | Device(config-flowspec-vrf-af)# exit |         |

### Verifying BGP Flow Specification Client

These commands display flow specification configuration details:

#### SUMMARY STEPS

1. `show flowspec summary`
2. `show bgp ipv4 flowspec`
3. `show flowspec vrf vrf-name afi-all`

#### DETAILED STEPS

**Step 1**

**show flowspec summary**

**Example:**

```
Device # show flowspec summary
FlowSpec Manager Summary:
Tables: 2
Flows: 1
```

Provides a summary of the flow specification rules present on the node.

In this example, the **Tables** field indicates that the flow specification policy mapping capability is enabled for IPv4 and IPv6 address families.

The **Flows** field indicates that a single flow has been defined across the entire table.

**Step 2**

**show bgp ipv4 flowspec**

**Example:**

```
Device # show bgp ipv4 flowspec
Dest:192.0.2.0/24, Source:10.1.1.0/24, DPort:=120&<=130,SPort:=25&<=30,DSCP:=30/208
BGP routing table entry for Dest:192.0.2.0/24,  
Source:10.1.1.0/24,Proto:=47,DPort:=120&<=130,SPort:=25&<=30,DSCP:=30/208 <snip>
Paths: (1 available, best #1)  
Advertised to update-groups (with more than one peer):  
0.3
Path #1: Received by speaker 0
```
Advertised to update-groups (with more than one peer):
0.3 Local
0.0.0.0 from 0.0.0.0 (3.3.3.3)
Origin IGP, localpref 100, valid, redistributed, best, group-best
Received Path ID 0, Local Path ID 1, version 42
Extended community: FLOWSPEC Traffic-rate:100,0

Use this command to verify if a flow specification rule configured on the flow specification controller (device) is available on the BGP side. In this example, redistributed indicates that the flow specification rule is not internally originated, but one that has been redistributed from the flow specification process to BGP. The extended community (the BGP attribute used to send the match and action criteria to peer devices) that is configured is also displayed.

In this example, the action defined is to rate limit the traffic.

**Step 3**

`show flowspec vrf vrf-name afi-all`

**Example:**

```
Device # show flowspec vrf vrf100 afi-all

VRF: vrf100   AFI: IPv4
Flow :DPort:=101,SPort:=101,TCPFlags:~0xFF,Length:>=100&<=1500,DSCP:=63
Actions :Redirect: VRF vrf200 Route-target: ASN2-200:2 (bgp.1)
Flow :DPort:=102,SPort:=102,TCPFlags:~0xFF,Length:>=100&<=1500,DSCP:=63
Actions :Redirect: VRF vrf200 Route-target: ASN2-200:2 (bgp.1)
```

Use this command to verify if a flow specification rule is in a specific VRF associated with the flow specification client (device).

---

**Configuration Examples for BGP Flow Specification Client**

**Example: Configuring a Device As a Flow Specification Client and Establishing a BGP Peer Relationship With Neighbor**

```
Device> enable
Device# configure terminal
Device (config)# router bgp 100
Device (config-bgp)# address-family ipv4 flowspec
Device (config-bgp-af)# neighbor 10.1.1.1 activate
Device (config-bgp-af)# exit
Device (config-bgp)# address-family ipv4 flowspec vrf vrf1
Device (config-bgp-af)# neighbor 2001:DB8:1::1 remote as 100
Device (config-bgp-af)# neighbor 2001:DB8:1::1 activate
Device (config-bgp-af)# exit
```
Example: Configuring a Flow Specification Policy On All Interfaces Of a Device

Device> enable
Device# configure terminal
Device(config)# flowspec
Device(config-flowspec)# address-family ipv4
Device(config-flowspec-af)# local-install interface-all
Device(config-flowspec-af)# exit
Device(config-flowspec)# address-family ipv6
Device(config-flowspec-af)# local-install interface-all
Device(config-flowspec-af)# exit
Device(config-flowspec)# vrf vrf10
Device(config-flowspec-vrf)# address-family ipv4
Device(config-flowspec-vrf-af)# local-install interface-all
Device(config-flowspec-vrf-af)# exit
Device(config-flowspec-vrf)# address-family ipv6
Device(config-flowspec-vrf-af)# local-install interface-all
Device(config-flowspec-vrf-af)# exit

Additional References for BGP Flow Specification Client

Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Commands List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
</tbody>
</table>

Standards and RFCs

<table>
<thead>
<tr>
<th>Standard/RFC</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFC 5575</td>
<td>Dissemination of Flow Specification Rules</td>
</tr>
</tbody>
</table>

MIBs

<table>
<thead>
<tr>
<th>MIB</th>
<th>MIBs Link</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CISCO-MIB</td>
<td>To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
<td></td>
</tr>
</tbody>
</table>
Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
<tr>
<td>To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds.</td>
<td></td>
</tr>
<tr>
<td>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</td>
<td></td>
</tr>
</tbody>
</table>

Feature Information for BGP Flow Specification Client

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 41: Feature Information for BGP Flow Specification Client

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP Flow Specification Client</td>
<td>Cisco IOS XE 3.15S</td>
<td>The BGP flow specification client feature enables a device to perform the role of a BGP flow specification client and receive flow specification rules from a BGP flow specification controller. The following command was introduced or modified: flowspec, local-install interface-all.</td>
</tr>
</tbody>
</table>
BGP NSF Awareness

Nonstop Forwarding (NSF) awareness allows a router to assist NSF-capable neighbors to continue forwarding packets during a Stateful Switchover (SSO) operation. The BGP Nonstop Forwarding Awareness feature allows an NSF-aware router that is running BGP to forward packets along routes that are already known for a router that is performing an SSO operation. This capability allows the BGP peers of the failing router to retain the routing information that is advertised by the failing router and continue to use this information until the failed router has returned to normal operating behavior and is able to exchange routing information. The peering session is maintained throughout the entire NSF operation.

- Finding Feature Information, on page 503
- Information About BGP NSF Awareness, on page 503
- How to Configure BGP NSF Awareness, on page 505
- Configuration Examples for BGP NSF Awareness, on page 511
- Additional References, on page 511
- Feature Information for BGP NSF Awareness, on page 512

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About BGP NSF Awareness

Cisco NSF Routing and Forwarding Operation

Cisco NSF is supported by the BGP, EIGRP, OSPF, and IS-IS protocols for routing and by Cisco Express Forwarding (CEF) for forwarding. Of the routing protocols, BGP, EIGRP, OSPF, and IS-IS have been enhanced with NSF capability and awareness, which means that devices running these protocols can detect a switchover and take the necessary actions to continue forwarding network traffic and to recover route information from the peer devices.
In this module, a networking device is said to be NSF-aware if it is running NSF-compatible software. A device is said to be NSF-capable if it has been configured to support NSF; therefore, it rebuilds routing information from NSF-aware or NSF-capable neighbors.

Each protocol depends on CEF to continue forwarding packets during switchover while the routing protocols rebuild the Routing Information Base (RIB) tables. Once the routing protocols have converged, CEF updates the Forwarding Information Base (FIB) table and removes stale route entries. CEF then updates the line cards with the new FIB information.

**Cisco Express Forwarding for NSF**

A key element of NSF is packet forwarding. In a Cisco networking device, packet forwarding is provided by CEF. CEF maintains the FIB and uses the FIB information that was current at the time of the switchover to continue forwarding packets during a switchover. This feature reduces traffic interruption during the switchover.

During normal NSF operation, CEF on the active RP synchronizes its current FIB and adjacency databases with the FIB and adjacency databases on the standby RP. Upon switchover of the active RP, the standby RP initially has FIB and adjacency databases that are mirror images of those that were current on the active RP. For platforms with intelligent line cards, the line cards will maintain the current forwarding information over a switchover; for platforms with forwarding engines, CEF will keep the forwarding engine on the standby RP current with changes that are sent to it by CEF on the active RP. In this way, the line cards or forwarding engines will be able to continue forwarding after a switchover as soon as the interfaces and a data path are available.

As the routing protocols start to repopulate the RIB on a prefix-by-prefix basis, the updates in turn cause prefix-by-prefix updates for CEF, which it uses to update the FIB and adjacency databases. Existing and new entries will receive the new version (epoch) number, indicating that they have been refreshed. The forwarding information is updated on the line cards or forwarding engine during convergence. The RP signals when the RIB has converged. The software removes all FIB and adjacency entries that have an epoch older than the current switchover epoch. The FIB now represents the newest routing protocol forwarding information.

The routing protocols run only on the active RP, and they receive routing updates from their neighbor routers. Routing protocols do not run on the standby RP. After a switchover, the routing protocols request that the NSF-aware neighbor devices send state information to help rebuild the routing tables.

---

**Note**

For NSF operation, the routing protocols depend on CEF to continue forwarding packets while the routing protocols rebuild the routing information.

**BGP Graceful Restart for NSF**

When an NSF-capable router begins a BGP session with a BGP peer, it sends an OPEN message to the peer. Included in the message is a declaration that the NSF-capable or NSF-aware router has graceful restart capability. Graceful restart is the mechanism by which BGP routing peers avoid a routing flap after a switchover. If the BGP peer has received this capability, it is aware that the device sending the message is NSF-capable. Both the NSF-capable router and its BGP peer(s) (NSF-aware peers) need to exchange the graceful restart capability in their OPEN messages, at the time of session establishment. If both peers do not exchange the graceful restart capability, the session will not be graceful restart capable.

If the BGP session is lost during the RP switchover, the NSF-aware BGP peer marks all the routes associated with the NSF-capable router as stale; however, it continues to use these routes to make forwarding decisions.
for a set period of time. This functionality means that no packets are lost while the newly active RP is waiting for convergence of the routing information with the BGP peers.

After an RP switchover occurs, the NSF-capable router reestablishes the session with the BGP peer. In establishing the new session, it sends a new graceful restart message that identifies the NSF-capable router as having restarted.

At this point, the routing information is exchanged between the two BGP peers. Once this exchange is complete, the NSF-capable device uses the routing information to update the RIB and the FIB with the new forwarding information. The NSF-aware device uses the network information to remove stale routes from its BGP table. Following that, the BGP protocol is fully converged.

If a BGP peer does not support the graceful restart capability, it will ignore the graceful restart capability in an OPEN message but will establish a BGP session with the NSF-capable device. This functionality will allow interoperability with non-NSF-aware BGP peers (and without NSF functionality), but the BGP session with non-NSF-aware BGP peers will not be graceful restart capable.

**BGP NSF Awareness**

BGP support for NSF requires that neighbor routers are NSF-aware or NSF-capable. NSF awareness in BGP is also enabled by the graceful restart mechanism. A router that is NSF-aware functions like a router that is NSF-capable with one exception: an NSF-aware router is incapable of performing an SSO operation. However, a router that is NSF-aware is capable of maintaining a peering relationship with an NSF-capable neighbor during an NSF SSO operation, as well as holding routes for this neighbor during the SSO operation.

The BGP Nonstop Forwarding Awareness feature provides an NSF-aware router with the capability to detect a neighbor that is undergoing an SSO operation, maintain the peering session with this neighbor, retain known routes, and continue to forward packets for these routes. The deployment of BGP NSF awareness can minimize the effects of Route Processor (RP) failure conditions and improve the overall network stability by reducing the amount of resources that are normally required for reestablishing peering with a failed router.

NSF awareness for BGP is not enabled by default. The `bgp graceful-restart` command is used to globally enable NSF awareness on a router that is running BGP. NSF-aware operations are also transparent to the network operator and to BGP peers that do not support NSF capabilities.

**Note**

NSF awareness is enabled automatically in supported software images for Interior Gateway Protocols, such as EIGRP, IS-IS, and OSPF. In BGP, global NSF awareness is not enabled automatically and must be started by issuing the `bgp graceful-restart` command in router configuration mode.

**How to Configure BGP NSF Awareness**

**Configuring BGP Nonstop Forwarding Awareness Using BGP Graceful Restart**

The tasks in this section show how configure BGP Nonstop Forwarding (NSF) awareness using the BGP graceful restart capability.

- The first task enables BGP NSF globally for all BGP neighbors and suggests a few troubleshooting options.
• The second task describes how to adjust the BGP graceful restart timers, although the default settings are optimal for most network deployments.

• The next three tasks demonstrate how to enable or disable BGP graceful restart for individual BGP neighbors, including peer session templates and peer groups.

• The final task verifies the local and peer router configurations of BGP NSF.

Enabling BGP Global NSF Awareness Using BGP Graceful Restart

Perform this task to enable BGP NSF awareness globally for all BGP neighbors. BGP NSF awareness is part of the graceful restart mechanism and BGP NSF awareness is enabled by issuing the `bgp graceful-restart` command in router configuration mode. BGP NSF awareness allows NSF-aware routers to support NSF-capable routers during an SSO operation. NSF-awareness is not enabled by default and should be configured on all neighbors that participate in BGP NSF.

Note

The configuration of the restart and stale-path timers is not required to enable the BGP graceful restart capability. The default values are optimal for most network deployments, and these values should be adjusted only by an experienced network operator.

Note

Configuring both Bidirectional Forwarding Detection (BFD) and BGP graceful restart for NSF on a device running BGP may result in suboptimal routing.

SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. bgp graceful-restart [restart-time seconds] [stalepath-time seconds]
5. end

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Step 2 configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example: Device# configure terminal</td>
<td></td>
</tr>
</tbody>
</table>
**Command or Action** | **Purpose**
---|---
**Step 3** | Enters router configuration mode and creates a BGP routing process.
router bgp *autonomous-system-number*

*Example:*
Device(config)# router bgp 45000

**Step 4** | Enables the BGP graceful restart capability and BGP NSF awareness.
bgp graceful-restart [restart-time *seconds*]
[stalepath-time *seconds*]

*Example:*
Device(config-router)# bgp graceful-restart

**Step 5** | Exits router configuration mode and enters privileged EXEC mode.
end

*Example:*
Device(config-router)# end

**Troubleshooting Tips**

To troubleshoot the NSF feature, use the following commands in privileged EXEC mode, as needed:

- **debug ip bgp** — Displays open messages that advertise the graceful restart capability.
- **debug ip bgp event** — Displays graceful restart timer events, such as the restart timer and the stalepath timer.
- **debug ip bgp updates** — Displays sent and received EOR messages. The EOR message is used by the NSF-aware router to start the stalepath timer, if configured.
- **show ip bgp** — Displays entries in the BGP routing table. The output from this command displays routes that are marked as stale by displaying the letter “S” next to each stale route.
- **show ip bgp neighbor** — Displays information about the TCP and BGP connections to neighbor devices. When enabled, the graceful restart capability is displayed in the output of this command.

**What to Do Next**

If the `bgp graceful-restart` command has been issued after the BGP session has been established, you must reset by issuing the `clear ip bgp` *command or by reloading the router before graceful restart capabilities will be exchanged. For more information about resetting BGP sessions and using the `clear ip bgp` command, see the “Configuring a Basic BGP Network” module.

**Configuring BGP NSF Awareness Timers**

Perform this task to adjust the BGP graceful restart timers. There are two BGP graceful restart timers that can be configured. The optional `restart-time` keyword and `seconds` argument determine how long peer routers will wait to delete stale routes before a BGP open message is received. The default value is 120 seconds. The optional `stalepath-time` keyword and `seconds` argument determine how long a router will wait before deleting.
stale routes after an end of record (EOR) message is received from the restarting router. The default value is 360 seconds.

**Note** The configuration of the restart and stale-path timers is not required to enable the BGP graceful restart capability. The default values are optimal for most network deployments, and these values should be adjusted only by an experienced network operator.

### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `bgp graceful-restart [restart-time seconds]`
5. `bgp graceful-restart [stalepath-time seconds]`
6. `end`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** | `enable` | Enables privileged EXEC mode.  
Example:  
Device> enable |
| **Step 2** | `configure terminal` | Enters global configuration mode.  
Example:  
Device# configure terminal |
| **Step 3** | `router bgp autonomous-system-number` | Enters router configuration mode and creates a BGP routing process.  
Example:  
Device(config)# router bgp 45000 |
| **Step 4** | `bgp graceful-restart [restart-time seconds]` | Enables the BGP graceful restart capability and BGP NSF awareness.  
Example:  
Device(config-router)# bgp graceful-restart  
restart-time 130 |

- The **restart-time** argument determines how long peer routers will wait to delete stale routes before a BGP open message is received.  
- The default value is 120 seconds. The range is from 1 to 3600 seconds.  

**Note** Only the syntax applicable to this step is used in this example. For more details, see the *Cisco IOS IP Routing: BGP Command Reference*.  

---
### Purpose

Command or Action | Purpose
--- | ---
Step 5 | **bgp graceful-restart** `[stalepath-time seconds]`
Example:  
Device(config-router)# bgp graceful-restart stalepath-time 350 | Enables the BGP graceful restart capability and BGP NSF awareness.
  - The **stalepath-time** argument determines how long a router will wait before deleting stale routes after an end of record (EOR) message is received from the restarting router.
  - The default value is 360 seconds. The range is from 1 to 3600 seconds.

**Note** Only the syntax applicable to this step is used in this example. For more details, see the *Cisco IOS IP Routing: BGP Command Reference*.

Step 6 | **end**
Example:  
Device(config-router)# end | Exits router configuration mode and enters privileged EXEC mode.

### What to Do Next

If the **bgp graceful-restart** command has been issued after the BGP session has been established, you must reset the peer sessions by issuing the **clear ip bgp** command or by reloading the router before graceful restart capabilities will be exchanged. For more information about resetting BGP sessions and using the **clear ip bgp** command, see the “Configuring a Basic BGP Network” module.

### Verifying the Configuration of BGP Nonstop Forwarding Awareness

Use the following steps to verify the local configuration of BGP NSF awareness on a router and to verify the configuration of NSF awareness on peer routers in a BGP network.

#### SUMMARY STEPS

1. **enable**
2. **show running-config** `[options]`
3. **show ip bgp neighbors** `[ip-address [received-routes | routes | advertised-routes | paths [regexp] | dampened-routes | flap-statistics | received prefix-filter | policy [detail]]]`

#### DETAILED STEPS

**Step 1**  
**enable**

Enables privileged EXEC mode. Enter your password if prompted.

**Example:**

Router> enable

**Step 2**  
**show running-config** `[options]`
Displays the running configuration on the local router. The output will display the configuration of the `bgp graceful-restart` command in the BGP section. Repeat this command on all BGP neighbor routers to verify that all BGP peers are configured for BGP NSF awareness. In this example, BGP graceful restart is enabled globally and the external neighbor at 192.168.1.2 is configured to be a BGP peer and will have the BGP graceful restart capability enabled.

**Example:**

```bash
Router# show running-config

router bgp 45000
  bgp router-id 172.17.1.99
  bgp log-neighbor-changes
  bgp graceful-restart restart-time 130
  bgp graceful-restart stalepath-time 350
  bgp graceful-restart timers bgp 70 120
  neighbor 192.168.1.2 remote-as 40000
  neighbor 192.168.1.2 activate
```

**Step 3**

`show ip bgp neighbors [ip-address [received-routes | routes | advertised-routes | paths [regexp] | dampened-routes | flap-statistics | received prefix-filter | policy [detail]]]`

Displays information about TCP and BGP connections to neighbors. “Graceful Restart Capability: advertised” will be displayed for each neighbor that has exchanged graceful restart capabilities with this router. In Cisco IOS Releases 12.2(33)SRC, 12.2(33)SB, or later releases, the ability to enable or disable the BGP graceful restart capability for an individual BGP neighbor, peer group or peer session template was introduced and output was added to this command to show the BGP graceful restart status.

The following partial output example using a Cisco IOS Release 12.2(33)SRC image, displays the graceful restart information for internal BGP neighbor 172.21.1.2 at Router C in the figure above. Note the “Graceful-Restart is enabled” message.

**Example:**

```bash
Router# show ip bgp neighbors 172.21.1.2

BGP neighbor is 172.21.1.2, remote AS 45000, internal link
  BGP version 4, remote router ID 172.22.1.1
  BGP state - Established, up for 00:01:01
  Last read 00:00:02, last write 00:00:07, hold time is 180, keepalive intervals
  Neighbor sessions:
    1 active, is multisession capable
  Neighbor capabilities:
    Route refresh: advertised and received(new)
    Address family IPv4 Unicast: advertised and received
    Graceful Restart Capability: advertised
    Multisession Capability: advertised and received
    Address tracking is enabled, the RIB does have a route to 172.21.1.2
    Connections established 1; dropped 0
    Last reset never
  Transport(tcp) path-mtu-discovery is enabled
  Graceful-Restart is enabled, restart-time 120 seconds, stalepath-time 360 secs
```
Configuration Examples for BGP NSF Awareness

Example: Enabling BGP Global NSF Awareness Using Graceful Restart

The following example enables BGP NSF awareness globally on all BGP neighbors. The restart time is set to 130 seconds, and the stale path time is set to 350 seconds. The configuration of these timers is optional, and the preconfigured default values are optimal for most network deployments.

```plaintext
configure terminal
router bgp 45000
  bgp graceful-restart
  bgp graceful-restart restart-time 130
  bgp graceful-restart stalepath-time 350
end
```

Additional References

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
</tbody>
</table>

MIBs

<table>
<thead>
<tr>
<th>MIB</th>
<th>MIBs Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>
Feature Information for BGP NSF Awareness

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 42: Feature Information for BGP NSF Awareness

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP NSF Awareness</td>
<td>Cisco IOS XE Release 2.1</td>
<td>Nonstop Forwarding (NSF) awareness allows a device to assist NSF-capable neighbors to continue forwarding packets during a Stateful Switchover (SSO) operation. The BGP Nonstop Forwarding Awareness feature allows an NSF-aware device that is running BGP to forward packets along routes that are already known for a device that is performing an SSO operation. This capability allows the BGP peers of the failing device to retain the routing information that is advertised by the failing device and continue to use this information until the failed device has returned to normal operating behavior and is able to exchange routing information. The peering session is maintained throughout the entire NSF operation. The following commands were introduced or modified: <code>bgp graceful-restart</code>, <code>show ip bgp</code>, <code>show ip bgp neighbors</code>.</td>
</tr>
</tbody>
</table>
The BGP graceful restart feature is already available on a global basis. The BGP Graceful Restart per Neighbor feature allows BGP graceful restart to be enabled or disable for an individual neighbor, providing greater network flexibility and service.

- Finding Feature Information, on page 513
- Information About BGP Graceful Restart per Neighbor, on page 513
- How to Configure BGP Graceful Restart per Neighbor, on page 514
- Configuration Examples for BGP Graceful Restart per Neighbor, on page 524
- Additional References, on page 526
- Feature Information for BGP Graceful Restart per Neighbor, on page 527

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About BGP Graceful Restart per Neighbor

BGP Graceful Restart per Neighbor

The ability to enable or disable BGP graceful restart for every individual BGP neighbor was introduced. Three new methods of configuring BGP graceful restart for BGP peers, in addition to the existing global BGP graceful restart configuration, are now available. Graceful restart can be enabled or disabled for a BGP peer or a BGP peer group using the neighbor ha-mode graceful-restart command, or a BGP peer can inherit a graceful restart configuration from a BGP peer-session template using the ha-mode graceful-restart command.

Although BGP graceful restart is disabled by default, the existing global command enables graceful restart for all BGP neighbors regardless of their capabilities. The ability to enable or disable BGP graceful restart for individual BGP neighbors provides a greater level of control for a network administrator.
When the BGP graceful restart capability is configured for an individual neighbor, each method of configuring graceful restart has the same priority, and the last configuration instance is applied to the neighbor. For example, if global graceful restart is enabled for all BGP neighbors but an individual neighbor is subsequently configured as a member of a peer group for which the graceful restart is disabled, graceful restart is disabled for that neighbor.

The configuration of the restart and stale-path timers is available only with the global `bgp graceful-restart` command, but the default values are set when the `neighbor ha-mode graceful-restart` or `ha-mode graceful-restart` commands are configured. The default values are optimal for most network deployments, and these values should be adjusted only by an experienced network operator.

**BGP Peer Session Templates**

Peer session templates are used to group and apply the configuration of general BGP session commands to groups of neighbors that share session configuration elements. General session commands that are common for neighbors that are configured in different address families can be configured within the same peer session template. Peer session templates are created and configured in peer session configuration mode. Only general session commands can be configured in a peer session template.

General session commands can be configured once in a peer session template and then applied to many neighbors through the direct application of a peer session template or through indirect inheritance from a peer session template. The configuration of peer session templates simplifies the configuration of general session commands that are commonly applied to all neighbors within an autonomous system.

Peer session templates support direct and indirect inheritance. A BGP neighbor can be configured with only one peer session template at a time, and that peer session template can contain only one indirectly inherited peer session template. A BGP neighbor can directly inherit only one session template and can indirectly inherit up to seven additional peer session templates.

Peer session templates support inheritance. A directly applied peer session template can directly or indirectly inherit configurations from up to seven peer session templates. So, a total of eight peer session templates can be applied to a neighbor or neighbor group.

Peer session templates support only general session commands. BGP policy configuration commands that are configured only for a specific address family or NLRI configuration mode are configured with peer policy templates.

To use a BGP peer session template to enable or disable BGP graceful restart, see the “Enabling and Disabling BGP Graceful Restart Using BGP Peer Session Templates” section.

**How to Configure BGP Graceful Restart per Neighbor**

**Enabling BGP Graceful Restart for an Individual BGP Neighbor**

Perform this task on Router B in the figure above to enable BGP graceful restart on the internal BGP peer at Router C in the figure above. Under the IPv4 address family, the neighbor at Router C is identified, and BGP graceful restart is enabled for the neighbor at Router C with the IP address 172.21.1.2. To verify that BGP graceful restart is enabled, the optional `show ip bgp neighbors` command is used.
### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `address-family ipv4 [unicast | multicast | vrf vrf-name]`
5. `neighbor ip-address remote-as autonomous-system-number`
6. `neighbor ip-address activate`
7. `neighbor ip-address ha-mode graceful-restart [disable]`
8. `end`
9. `show ip bgp neighbors [ip-address [received-routes | routes | advertised-routes | paths [regexp] | dampened-routes | flap-statistics | received prefix-filter | policy [detail]]]`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>Device&gt; enable</code></td>
<td>Enter your password if prompted.</td>
</tr>
<tr>
<td>2</td>
<td><code>configure terminal</code></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>Device# configure terminal</code></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td><code>router bgp autonomous-system-number</code></td>
<td>Enters router configuration mode and creates a BGP routing process.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>Device(config)# router bgp 45000</code></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>`address-family ipv4 [unicast</td>
<td>multicast</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>Device(config-router)# address-family ipv4 unicast</code></td>
<td>• The <code>unicast</code> keyword specifies the IPv4 unicast address family. By default, the router is placed in address family configuration mode for the IPv4 unicast address family if the <code>unicast</code> keyword is not specified.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The <code>multicast</code> keyword specifies IPv4 multicast address prefixes.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The <code>vrf</code> keyword and <code>vrf-name</code> argument specify the name of the VRF instance to associate with subsequent IPv4 address family configuration mode commands.</td>
</tr>
<tr>
<td>5</td>
<td><code>neighbor ip-address remote-as autonomous-system-number</code></td>
<td>Configures peering with a BGP neighbor in the specified autonomous system.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• In this example, the BGP peer at 172.21.1.2 is an internal BGP peer because it has the same autonomous</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td>Device(config-router-af)# neighbor 172.21.1.2 remote-as 45000</td>
<td>system number as the router where the BGP configuration is being entered (see Step 3).</td>
<td></td>
</tr>
</tbody>
</table>

**Step 6**

**neighbor ip-address activate**

**Example:**

Device(config-router-af)# neighbor 172.21.1.2 activate

Enables the neighbor to exchange prefixes for the IPv4 address family with the local router.

- In this example, the internal BGP peer at 172.21.1.2 is activated.

**Step 7**

**neighbor ip-address ha-mode graceful-restart [disable]**

**Example:**

Device(config-router-af)# neighbor 172.21.1.2 ha-mode graceful-restart

Enables the BGP graceful restart capability for a BGP neighbor.

- Use the `disable` keyword to disable BGP graceful restart capability.
- If you enter this command after the BGP session has been established, you must restart the session in order for the capability to be exchanged with the BGP neighbor.
- In this example, the BGP graceful restart capability is enabled for the neighbor at 172.21.1.2.

**Step 8**

**end**

**Example:**

Device(config-router-af)# end

Exits address family configuration mode and returns to privileged EXEC mode.

**Step 9**

**show ip bgp neighbors [ip-address [received-routes | routes | advertised-routes | paths [regexp] | dampened-routes | flap-statistics | received prefix-filter | policy [detail]]]**

**Example:**

Device# show ip bgp neighbors 172.21.1.2

(Optional) Displays information about TCP and BGP connections to neighbors.

- “Graceful Restart Capability: advertised” will be displayed for each neighbor that has exchanged graceful restart capabilities with this router.
- In this example, the output is filtered to display information about the BGP peer at 172.21.1.2.

**Examples**

The following example shows partial output from the `show ip bgp neighbors` command for the BGP peer at 172.21.1.2. Graceful restart is shown as enabled. Note the default values for the restart and stale-path timers. These timers can be set using only the global `bgp graceful-restart` command.

Device# show ip bgp neighbors 172.21.1.2

BGP neighbor is 172.21.1.2, remote AS 45000, internal link
BGP version 4, remote router ID 172.22.1.1
BGP state - Established, up for 00:01:01
Last read 00:00:02, last write 00:00:07, hold time is 180, keepalive intervals
Neighbor sessions:
1 active, is multisession capable
Neighbor capabilities:
Route refresh: advertised and received
Address family IPv4 Unicast: advertised and received
Graceful Restart Capability: advertised
Multisession Capability: advertised and received
Address tracking is enabled, the RIB does have a route to 172.21.1.2
Connections established 1; dropped 0
Last reset never
Transport(tcp) path-mtu-discovery is enabled
Graceful-Restart is enabled, restart-time 120 seconds, stalepath-time 360 secs
Connection state is ESTAB, I/O status: 1, unread input bytes: 0

Enabling and Disabling BGP Graceful Restart Using BGP Peer Session Templates

Perform this task to enable and disable BGP graceful restart for BGP neighbors using peer session templates. In this task, a BGP peer session template is created, and BGP graceful restart is enabled. A second peer session template is created, and this template is configured to disable BGP graceful restart.

In this example, the configuration is performed at Router B in the figure below, and two external BGP neighbors—Router A and Router E—are identified. The first BGP peer at Router A is configured to inherit the first peer session template, which enables BGP graceful restart, whereas the second BGP peer at Router E inherits the second template, which disables BGP graceful restart. Using the optional `show ip bgp neighbors` command, the status of the BGP graceful restart capability is verified for each BGP neighbor configured in this task.

Figure 44: Network Topology Showing BGP Neighbors

The restart and stale-path timers can be modified only using the global `bgp graceful-restart` command. The restart and stale-path timers are set to the default values when BGP graceful restart is enabled for BGP neighbors using peer session templates.
### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `template peer-session session-template-name`
5. `ha-mode graceful-restart [disable]`
6. `exit-peer-session`
7. `template peer-session session-template-name`
8. `ha-mode graceful-restart [disable]`
9. `exit-peer-session`
10. `bgp log-neighbor-changes`
11. `neighbor ip-address remote-as autonomous-system-number`
12. `neighbor ip-address inherit peer-session session-template-number`
13. `neighbor ip-address remote-as autonomous-system-number`
14. `neighbor ip-address inherit peer-session session-template-number`
15. `end`
16. `show ip bgp template peer-session [session-template-number]`
17. `show ip bgp neighbors [ip-address [received-routes | routes | advertised-routes | paths [regexp] | dampened-routes | flap-statistics | received prefix-filter | policy [detail]]]`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** `enable` | Enables privileged EXEC mode.  
  Example:  
  `Device> enable`
| **Step 2** `configure terminal` | Enters global configuration mode.  
  Example:  
  `Device# configure terminal`
| **Step 3** `router bgp autonomous-system-number` | Enters router configuration mode and creates a BGP routing process.  
  Example:  
  `Device(config)# router bgp 45000`
| **Step 4** `template peer-session session-template-name` | Enters session-template configuration mode and creates a peer session template.  
  Example:  
  `Device(config)# template peer-session session-template-name` |
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device(config-router)# template peer-session S1</td>
<td>In this example, a peer session template named S1 is created.</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>Enables the BGP graceful restart capability and BGP NSF awareness.</td>
</tr>
<tr>
<td></td>
<td>• Use the <code>disable</code> keyword to disable BGP graceful restart capability.</td>
</tr>
<tr>
<td></td>
<td>• If you enter this command after the BGP session has been established, you must restart the session in order for the capability to be exchanged with the BGP neighbor.</td>
</tr>
<tr>
<td></td>
<td>• In this example, the BGP graceful restart capability is enabled for the peer session template named S1.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config-router-stmp)# ha-mode graceful-restart</td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>Exits session-template configuration mode and returns to router configuration mode.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exits session-template configuration mode and returns to router configuration mode.</td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>Enters session-template configuration mode and creates a peer session template.</td>
</tr>
<tr>
<td></td>
<td>• In this example, a peer session template named S2 is created.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config-router)# template peer-session S2</td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td>Enables the BGP graceful restart capability and BGP NSF awareness.</td>
</tr>
<tr>
<td></td>
<td>• Use the <code>disable</code> keyword to disable BGP graceful restart capability.</td>
</tr>
<tr>
<td></td>
<td>• If you enter this command after the BGP session has been established, you must restart the session in order for the capability to be exchanged with the BGP neighbor.</td>
</tr>
<tr>
<td></td>
<td>• In this example, the BGP graceful restart capability is disabled for the peer session template named S2.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config-router-stmp)# ha-mode graceful-restart disable</td>
</tr>
<tr>
<td><strong>Step 9</strong></td>
<td>Exits session-template configuration mode and returns to router configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config-router-stmp)# exit-peer-session</td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td>Enables logging of BGP neighbor status changes (up or down) and neighbor resets.</td>
</tr>
<tr>
<td></td>
<td>• Use this command for troubleshooting network connectivity problems and measuring network</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config-router)# bgp log-neighbor-changes</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Purpose</strong></td>
<td>Configures peering with a BGP neighbor in the specified autonomous system.</td>
</tr>
<tr>
<td><strong>Step 11</strong></td>
<td><strong>neighbor ip-address remote-as autonomous-system-number</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Device(config-router)# neighbor 192.168.1.2 remote-as 40000</td>
</tr>
<tr>
<td><strong>Step 12</strong></td>
<td><strong>neighbor ip-address inherit peer-session session-template-number</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Device(config-router)# neighbor 192.168.1.2 inherit peer-session S1</td>
</tr>
<tr>
<td><strong>Step 13</strong></td>
<td><strong>neighbor ip-address remote-as autonomous-system-number</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Device(config-router)# neighbor 192.168.3.2 remote-as 50000</td>
</tr>
<tr>
<td><strong>Step 14</strong></td>
<td><strong>neighbor ip-address inherit peer-session session-template-number</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Device(config-router)# neighbor 192.168.3.2 inherit peer-session S2</td>
</tr>
<tr>
<td><strong>Step 15</strong></td>
<td><strong>end</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Device(config-router)# end</td>
</tr>
<tr>
<td><strong>Step 16</strong></td>
<td><strong>show ip bgp template peer-session [session-template-number]</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Device# show ip bgp template peer-session</td>
</tr>
<tr>
<td><strong>Step 17</strong></td>
<td>**show ip bgp neighbors [ip-address [received-routes</td>
</tr>
</tbody>
</table>
### BGP Graceful Restart per Neighbor

#### Enabling and Disabling BGP Graceful Restart Using BGP Peer Session Templates

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>dampened-routes</td>
<td>“Graceful Restart Capability: advertised” will be displayed for each neighbor that has exchanged graceful restart capabilities with this router.</td>
</tr>
<tr>
<td>flap-statistics</td>
<td></td>
</tr>
<tr>
<td>received prefix-filter [policy [detail]]</td>
<td></td>
</tr>
</tbody>
</table>

### Example:

```
Device# show ip bgp neighbors 192.168.1.2
```

### Examples

The following example shows partial output from the `show ip bgp neighbors` command for the BGP peer at 192.168.1.2 (Router A in the figure above). Graceful restart is shown as enabled. Note the default values for the restart and stale-path timers. These timers can be set only by using the `bgp graceful-restart` command.

```
Device# show ip bgp neighbors 192.168.1.2
```

The following example shows partial output from the `show ip bgp neighbors` command for the BGP peer at 192.168.3.2 (Router E in the figure above). Graceful restart is shown as disabled.

```
Device# show ip bgp neighbors 192.168.3.2
```
Disabling BGP Graceful Restart for a BGP Peer Group

Perform this task to disable BGP graceful restart for a BGP peer group. In this task, a BGP peer group is created and graceful restart is disabled for the peer group. A BGP neighbor, Router D at 172.16.1.2 in the figure above, is then identified and added as a peer group member. It inherits the configuration associated with the peer group, which, in this example, disables BGP graceful restart.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `address-family ipv4 [unicast | multicast | vrf vrf-name]`
5. `neighbor peer-group-name peer-group`
6. `neighbor peer-group-name remote-as autonomous-system-number`
7. `neighbor peer-group-name ha-mode graceful-restart [disable]`
8. `neighbor ip-address peer-group peer-group-name`
9. `end`
10. `show ip bgp neighbors [ip-address] [received-routes | routes | advertised-routes | paths [regexp] | dampened-routes | flap-statistics | received prefix-filter | policy [detail]]`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td><code>enable</code></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><code>Device&gt; enable</code></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td><code>configure terminal</code></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><code>Device# configure terminal</code></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td><code>router bgp autonomous-system-number</code></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><code>Device(config)# router bgp 45000</code></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>`address-family ipv4 [unicast</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><code>Device(config-router)# address-family ipv4 unicast</code></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>------------------</td>
<td>---------</td>
</tr>
<tr>
<td>unicast address family if the <code>unicast</code> keyword is not specified. • The <code>multicast</code> keyword specifies IPv4 multicast address prefixes. • The <code>vrf</code> keyword and <code>vrf-name</code> argument specify the name of the VRF instance to associate with subsequent IPv4 address family configuration mode commands.</td>
<td></td>
</tr>
</tbody>
</table>

**Step 5**

**neighbor** *peer-group-name* **peer-group**

**Example:**

```
Device(config-router-af)# neighbor PG1 peer-group
```

Creates a BGP peer group.

- In this example, the peer group named PG1 is created.

**Step 6**

**neighbor** *peer-group-name* **remote-as** *autonomous-system-number*

**Example:**

```
Device(config-router-af)# neighbor PG1 remote-as 45000
```

Configures peering with a BGP peer group in the specified autonomous system.

- In this example, the BGP peer group named PG1 is added to the IPv4 multiprotocol BGP neighbor table of the local router.

**Step 7**

**neighbor** *peer-group-name* **ha-mode** **graceful-restart** *
[disable] *

**Example:**

```
Device(config-router-af)# neighbor PG1 ha-mode graceful-restart disable
```

Enables the BGP graceful restart capability for a BGP neighbor.

- Use the `disable` keyword to disable BGP graceful restart capability.
- If you enter this command after the BGP session has been established, you must restart the session for the capability to be exchanged with the BGP neighbor.
- In this example, the BGP graceful restart capability is disabled for the BGP peer group named PG1.

**Step 8**

**neighbor** *ip-address* **peer-group** *peer-group-name*

**Example:**

```
Device(config-router-af)# neighbor 172.16.1.2 peer-group PG1
```

Assigns the IP address of a BGP neighbor to a peer group.

- In this example, the BGP neighbor peer at 172.16.1.2 is configured as a member of the peer group named PG1.

**Step 9**

**end**

**Example:**

```
Device(config-router-af)# end
```

Exits address family configuration mode and returns to privileged EXEC mode.

**Step 10**

**show ip bgp neighbors** *ip-address* *
[received-routes | routes | advertised-routes | paths [regexp] | dampened-routes | flap-statistics | received prefix-filter | policy [ detail]]* 

(Optional) Displays information about TCP and BGP connections to neighbors.
**Purpose**

*In this example, the output is filtered to display information about the BGP peer at 172.16.1.2 and the “Graceful-Restart is disabled” line shows that the graceful restart capability is disabled for this neighbor.*

---

**Examples**

The following example shows partial output from the `show ip bgp neighbors` command for the BGP peer at 172.16.1.2. Graceful restart is shown as disabled. Note the default values for the restart and stale-path timers. These timers can be set using only the global `bgp graceful-restart` command.

```
Device# show ip bgp neighbors 172.16.1.2

BGP neighbor is 172.16.1.2, remote AS 45000, internal link
Member of peer-group PG1 for session parameters
  BGP version 4, remote router ID 0.0.0.0
  BGP state = Idle
  Neighbor sessions:
    0 active, is multisession capable
Address tracking is enabled, the RIB does have a route to 172.16.1.2
  Connections established 0; dropped 0
  Last reset never
  Transport(tcp) path-mtu-discovery is enabled
  Graceful-Restart is disabled
```

---

**Configuration Examples for BGP Graceful Restart per Neighbor**

**Examples: Enabling and Disabling BGP Graceful Restart per Neighbor**

The ability to enable or disable the BGP graceful restart capability for an individual BGP neighbor, peer group, or peer session template was introduced. The following example is configured on Router B in the figure below and enables the BGP graceful restart capability for the BGP peer session template named S1 and disables the BGP graceful restart capability for the BGP peer session template named S2. The external BGP neighbor at Router A (192.168.1.2) inherits peer session template S1, and the BGP graceful restart capability is enabled for this neighbor. Another external BGP neighbor at Router E (192.168.3.2) is configured with the BGP graceful restart capability disabled after inheriting peer session template S2.
The BGP graceful restart capability is enabled for an individual internal BGP neighbor, Router C at 172.21.1.2, whereas the BGP graceful restart is disabled for the BGP neighbor at Router D, 172.16.1.2, because it is a member of the peer group PG1. The disabling of BGP graceful restart is configured for all members of the peer group, PG1. The restart and stale-path timers are modified, and the BGP sessions are reset.

```
router bgp 45000
    template peer-session S1
        remote-as 40000
        ha-mode graceful-restart
        exit-peer-session
    template peer-session S2
        remote-as 50000
        ha-mode graceful-restart disable
        exit-peer-session
    bgp log-neighbor-changes
    bgp graceful-restart restart-time 150
    bgp graceful-restart stalepath-time 400
    address-family ipv4 unicast
    neighbor PG1 peer-group
    neighbor PG1 remote-as 45000
    neighbor PG1 ha-mode graceful-restart disable
    neighbor 172.16.1.2 peer-group PG1
    neighbor 172.21.1.2 remote-as 45000
    neighbor 172.21.1.2 activate
    neighbor 172.21.1.2 ha-mode graceful-restart
    neighbor 192.168.1.2 remote-as 40000
    neighbor 192.168.1.2 inherit peer-session S1
    neighbor 192.168.3.2 remote-as 50000
    neighbor 192.168.3.2 inherit peer-session S2
end

clear ip bgp *
```

To demonstrate how the last configuration instance of the BGP graceful restart capability is applied, the following example initially enables the BGP graceful restart capability globally for all BGP neighbors. A BGP peer group, PG2, is configured with the BGP graceful restart capability disabled. An individual external BGP neighbor, Router A at 192.168.1.2 in the figure above, is then configured to be a member of the peer
group, PG2. The last graceful restart configuration instance is applied, and, in this case, the neighbor, 192.168.1.2, inherits the configuration instance from the peer group PG2, and the BGP graceful restart capability is disabled for this neighbor.

```
router bgp 45000
  bgp log-neighbor-changes
  bgp graceful-restart
  address-family ipv4 unicast
  neighbor PG2 peer-group
  neighbor PG2 remote-as 40000
  neighbor PG2 ha-mode graceful-restart disable
  neighbor 192.168.1.2 peer-group PG2
end
clear ip bgp *
```

### Additional References

#### Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
</tbody>
</table>

#### Standards and RFCs

<table>
<thead>
<tr>
<th>Standard/RFC</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFC 4724</td>
<td>Graceful Restart Mechanism for BGP</td>
</tr>
</tbody>
</table>

#### Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>
Feature Information for BGP Graceful Restart per Neighbor

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 43: Feature Information for BGP Graceful Restart per Neighbor

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP Graceful Restart per Neighbor</td>
<td>12.2(33)SRC</td>
<td>The BGP Graceful Restart per Neighbor feature enables or disables the BGP graceful restart capability for an individual BGP neighbor, including using peer session templates and BGP peer groups.</td>
</tr>
<tr>
<td></td>
<td>12.2(33)SB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cisco IOS XE 3.8S</td>
<td>In Cisco IOS Release 12.2(33)SB, platform support includes the Cisco 10000 series routers.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The following commands were introduced by this feature: ha-mode graceful-restart, and neighbor ha-mode graceful-restart.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The following command was modified by this feature: show ip bgp neighbors.</td>
</tr>
</tbody>
</table>
BGP Support for BFD

Bidirectional Forwarding Detection (BFD) is a detection protocol designed to provide fast forwarding path failure detection times for all media types, encapsulations, topologies, and routing protocols. In addition to fast forwarding path failure detection, BFD provides a consistent failure detection method for network administrators. Because the network administrator can use BFD to detect forwarding path failures at a uniform rate, rather than the variable rates for different routing protocol hello mechanisms, network profiling and planning will be easier, and reconvergence time will be consistent and predictable. The main benefit of implementing BFD for BGP is a significantly faster reconvergence time.

- Finding Feature Information, on page 529
- Information About BGP Support for BFD, on page 529
- How to Decrease BGP Convergence Time Using BFD, on page 530
- Additional References, on page 533
- Feature Information for BGP Support for BFD, on page 534

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About BGP Support for BFD

BFD for BGP

Bidirectional Forwarding Detection (BFD) is a detection protocol designed to provide fast forwarding path failure detection times for all media types, encapsulations, topologies, and routing protocols. In addition to fast forwarding path failure detection, BFD provides a consistent failure detection method for network administrators. Because the network administrator can use BFD to detect forwarding path failures at a uniform rate, rather than the variable rates for different routing protocol hello mechanisms, network profiling and
planning will be easier, and reconvergence time will be consistent and predictable. The main benefit of implementing BFD for BGP is a marked decrease in reconvergence time.

See also the “Configuring BGP Neighbor Session Options” chapter, the section “Configuring BFD for BGP IPv6 Neighbors.”

For more details about BFD, see the Cisco IOS IP Routing: BFD Configuration Guide.

How to Decrease BGP Convergence Time Using BFD

Prerequisites

- Cisco Express Forwarding (CEF) and IP routing must be enabled on all participating routers.
- BGP must be configured on the routers before BFD is deployed. You should implement fast convergence for the routing protocol that you are using. See the IP routing documentation for your version of Cisco IOS software for information on configuring fast convergence.

Restrictions

- For the Cisco implementation of BFD Support for BGP in Cisco IOS Release 15.1(1)SG, only asynchronous mode is supported. In asynchronous mode, either BFD peer can initiate a BFD session.
- IPv6 encapsulation is supported.
- BFD multihop is supported.

Decreasing BGP Convergence Time Using BFD

You start a BFD process by configuring BFD on the interface. When the BFD process is started, no entries are created in the adjacency database, in other words, no BFD control packets are sent or received. The adjacency creation takes places once you have configured BFD support for the applicable routing protocols. The first two tasks must be configured to implement BFD support for BGP to reduce the BGP convergence time. The third task is an optional task to help monitor or troubleshoot BFD.

See also the “Configuring BFD for BGP IPv6 Neighbors” section in the “Configuring BGP Neighbor Session Options” module.

Configuring BFD Session Parameters on the Interface

The steps in this procedure show how to configure BFD on the interface by setting the baseline BFD session parameters on an interface. Repeat the steps in this procedure for each interface over which you want to run BFD sessions to BFD neighbors.

SUMMARY STEPS

1. enable
2. configure terminal
### 3. interface type number

### 4. bfd interval milliseconds min_rx milliseconds multiplier interval-multiplier

### 5. end

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Router&gt; enable</td>
<td></td>
</tr>
<tr>
<td>Step 2 configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td>Step 3 interface type number</td>
<td>Enters interface configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config)# interface FastEthernet 6/0</td>
<td></td>
</tr>
<tr>
<td>Step 4 bfd interval milliseconds min_rx milliseconds multiplier interval-multiplier</td>
<td>Enables BFD on the interface.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config-if)# bfd interval 50 min_rx 50 multiplier 5</td>
<td></td>
</tr>
<tr>
<td>Step 5 end</td>
<td>Exits interface configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config-if)# end</td>
<td></td>
</tr>
</tbody>
</table>

#### Configuring BFD Support for BGP

Perform this task to configure BFD support for BGP, so that BGP is a registered protocol with BFD and will receive forwarding path detection failure messages from BFD.

**Before you begin**

- BGP must be running on all participating routers.
- The baseline parameters for BFD sessions on the interfaces over which you want to run BFD sessions to BFD neighbors must be configured. See "Configuring BFD Session Parameters on the Interface" for more information.
### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `neighbor ip-address fall-over bfd`
5. `end`
6. `show bfd neighbors [details]`
7. `show ip bgp neighbors [ip-address [received-routes | routes | advertised-routes | paths [regexp] | dampened-routes | flap-statistics | received prefix-filter | policy [detail]]]`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** enable | Enables privileged EXEC mode.  
  Example:  
  Router> enable |
| **Step 2** configure terminal | Enters global configuration mode.  
  Example:  
  Router# configure terminal |
| **Step 3** router bgp autonomous-system-number | Specifies a BGP process and enters router configuration mode.  
  Example:  
  Router(config)# router bgp tag1 |
| **Step 4** neighbor ip-address fall-over bfd | Enables BFD support for fallover.  
  Example:  
  Router(config-router)# neighbor 172.16.10.2 fall-over bfd |
| **Step 5** end | Returns the router to privileged EXEC mode.  
  Example:  
  Router(config-router)# end |
| **Step 6** show bfd neighbors [details] | Verifies that the BFD neighbor is active and displays the routing protocols that BFD has registered.  
  Example:  
  Router# show bfd neighbors detail |
| **Step 7** show ip bgp neighbors [ip-address [received-routes | routes | advertised-routes | paths [regexp] | dampened-routes | flap-statistics | received prefix-filter | policy [detail]]] | Displays information about BGP and TCP connections to neighbors. |
Monitoring and Troubleshooting BFD

To monitor or troubleshoot BFD, perform one or more of the steps in this section.

SUMMARY STEPS

1. `enable`
2. `show bfd neighbors [details]`
3. `debug bfd [event | packet | ipc-error | ipc-event | oir-error | oir-event]`

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td><code>enable</code> Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><code>Router&gt; enable</code></td>
<td></td>
</tr>
</tbody>
</table>

| **Step 2**        | `show bfd neighbors [details]` Displays the BFD adjacency database. |
| Example:          | • The `details` keyword shows all BFD protocol parameters and timers per neighbor. |
| `Router# show bfd neighbors details` | |

| **Step 3**        | `debug bfd [event | packet | ipc-error | ipc-event | oir-error | oir-event]` Displays debugging information about BFD packets. |
| Example:          | |
| `Router# debug bfd packet` | |

Additional References

Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
<tr>
<td>BFD commands</td>
<td>Cisco IOS IP Routing: Protocol Independent Command Reference</td>
</tr>
</tbody>
</table>
### Feature Information for BGP Support for BFD

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to [http://www.cisco.com/go/cfn](http://www.cisco.com/go/cfn). An account on Cisco.com is not required.
Table 44: Feature Information for BGP Support for BFD

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP Support for BFD</td>
<td>12.2(33)SRA, 12.2(33)SB, 15.1(1)SG, Cisco IOS XE Release 2.1, Cisco IOS XE Release 3.5S</td>
<td>Bidirectional Forwarding Detection (BFD) is a detection protocol designed to provide fast forwarding path failure detection times for all media types, encapsulations, topologies, and routing protocols. In addition to fast forwarding path failure detection, BFD provides a consistent failure detection method for network administrators. Because the network administrator can use BFD to detect forwarding path failures at a uniform rate, rather than the variable rates for different routing protocol hello mechanisms, network profiling and planning will be easier, and reconvergence time will be consistent and predictable. The main benefit of implementing BFD for BGP is a significantly faster reconvergence time. The following commands were introduced or modified by this feature: bfd, neighbor fall-over, show bfd neighbors, and show ip bgp neighbors.</td>
</tr>
</tbody>
</table>
IPv6 NSF and Graceful Restart for MP-BGP IPv6 Address Family

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About IPv6 NSF and Graceful Restart for MP-BGP IPv6 Address Family

Nonstop Forwarding and Graceful Restart for MP-BGP IPv6 Address Family

The graceful restart capability is supported for IPv6 BGP unicast, multicast, and VPNv6 address families, enabling Cisco nonstop forwarding (NSF) functionality for BGP IPv6. The BGP graceful restart capability allows the BGP routing table to be recovered from peers without keeping the TCP state.

NSF continues forwarding packets while routing protocols converge, therefore avoiding a route flap on switchover. Forwarding is maintained by synchronizing the FIB between the active and standby RP. On switchover, forwarding is maintained using the FIB. The RIB is not kept synchronized; therefore, the RIB is empty on switchover. The RIB is repopulated by the routing protocols and subsequently informs FIB about...
RIB convergence by using the NSF_RIB_CONVERGED registry call. The FIB tables are updated from the RIB, removing any stale entries. The RIB starts a fail-safe timer during RP switchover, in case the routing protocols fail to notify the RIB of convergence.

The Cisco BGP address family identifier (AFI) model is designed to be modular and scalable, and to support multiple AFI and subsequent address family identifier (SAFI) configurations.

How to Configure IPv6 NSF and Graceful Restart for MP-BGP IPv6 Address Family

Configuring the IPv6 BGP Graceful Restart Capability

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp as-number`
4. `address-family ipv6 [vrf vrf-name] [unicast | multicast | vpnv6]`
5. `bgp graceful-restart [restart-time seconds | stalepath-time seconds] [all]`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp as-number</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# router bgp 65000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> address-family ipv6 [vrf vrf-name] [unicast</td>
<td>multicast</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router)# address-family ipv6</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> bgp graceful-restart [restart-time seconds</td>
<td>stalepath-time seconds] [all]</td>
</tr>
</tbody>
</table>
### Configuration Examples for IPv6 NSF and Graceful Restart for MP-BGP IPv6 Address Family

#### Example: Configuring the IPv6 BGP Graceful Restart Capability

In the following example, the BGP graceful restart capability is enabled:

```plaintext
Device# configure terminal
Device(config)# router bgp 65000
Device(config-router)# address-family ipv6
Device(config-router-af)# bgp graceful-restart
```

In the following example, the restart timer is set to 130 seconds:

```plaintext
Device# configure terminal
Device(config)# router bgp 65000
Device(config-router)# address-family ipv6
Device(config-router-af)# bgp graceful-restart restart-time 130
```

In the following example, the stalepath timer is set to 350 seconds:

```plaintext
Device# configure terminal
Device(config)# router bgp 65000
Device(config-router)# address-family ipv6
Device(config-router-af)# bgp graceful-restart stalepath-time 350
```

### Additional References

#### Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
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<tbody>
<tr>
<td>IPv6 addressing and connectivity</td>
<td><em>IPv6 Configuration Guide</em></td>
</tr>
<tr>
<td>Cisco IOS commands</td>
<td><em>Cisco IOS Master Command List, All Releases</em></td>
</tr>
<tr>
<td>IPv6 commands</td>
<td><em>Cisco IOS IPv6 Command Reference</em></td>
</tr>
<tr>
<td>Cisco IOS IPv6 features</td>
<td><em>Cisco IOS IPv6 Feature Mapping</em></td>
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Standards and RFCs

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<tr>
<td>RFCs for IPv6</td>
<td>IPv6 RFCs</td>
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MIBs

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<tr>
<th>MIB</th>
<th>MIBs Link</th>
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<tbody>
<tr>
<td></td>
<td>To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL:</td>
</tr>
<tr>
<td></td>
<td><a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
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<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

Feature Information for IPv6 NSF and Graceful Restart for MP-BGP IPv6 Address Family

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.
<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPv6: NSF and Graceful Restart for MP-BGP IPv6 Address Family</td>
<td>Cisco IOS XE Release 3.1</td>
<td>The graceful restart capability is supported for IPv6 BGP unicast, multicast, and VPNv6 address families, enabling Cisco NSF functionality for BGP IPv6. The BGP graceful restart capability allows the BGP routing table to be recovered from peers without keeping the TCP state.</td>
</tr>
</tbody>
</table>
BGP Persistence

BGP persistence enables the router to retain routes that it has learnt from the configured neighbor even when the neighbor session is down. BGP persistence is also referred as long lived graceful restart (LLGR). LLGR comes into effect after graceful restart (GR) ends.

- Restrictions for BGP Persistence, on page 543
- Information About BGP Persistence, on page 543
- How to Configure BGP Persistence, on page 545
- Verifying BGP Persistence, on page 545
- Feature Information for BGP Persistence, on page 547

Restrictions for BGP Persistence

- LLGR is not supported for multicast address-families.

Information About BGP Persistence

BGP paths received from neighbor are removed immediately when it detects that the session is down. This behavior is to keep BGP table and forwarding table updated with current network state. Eventually this avoids traffic blackhole and routing loops. But in some scenarios keeping the routes for longer time during control plane failure helps the services that are less IP sensitive to continue uninterrupted for longer duration. The traffic flow does not get affected in the following scenarios, even if the BGP routes are stored for longer time during the BGP neighbor failures:

- When route advertisement path is different than the forwarding path that is, through MPLS tunnels. For example, VPN routes.
- When the purpose of route advertisement is to push configuration that is, filter programming on the router. For example, flow-spec, route-targets.
- When route advertisement is used for auto-discovery. For example, VPLS.

BGP persistence enables the local router to retain routes that it has learnt from the configured neighbor even when the neighbor session is down. BGP persistence is also referred as long lived graceful restart (LLGR). LLGR comes into effect after graceful restart (GR) ends. LLGR ends either when the LLGR stale timer expires or when the neighbor sends the end-of-RIB marker after it has sent its routes. When LLGR for a neighbor ends, all routes from that neighbor that are still LLGR stale gets deleted. The LLGR capability is signaled to
a neighbor in the BGP OPEN message, if configured. With BGP persistence the paths are held for very long time (days), and unlike graceful-restart behavior the paths are de-preferenced so that a non-stale path is chosen over a stale path.

BGP speaker advertises LLGR capability including all address-families configured with LLGR. LLGR stale time is per address-family. The BGP persistence feature is supported on the following address family indicators (AFIs):

- VPNv4 and VPNv6
- Flow spec (IPv4, IPv6, VPNv4 and VPNv6)

With BGP persistence, the paths are held for a very long time (days), but unlike basic graceful-restart behavior, the paths are de-preferenced so that a non-stale path is always chosen over a stale path. When the neighbor goes down, it first performs the classic graceful restart which consists of the following steps:

- Starts graceful-restart timer
- Marks the prefixes from its neighbor as stale

Persistence is executed by the helper router only after the graceful-restart is completed. Persistence ends when neighbor sends end-of-row (EoR) or persistence timer expires.

**Restart Router**

Graceful-restart configuration is mandatory to support persistence (LLGR) neighbor configuration knob to configure persistence. Persistence timer can range between 0 to 4294967.

**Helper Router**

Helper router executes persistence when graceful-restart is completed. It performs the following tasks:

- Starts persistence timer.
- Marks the prefixes learned from neighbor as **long-lived stale path**.
- Performs best path calculation to de-preference the long lived stale paths. If route has only long lived stale path, it is selected as the best path. If route has multiple long lived stale paths, normal tie-breaking is executed to find the best path.
- Re-advertises the long lived stale path as the best path/add-path with LLGR_STALE (65535:6) community attribute to all LLGR capable configured neighbors.
-Withdraws long lived stale routes from non-LLGR capable neighbors.

**Helper Router's Peer**

If helper router’s neighbor is LLGR capable, it performs the following for routes received with LLGR_STALE community:

- De-preferences the routes received with LLGR_STALE community attribute.
- Re-advertises the path with LLGR_STALE community attribute as the best path/add-path to the LLGR capable routers with same LLGR_STALE attribute attached.
How to Configure BGP Persistence

Configuring BGP Persistence

Device# configure terminal
Device(config)# router bgp AS
Device(config-router)# address-family vpnv4
Device(config-router-af)# neighbor neighbor-id
Device(config-router-af-nbr)# bgp long-lived-graceful-restart {stale-time send time accept time}

- **bgp long-lived-graceful-restart**: Enables long lived graceful restart support for the neighbor.
- **stale-time**: Specifies maximum time to wait before purging long-lived stale routes. If the neighbor router negotiates the capability and accept knob is configured locally then lowest of these two values is used as long-lived stale time.
- **send time**: Specifies stale-time sent in capability. The specified range is between 0-4294967 seconds.
- **accept time**: Specifies maximum stale-time acceptable from neighbor. The specified range is between 0-4294967 seconds. BGP speaker acts as helper for LLGR capable neighbors. However, it can also act as helper for non-LLGR capable neighbors by configuring accept knob. In that case, value configured with this knob is used as long-lived stale time.

The following is an example:

```
router bgp 1
address-family vpnv4
eighbor 1.1.1.1
   long-lived-graceful-restart stale-time send 300 accept 300
   long-lived-graceful-restart stale-time accept 300
```

Verifying BGP Persistence

1. To verify LLGR capability advertise and receive status, use the command `show ip bgp vpnv4 unicast neighbors neighbor-id`.

```
show ip bgp vpnv4 unicast neighbors 1.1.1.1
......
BGP neighbor is 1.1.1.1, remote AS 1, internal link
Description: test1
......
Neighbor capabilities:
   Route refresh: advertised and received(new)
   Four-octets ASN Capability: advertised and received
   Address family IPv4 Unicast: advertised and received
   Address family VPNv4 Unicast: advertised and received
   Address family VPNv6 Unicast: advertised and received
   Graceful Restart Capability: advertised and received
```
Remote Restart timer is 10 seconds
Address families advertised by peer:
  none
Address families advertised by peer before restart:
  none
Long-lived Graceful Restart Capability:
  VPNv4 Unicast: advertised and received (was preserved)
  VPNv6 Unicast: received (was preserved)
Enhanced Refresh Capability: advertised and received
Multisession Capability:
  Stateful switchover support enabled: NO for session 1

For address family: VPNv4 Unicast
  Session: 1.1.1.1
  ..........
  ..........
  Long-lived Graceful-Restart (was preserved)
  Stalepath-time: sent 2000s, received 50s, accepted 2000s, used 50s

2. To verify restarting of the peer, use the command `show ip bgp vpnv4 unicast neighbors neighbor-id`.

```
Device# show ip bgp vpnv4 unicast neighbors 1.1.1.1
.............
BGP neighbor is 1.1.1.1, remote AS 1, internal link
Description: test1
.............
BGP version 4, remote router ID 0.0.0.0
BGP state = Active, down for 00:00:23
Configured hold time is 15, keepalive interval is 5 seconds
Minimum holdtime from neighbor is 0 seconds
Neighbor sessions:
  0 active, is not multisession capable (disabled)
Stateful switchover support enabled: NO for session 0
Message statistics:
  InQ depth is 0
..........
For address family: VPNv4 Unicast
  Session: 1.1.1.1
  ..........
  ..........
  Long-lived Graceful-Restart
  Stalepath-time: sent 2000s, accepted 2000s, used 2000s
  Stalepath-timer running 37s remaining
```

3. To verify routes marked with long-lived stale routes, use the command `show ip bgp vpnv4 all`.

```
Device# show ip bgp vpnv4 all
BGP table version is 33, local router ID is 19.19.19.19
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
  r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
  x best-external, a additional-path, c RIB-compressed,
  L long-lived-stale-path
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

<table>
<thead>
<tr>
<th>Network Route Distinguisher</th>
<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>*L&gt;i 20.0.0.0.16</td>
<td>1.1.88.1</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>81</td>
</tr>
<tr>
<td>*L&gt;i 38.1.1.0.24</td>
<td>1.1.88.1</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>81</td>
</tr>
<tr>
<td>*L&gt;i 180.180.180.180/32</td>
<td>1.1.88.1</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>81</td>
</tr>
</tbody>
</table>
```
Router#show ip bgp vpnv4 all 20.0.0.0/16
BGP routing table entry for 2:2:20.0.0.0/16, version 9
Paths: (1 available, best #1, table example)
  Advertised to update-groups:
    1
  Refresh Epoch 1
  81 (long-lived-stale), imported path from 5:5:20.0.0.0/16 (global)
    1.1.88.1 (metric 40) (via default) from 1.1.1.188 (1.1.1.188)
      Origin incomplete, metric 0, localpref 100, valid, internal, best
      Community: 100:100
      Extended Community: RT:1:1
      Originator: 1.1.88.1, Cluster list: 1.1.1.188
      mpls labels in/out nolabel/44
      rx pathid: 0, tx pathid: 0x0

Feature Information for BGP Persistence

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 46: Feature Information for BGP Persistence

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Configuration Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP Persistence</td>
<td>Cisco IOS XE Fuji 16.7.1</td>
<td>BGP persistence enables the router to retain routes that it has learnt from the configured neighbor even after the neighbor session is down. BGP persistence is also referred as Long Lived Graceful Restart (LLGR). The following commands were modified: address-family vpnv4, bgp long-lived-graceful-restart {stale-time send time accept time}, neighbor neighbor-id, router bgp AS, show ip bgp vpnv4 all, and show ip bgp vpnv4 unicast neighbors &lt;neighbor-id&gt;.</td>
</tr>
</tbody>
</table>
CHAPTER 31

BGP Link Bandwidth

The Border Gateway Protocol (BGP) Link Bandwidth feature is used to advertise the bandwidth of an autonomous system exit link as an extended community. This feature is configured for links between directly connected external BGP (eBGP) neighbors. The link bandwidth extended community attribute is propagated to iBGP peers when extended community exchange is enabled. This feature is used with BGP multipath features to configure load balancing over links with unequal bandwidth.

• Finding Feature Information, on page 549
• Prerequisites for BGP Link Bandwidth, on page 549
• Restrictions for BGP Link Bandwidth, on page 550
• Information About BGP Link Bandwidth, on page 550
• How to Configure BGP Link Bandwidth, on page 551
• Configuration Examples for BGP Link Bandwidth, on page 553
• Additional References, on page 557
• Feature Information for BGP Link Bandwidth, on page 558

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for BGP Link Bandwidth

• BGP load balancing or multipath load balancing must be configured before BGP Link Bandwidth feature is enabled.

• BGP extended community exchange must be enabled between iBGP neighbors to which the link bandwidth attribute is to be advertised.

• Cisco Express Forwarding or distributed Cisco Express Forwarding must be enabled on all participating routers.
Restrictions for BGP Link Bandwidth

- The BGP Link Bandwidth feature can be configured only under IPv4 and VPNv4 address family sessions.
- BGP can originate the link bandwidth community only for directly connected links to eBGP neighbors.
- Both iBGP and eBGP load balancing are supported in IPv4 and VPNv4 address families. However, eiBGP load balancing is supported only in VPNv4 address families.

Information About BGP Link Bandwidth

BGP Link Bandwidth Overview

The BGP Link Bandwidth feature is used to enable multipath load balancing for external links with unequal bandwidth capacity. This feature is enabled under an IPv4 or VPNv4 address family session by entering the `bgp dmzlink-bw` command. This feature supports iBGP, eBGP multipath load balancing, and eiBGP multipath load balancing in Multiprotocol Label Switching (MPLS) VPNs. When this feature is enabled, routes learned from directly connected external neighbor are propagated through the internal BGP (iBGP) network with the bandwidth of the source external link.

The link bandwidth extended community indicates the preference of an autonomous system exit link in terms of bandwidth. This extended community is applied to external links between directly connected eBGP peers by entering the `neighbor dmzlink-bw` command. The link bandwidth extended community attribute is propagated to iBGP peers when extended community exchange is enabled with the `neighbor send-community` command.

Link Bandwidth Extended Community Attribute

The link bandwidth extended community attribute is a 4-byte value that is configured for a link on the demilitarized zone (DMZ) interface that connects two single hop eBGP peers. The link bandwidth extended community attribute is used as a traffic sharing value relative to other paths while traffic is being forwarded. Two paths are designated as equal for load balancing if the weight, local-pref, as-path length, Multi Exit Discriminator (MED), and Interior Gateway Protocol (IGP) costs are the same.

Benefits of the BGP Link Bandwidth Feature

The BGP Link Bandwidth feature allows BGP to be configured to send traffic over multiple iBGP or eBGP learned paths where the traffic that is sent is proportional to the bandwidth of the links that are used to exit the autonomous system. The configuration of this feature can be used with eBGP and iBGP multipath features to enable unequal cost load balancing over multiple links. Unequal cost load balancing over links with unequal bandwidth was not possible in BGP before the BGP Link Bandwidth feature was introduced.
How to Configure BGP Link Bandwidth

Configuring BGP Link Bandwidth

To configure the BGP Link Bandwidth feature, perform the steps in this section.

SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `address-family ipv4 [mdt | multicast | tunnel | unicast [vrf vrf-name] | vrf vrf-name] | vpnv4 [unicast]`
5. `bgp dmzlink-bw`
6. `neighbor ip-address dmzlink-bw`
7. `neighbor ip-address send-community [both | extended | standard]`
8. `end`

DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td><code>enable</code></td>
<td>Enables higher privilege levels, such as privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td><code>Router&gt; enable</code></td>
<td>Enter your password if prompted.</td>
</tr>
<tr>
<td>Step 2</td>
<td><code>configure terminal</code></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td><code>Router# configure terminal</code></td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td><code>router bgp autonomous-system-number</code></td>
<td>Enters router configuration mode to create or configure a BGP routing process.</td>
</tr>
<tr>
<td>Example:</td>
<td><code>Router(config)# router bgp 50000</code></td>
<td></td>
</tr>
<tr>
<td>Step 4</td>
<td>`address-family ipv4 [mdt</td>
<td>multicast</td>
</tr>
<tr>
<td>Example:</td>
<td><code>Router(config-router)# address-family ipv4</code></td>
<td>• The BGP Link Bandwidth feature is supported only under the IPv4 and VPNv4 address families.</td>
</tr>
<tr>
<td>Step 5</td>
<td><code>bgp dmzlink-bw</code></td>
<td>Configures BGP to distribute traffic proportionally to the bandwidth of the link.</td>
</tr>
<tr>
<td>Example:</td>
<td><code>Router(config-router-af)# bgp dmzlink-bw</code></td>
<td>• This command must be entered on each router that contains an external interface that is to be used for multipath load balancing.</td>
</tr>
</tbody>
</table>
Verifying BGP Link Bandwidth Configuration

To verify the BGP Link Bandwidth feature, perform the steps in this section.

**SUMMARY STEPS**

1. `enable`
2. `show ip bgp ip-address [longer-prefixes [injected]] [shorter-prefixes [mask-length]]`
3. `show ip route [[ip-address [mask] [longer-prefixes]] [protocol [process-id]] [list access-list-number | access-list-name] | [static download]]`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 6**

**neighbor ip-address dmzlink-bw**

*Example:*

Router(config-router-af)# neighbor 172.16.1.1 dmzlink-bw

<table>
<thead>
<tr>
<th>Purpose</th>
</tr>
</thead>
</table>
| Configures BGP to include the link bandwidth attribute for routes learned from the external interface specified IP address.

- This command must be configured for each eBGP link that is to be configured as a multipath. Enabling this command allows the bandwidth of the external link to be propagated through the link bandwidth extended community. |

| **Step 7**

**neighbor ip-address send-community [both | extended [standard]]**

*Example:*

Router(config-router-af)# neighbor 10.10.10.1 send-community extended

<table>
<thead>
<tr>
<th>Purpose</th>
</tr>
</thead>
</table>
| (Optional) Enables community and/or extended community exchange with the specified neighbor.

- This command must be configured for iBGP peers to which the link bandwidth extended community attribute is to be propagated. |

| **Step 8**

**end**

*Example:*

Router(config-router-af)# end

<table>
<thead>
<tr>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exits address family configuration mode, and enters Privileged EXEC mode.</td>
</tr>
</tbody>
</table>
**BGP Link Bandwidth Configuration Example**

In the following examples, the BGP Link Bandwidth feature is configured so BGP will distribute traffic proportionally to the bandwidth of each external link. The figure below shows two external autonomous systems connected by three links that each carry a different amount of bandwidth (unequal cost links). Multipath load balancing is enabled and traffic is balanced proportionally.

*Figure 46: BGP Link Bandwidth Configuration*

**Router A Configuration**

In the following example, Router A is configured to support iBGP multipath load balancing and to exchange the BGP extended community attribute with iBGP neighbors:

```
Router A(config)# router bgp 100
```
Router A(config-router)# neighbor 10.10.10.2 remote-as 100
Router A(config-router)# neighbor 10.10.10.2 update-source Loopback 0
Router A(config-router)# neighbor 10.10.10.3 remote-as 100
Router A(config-router)# neighbor 10.10.10.3 update-source Loopback 0
Router A(config-router)# address-family ipv4
Router A(config-router)# bgp dmzlink-bw
Router A(config-router-af)# neighbor 10.10.10.2 activate
Router A(config-router-af)# neighbor 10.10.10.2 send-community both
Router A(config-router-af)# neighbor 10.10.10.3 activate
Router A(config-router-af)# neighbor 10.10.10.3 send-community both
Router A(config-router-af)# maximum-paths ibgp 6

**Router B Configuration**

In the following example, Router B is configured to support multipath load balancing, to distribute Router D and Router E link traffic proportionally to the bandwidth of each link, and to advertise the bandwidth of these links to iBGP neighbors as an extended community:

Router B(config)# router bgp 100
Router B(config-router)# neighbor 10.10.10.1 remote-as 100
Router B(config-router)# neighbor 10.10.10.1 update-source Loopback 0
Router B(config-router)# neighbor 10.10.10.3 remote-as 100
Router B(config-router)# neighbor 10.10.10.3 update-source Loopback 0
Router B(config-router)# neighbor 172.16.1.1 remote-as 200
Router B(config-router)# neighbor 172.16.1.1 ebgp-multihop 1
Router B(config-router)# neighbor 172.16.2.2 remote-as 200
Router B(config-router)# neighbor 172.16.2.2 ebgp-multihop 1
Router B(config-router)# address-family ipv4
Router B(config-router-af)# bgp dmzlink-bw
Router B(config-router-af)# neighbor 10.10.10.1 activate
Router B(config-router-af)# neighbor 10.10.10.1 next-hop-self
Router B(config-router-af)# neighbor 10.10.10.1 send-community both
Router B(config-router-af)# neighbor 172.16.1.1 activate
Router B(config-router-af)# neighbor 172.16.1.1 send-community both
Router B(config-router-af)# neighbor 10.10.10.3 activate
Router B(config-router-af)# neighbor 10.10.10.3 next-hop-self
Router B(config-router-af)# neighbor 10.10.10.3 send-community both
Router B(config-router-af)# neighbor 172.16.1.1 activate
Router B(config-router-af)# neighbor 172.16.1.1 dmzlink-bw
Router B(config-router-af)# neighbor 172.16.2.2 activate
Router B(config-router-af)# neighbor 172.16.2.2 dmzlink-bw
Router B(config-router-af)# maximum-paths ibgp 6
Router B(config-router-af)# maximum-paths 6

Router C Configuration
In the following example, Router C is configured to support multipath load balancing and to advertise the bandwidth of the link with Router E to iBGP neighbors as an extended community:

Router C(config)# router bgp 100
Router C(config-router)# neighbor 10.10.10.1 remote-as 100
Router C(config-router)# neighbor 10.10.10.1 update-source Loopback 0
Router C(config-router)# neighbor 10.10.10.2 remote-as 100
Router C(config-router)# neighbor 10.10.10.2 update-source Loopback 0
Router C(config-router)# neighbor 172.16.3.30 remote-as 200
Router C(config-router)# neighbor 172.16.3.30 ebgp-multihop 1
Router C(config-router)# address-family ipv4
Router C(config-router-af)# bgp dmzlink-bw
Router C(config-router-af)# neighbor 10.10.10.1 activate
Router C(config-router-af)# neighbor 10.10.10.1 send-community both
Router C(config-router-af)# neighbor 10.10.10.2 activate
Router C(config-router-af)# neighbor 10.10.10.2 send-community both
Router C(config-router-af)# neighbor 10.10.10.2 next-hop-self
Router C(config-router-af)# neighbor 172.16.3.3 activate
Router C(config-router-af)# neighbor 172.16.3.3 dmzlink-bw
Router C(config-router-af)# maximum-paths ibgp 6
Router C(config-router-af)# maximum-paths 6

Verifying BGP Link Bandwidth

The examples in this section show the verification of this feature on Router A and Router B.

Router B
In the following example, the `show ip bgp` command is entered on Router B to verify that two unequal cost best paths have been installed into the BGP routing table. The bandwidth for each link is displayed with each route.

Router B# show ip bgp 192.168.1.0
BGP routing table entry for 192.168.1.0/24, version 48
Paths: (2 available, best #2)
Multipath: eBGP
  Advertised to update-groups:
    1    2
    200
    172.16.1.1 from 172.16.1.2 (192.168.1.1)
      Origin incomplete, metric 0, localpref 100, valid, external, multipath, best
      Extended Community: 0x0:0:0
      DMZ-Link Bw 278 kbytes
    200
172.16.2.2 from 172.16.2.2 (192.168.1.1)
Origin incomplete, metric 0, localpref 100, valid, external, multipath, best
Extended Community: 0x0:0:0
DMZ-Link Bw 625 kbytes

Router A
In the following example, the `show ip bgp` command is entered on Router A to verify that the link bandwidth extended community has been propagated through the iBGP network to Router A. The output shows that a route for each exit link (on Router B and Router C) to autonomous system 200 has been installed as a best path in the BGP routing table.

Router A# `show ip bgp 192.168.1.0`
BGP routing table entry for 192.168.1.0/24, version 48
Paths: (3 available, best #3)
Multipath: eBGP
    Advertised to update-groups:
        1    2
    200
        172.16.1.1 from 172.16.1.2 (192.168.1.1)
            Origin incomplete, metric 0, localpref 100, valid, external, multipath
            Extended Community: 0x0:0:0
            DMZ-Link Bw 278 kbytes
    200
        172.16.2.2 from 172.16.2.2 (192.168.1.1)
            Origin incomplete, metric 0, localpref 100, valid, external, multipath, best
            Extended Community: 0x0:0:0
            DMZ-Link Bw 625 kbytes
    200
        172.16.3.3 from 172.16.3.3 (192.168.1.1)
            Origin incomplete, metric 0, localpref 100, valid, external, multipath, best
            Extended Community: 0x0:0:0
            DMZ-Link Bw 2500 kbytes

Router A
In the following example, the `show ip route` command is entered on Router A to verify the multipath routes that are advertised and the associated traffic share values:

Router A# `show ip route 192.168.1.0`
Routing entry for 192.168.1.0/24
    Known via "bgp 100", distance 200, metric 0
    Tag 200, type internal
    Last update from 172.168.1.1 00:01:43 ago
    Routing Descriptor Blocks:
        * 172.168.1.1, from 172.168.1.1, 00:01:43 ago
            Route metric is 0, traffic share count is 13
            AS Hops 1, BGP network version 0
            Route tag 200
        172.168.2.2, from 172.168.2.2, 00:01:43 ago
            Route metric is 0, traffic share count is 30
            AS Hops 1, BGP network version 0
            Route tag 200
        172.168.3.3, from 172.168.3.3, 00:01:43 ago
            Route metric is 0, traffic share count is 120
            AS Hops 1, BGP network version 0
            Route tag 200
### Additional References

The following sections provide references related to the BGP Link Bandwidth feature.

#### Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP commands: complete command syntax, command mode, command history, defaults, usage guidelines, and examples</td>
<td><em>Cisco IOS IP Routing: BGP Command Reference</em></td>
</tr>
<tr>
<td>BGP multipath load sharing for both eBGP and iBGP in an MPLS-VPN</td>
<td>&quot;BGP Multipath Load Sharing for Both eBGP and iBGP in an MPLS-VPN&quot;</td>
</tr>
<tr>
<td>iBGP multipath load sharing</td>
<td>&quot;iBGP Multipath Load Sharing&quot;</td>
</tr>
<tr>
<td>Cisco IOS master command list, all releases</td>
<td><em>Cisco IOS Master Command List, All Releases</em></td>
</tr>
</tbody>
</table>

#### Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.</td>
<td>--</td>
</tr>
</tbody>
</table>

#### MIBs

<table>
<thead>
<tr>
<th>MIB</th>
<th>MIBs Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>No new or modified MIBs are supported by this feature, and support for existing MIBs has not been modified by this feature.</td>
<td>To locate and download MIBs for selected platforms, Cisco IOS XE software releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
</tr>
</tbody>
</table>

#### Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/techsupport">http://www.cisco.com/techsupport</a></td>
</tr>
</tbody>
</table>
Feature Information for BGP Link Bandwidth

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 47: Feature Information for BGP Link Bandwidth

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP Link Bandwidth</td>
<td>Cisco IOS XE Release 2.1</td>
<td>This feature was introduced on the Cisco ASR 1000 Series Aggregation Services Routers. The following commands were added or modified by this feature: bgp dmzlink-bw, neighbor dmzlink-bw.</td>
</tr>
</tbody>
</table>
CHAPTER 32

Border Gateway Protocol Link-State

Border Gateway Protocol Link-State (BGP-LS) is an Address Family Identifier (AFI) and Sub-address Family Identifier (SAFI) defined to carry interior gateway protocol (IGP) link-state database through BGP routing protocol. BGP-LS delivers network topology information to topology servers and Application Layer Traffic Optimization (ALTO) servers. BGP-LS allows policy-based control to aggregation, information-hiding, and abstraction. BGP-LS supports IS-IS and OSPFv2.

- Finding Feature Information, on page 559
- Information About Border Gateway Protocol Link-State, on page 559
- How to Configure OSPF With Border Gateway Protocol Link-State, on page 563
- How to Configure IS-IS With Border Gateway Protocol Link-State, on page 564
- Verifying Border Gateway Protocol Link-State Configurations, on page 566
- Border Gateway Protocol Link-State Debug Commands, on page 569
- Additional References for Border Gateway Protocol Link-State, on page 569
- Feature Information for Border Gateway Protocol Link-State, on page 570

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About Border Gateway Protocol Link-State

Overview of Link-State Information in Border Gateway Protocol

In a number of environments, a component external to a network is called upon to perform computations based on the network topology and current state of the connections within the network, including Traffic Engineering (TE) information. This information is typically distributed by interior gateway protocol (IGP) routing protocols within the network.
This module describes a mechanism by which link-state (LS) and Traffic Engineering (TE) information from IGPs are collected from networks and shared with external components using the BGP routing protocol, which uses a new BGP Network Layer Reachability Information (NLRI) encoding format. This mechanism is applicable to both physical and virtual links. Applications of this technique include Application-Layer Traffic Optimization (ALTO) servers and Path Computation Elements (PCEs), which are outside the network, but requires real-time information of the state of the network. For example, the link-state database information of each IGP node (OSPF or IS-IS) from the entire network.

In order to address the need for applications that require topological visibility across IGP areas, or even across Autonomous Systems (AS), the BGP-LS address-family or a sub-address-family have been defined to allow BGP to carry link-state information. The identifying key of each link-state object, for example, a node, link, or prefix, is encoded in the NLRI and the properties of the object are encoded in the BGP-LS attribute.

The below figure describes a typical deployment scenario of a network that utilizes BGP-LS. In each IGP area, one or more nodes are configured with BGP-LS. These BGP speakers form an IBGP mesh by connecting to one or more route-reflectors. This way, all BGP speakers (specifically the route-reflectors (RR)) obtain link-state information from all IGP areas (and from other ASes from EBGP peers). An external component connects to the route-reflector to obtain this information (perhaps moderated by a policy regarding what information is or is not advertised to the external component). An external component (for example, a controller) then can collect these information in the "northbound" direction across IGP areas or ASes and construct the end-to-end path (with its associated SIDs) that are applied to an incoming packet for end-to-end forwarding.

Figure 47: Relation between IGP nodes and BGP

Carrying Link-State Information in Border Gateway Protocol

Carrying link-state information contains two parts:

- Definition of a new BGP NLRI that describes links, nodes, and prefixes comprises of IGP link-state information.

- Definition of a new BGP-LS attribute that carries link, node, and prefix properties and attributes, such as the link and prefix metric or auxiliary Router IDs of nodes, and so on.
TLV Format

Information in the new Link-State NLRI attributes is encoded in Type/Length/Value (TLV) triplets. The TLV format is shown in the below figure.

```
0 1 2 3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Type | Length |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
// Value (variable) //
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The Length field defines the length of the value portion in octets (thus, a TLV with no value portion would have a length of zero).

Link-State NLRI

The MP_REACH_NLRI and MP_UNREACH_NLRI attributes are BGP's containers for carrying opaque information. Each Link-State Network Layer Reachability Information (NLRI) describes either a node, a link, or a prefix. NLRI body is a set of Type/Length/Value triplets (TLV) and contains the data that identifies an object.

```
0 1 2 3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| NLRI Type | Total NLRI Length |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
// Link-State NLRI (variable) //
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

NLRI Types

The Total NLRI length field contains the cumulative length, in octets, of the rest of the NLRI, not including the NLRI Type field or itself.

*Figure 48: The NLRI Types*

```
+---------------------------------+
| Type | NLRI Type                  |
+---------------------------------+
| 1    | Node NLRI                  |
| 2    | Link NLRI                   |
| 3    | IPv4 Topology Prefix NLRI  |
| 4    | IPv6 Topology Prefix NLRI  |
```

The NLRI Types are shown in the following figures:

*Figure 49: The Node NLRI Format*

```
0 1 2 3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Protocol-ID |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Identifier   |
| (64 bits)    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
The IPv4 and IPv6 Prefix NLRIs (NLRI Type = 3 and Type = 4) use the same format, as shown in the following figure.

**Figure 51: The IPv4/IPv6 Topology Prefix NLRI Format**

```
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+---------------+-------------------+
| Identifier    | (64 bits)         |
|---------------+-------------------+
+---------------+-------------------+
```

**Node Descriptors**

Each link is anchored by a pair of Router-IDs that are used by the underlying IGP, namely, a 48-bit ISO System-ID for IS-IS and a 32-bit Router-ID for OSPFv2 and OSPFv3. An IGP may use one or more additional auxiliary Router-IDs, mainly for traffic engineering purposes. For example, IS-IS may have one or more IPv4 and IPv6 TE Router-IDs. These auxiliary Router-IDs must be included in the link attribute.

**Link Descriptors**

The Link Descriptor field is a set of Type/Length/Value (TLV) triplets. The link descriptor TLVs uniquely identify a link among multiple parallel links between a pair of anchor routers. A link described by the link descriptor TLVs actually is a "half-link", a unidirectional representation of a logical link. In order to fully describe a single logical link, two originating routers advertise a half-link each, that is, two Link NLRIs are advertised for a given point-to-point link.

**Prefix Descriptors**

The Prefix Descriptor field is a set of Type/Length/Value (TLV) triplets. Prefix Descriptor TLVs uniquely identify an IPv4 or IPv6 prefix originated by a node.
BGP-LS Attribute

The BGP-LS attribute is an optional, non-transitive BGP attribute that is used to carry link, node, and prefix parameters and attributes. It is defined as a set of Type/Length/Value (TLV) triplets. This attribute should only be included with Link-State NLRIs. This attribute must be ignored for all other address families.

How to Configure OSPF With Border Gateway Protocol Link-State

OSPF is one of the IGP protocols that feeds its topology into BGP into the LS cache. Link state information can be passed to BGP in two ways:

- When new communications between OSPF and BGP has been established, or when BGP-LS functionality has been initially enabled under OSPF, then all LSA information is downloaded to BGP via the LS library.
- As new LSA information is being processed or received from remote OSPF nodes, this information is added or updated in BGP.

Configuring Border Gateway Protocol Link-State With OSPF

Perform the following steps to configure OSPF with BGP-LS:

1. Enable the OSPF routing protocol and enter router configuration mode.
   
   `router ospf`
   
   For example,
   
   Device(config-router)# router ospf 10

2. Distribute BGP link-state.
   
   `distribute link-state`
   
   For example,
   
   Device(config-router)# distribute link-state instance-id <instdid>
   Device(config-router)# distribute link-state throttle <time>

   **instance-id** (optional): Sets instance ID for LS distribution. Default Value is 0. Range: 32 to $2^{32}$-1.
   
   **throttle** (optional): Sets throttle time to process LS distribution queue. Default value is 5 seconds. Range: 1 to 3600 seconds.

   **Note**
   
   In the scenarios where any area gets deleted, throttle timer does not get honored. Queue is walked by OSPF completely and updates to all the areas are sent to BGP.
   
   If you do not specify any value for instance ID and throttle, default values are taken.

   **Example:**
How to Configure IS-IS With Border Gateway Protocol Link-State

IS-IS distributes routing information into BGP. IS-IS processes the routing information in its LSP database and extract the relevant objects. It advertises IS-IS nodes, links, and prefix information and their attributes into BGP. This update from IS-IS into BGP only happens when there is a change in the LSP fragments, either belonging to the local router or any remote routers.

Configuring IS-IS With Border Gateway Protocol Link-State

Perform the following steps to configure IS-IS with BGP-LS:

1. Enable the IS-IS routing protocol and enter router configuration mode.
   
   router isis
   
   For example,
   
   Device(config-router)# router isis
   
   2. Distribute BGP link-state.
      
      distribute link-state
      
      For example,
      
      Device(config-router)# distribute link-state
      Device(config-router)# distribute link-state instance-id <instid>
      Device(config-router)# distribute link-state throttle <time>
      
      **instance-id** (optional): Sets instance ID for LS distribution. The range is from 32-4294967294.
      
      **throttle** (optional): Sets throttle time to process LS distribution queue. The range is from 5-20 seconds.

Configuring BGP

Perform the following steps to configure BGP with BGP-LS:

1. Enable the BGP routing protocol and enter router configuration mode.
   
   router bgp
   
   For example,
Device(config-if)# router bgp 100

2. Configure the address-family link-state.
   address-family link-state link-state
   
   For example,
   Device(config-router)# address-family link-state link-state

3. Exit the address-family.
   exit-address-family
   
   For example,
   Device(config-router)# exit-address-family

Example: Configuring ISIS With Border Gateway Protocol Link-State

Example: IS-IS Configuration

router isis 1
net 49.0001.1720.1600.1001.00
is-type level-1
metric-style wide
distribute link-state level-1
segment-routing mpls
segment-routing prefix-sid-map advertise-local
mpls traffic-eng router-id Loopback0
mpls traffic-eng level-1

interface GigabitEthernet2/2/2
ip address 172.16.0.1 255.255.0.0
ip router isis 1
negotiation auto
mpls traffic-eng tunnels
isis network point-to-point

Example: BGP Configuration

router bgp 100
bgp log-neighbor-changes
neighbor 10.0.0.1 remote-as 100
neighbor 10.0.0.4 remote-as 100

! address-family ipv4
neighbor 10.0.0.1 activate
neighbor 10.0.0.4 activate
exit-address-family
!
address-family link-state link-state
neighbor 10.0.0.1 activate
neighbor 10.0.0.4 activate
exit-address-family
Verifying Border Gateway Protocol Link-State Configurations

Use the following show commands in any order to verify the status of the BGP-LS configurations.

**show ip ospf ls-distribution**
Displays the status of LS distribution.

```
Device# show ip ospf ls-distribution

OSPF Router with ID (10.0.0.6) (Process ID 10)
OSPF LS Distribution is Enabled
Instance Id: 0
Throttle time: 5
Registration Handle: 0x0
Status: Ready Active
Num DBs Queued for LSCache Update: 0
Num of DBs with Unresolved Links: 0
```

**show ip ospf database dist-ls-pending**
Displays the LSAs that are pending, to be sent to BGP.

Sample Output:
```
Device# show ip ospf database dist-ls-pending

OSPF Router with ID (10.0.0.6) (Process ID 10)

Router Link States (Area 0)

<table>
<thead>
<tr>
<th>Link ID</th>
<th>ADV Router</th>
<th>Age</th>
<th>Seq#</th>
<th>Checksum Link count</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.0.0.7</td>
<td>10.0.0.6</td>
<td>4</td>
<td>0x80000006 0x009678 1</td>
<td></td>
</tr>
<tr>
<td>172.16.0.6</td>
<td>172.16.0.6</td>
<td>1110</td>
<td>0x80000018 0x00CAF9 2</td>
<td></td>
</tr>
</tbody>
</table>

(Has-unresolved-links)
```

**show isis distribute-ls [level-1 | level-2]**
Displays IS-IS internal LS cache information that are distributed to BGP.

```
Device# sh isis distribute-ls

ISIS distribute link-state: configured
distls_levels:0x3, distls_initialized:1,
distls_instance_id:0, distls_throttle_delay:10
LS DB: ls_init_started(0) ls_initialized(1) ls_pending_delete(0)
distls_enabled[1]:1
distls_enabled[2]:1
Level 1:
Node System ID:0003.0003.0003 Pseudonode-Id:0 ls_change_flags:0x0
LSP: lspid(0003.0003.0003.00-00), lsptype(0) lsp_change_flags(0x0)
Node Attr: name(r3) bitfield(0x0f) node_flags(0x0)
area_len/area_addr(2/33) num_mtid/mtid(0/0) ipv4_id(172.16.0.9)
num_alg/sr_alg(0/0) num_srgb/srgb(1/(start:16000, range:8000)
srgb_flags(0x80)
opaqe_len/opaqe(0/0x0)
ISIS LS Links:
mtid(0): nid:00002.0002.0002.00 0, 0, 0, 6.6.6.1, 6.6.6.6
Link Attr: bitbfield:0x940f, local_ipv4_id:6.6.6.1, remote_ipv4_id:172.16.0.8,
max_link_bw:10000, max_resv_bw:10000,
num_unresv_bw/unresv_bw:8/
[0]: 10000 kbits/sec, [1]: 8000 kbits/sec
[2]: 8000 kbits/sec, [3]: 8000 kbits/sec
[4]: 8000 kbits/sec, [5]: 8000 kbits/sec
```
### show bgp link-state link-state

Status codes: s suppressed, d damped, h history, * valid, > best, i - internal, r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter, x best-external, a additional-path, c RIB-compressed, t secondary path, 

Origin codes: i - IGP, e - EGP, ? - incomplete 
RPKI validation codes: V valid, I invalid, N Not found 
Prefix codes: E link, V node, T4 IPv4 reachable route, T6 IPv6 reachable route, I Identifier, 
N local node, R remote node, L link, P prefix, L1/L2 ISIS level-1/level-2, O OSPF, a area-ID, l link-ID, t topology-ID, s ISO-ID, c confed-ID/ASN, b bgp-identifier, r router-ID, i if-address, n nbr-address, o OSPF Route-type, p IP-prefix, d designated router address, u/U Unknown, x/X Unexpected, m/M Malformed 

<table>
<thead>
<tr>
<th>Network</th>
<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>*[V][L1][10x43][N[c100][b0.0.0.0][s1720.1600.1001.00]]</td>
<td>15.0.0.1</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>i</td>
</tr>
<tr>
<td>*[V][L1][10x43][N[c100][b0.0.0.0][s1720.1600.2002.00]]</td>
<td>15.0.0.1</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>i</td>
</tr>
<tr>
<td>*[V][L1][10x43][N[c100][b0.0.0.0][s1720.1600.3003.00]]</td>
<td>15.0.0.1</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>i</td>
</tr>
<tr>
<td>*[V][L1][10x43][N[c100][b0.0.0.0][s1720.1600.4004.00]]</td>
<td>15.0.0.1</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>i</td>
</tr>
<tr>
<td>*[V][L1][10x43][N[c100][b0.0.0.0][s1720.1600.5005.00]]</td>
<td>15.0.0.1</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>i</td>
</tr>
<tr>
<td>*[E][L1][10x43][N[c100][b0.0.0.0][s1720.1600.1001.00]]</td>
<td>15.0.0.1</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>i</td>
</tr>
<tr>
<td>*[E][L1][10x43][N[c100][b0.0.0.0][s1720.1600.2002.00]]</td>
<td>15.0.0.1</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>i</td>
</tr>
<tr>
<td>*[E][L1][10x43][N[c100][b0.0.0.0][s1720.1600.3003.00]]</td>
<td>15.0.0.1</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>i</td>
</tr>
<tr>
<td>*[E][L1][10x43][N[c100][b0.0.0.0][s1720.1600.4004.00]]</td>
<td>15.0.0.1</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>i</td>
</tr>
</tbody>
</table>
show bgp link-state link-state nlri <nlri string>

BGP routing table entry for [V][L1][I0x43][N[c100][b0.0.0.0][s1720.1600.4004.00]], version 95
Paths: (1 available, best #1, table link-state link-state)
Not advertised to any peer
Refresh Epoch 4
Local
16.16.16.16 (metric 30) from 15.15.15.15 (15.15.15.15)
   Origin IGP, metric 0, localpref 100, valid, internal, best
   Originator: 16.16.16.16, Cluster list: 15.15.15.15
   LS Attribute: Node-name: R4, ISIS area: 49.12.34
   rx pathid: 0, tx pathid: 0x0

Border Gateway Protocol Link-State Debug Commands

- **debug ip ospf dist-ls [detail]**
  
  Turns on ls-distribution related debugs in OSPF.

- **debug isis distribute-ls**
  
  Displays the items being advertised into the BGP from IS-IS.

Additinal References for Border Gateway Protocol Link-State

**Related Documents**

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Commands List, All Releases</td>
</tr>
</tbody>
</table>

**MIBs**

<table>
<thead>
<tr>
<th>MIB</th>
<th>MIBs Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>CISCO-MIB</td>
<td>To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
</tr>
</tbody>
</table>

**RFCs**

<table>
<thead>
<tr>
<th>RFCs</th>
<th>Title</th>
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<tbody>
<tr>
<td>RFC 7752</td>
<td><em>Link-State Info Distribution Using BGP</em></td>
</tr>
</tbody>
</table>
Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

Feature Information for Border Gateway Protocol Link-State

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to [www.cisco.com/go/cfn](http://www.cisco.com/go/cfn). An account on Cisco.com is not required.

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Border Gateway Protocol Link-State</td>
<td>Cisco IOS XE Everest 16.4.1</td>
<td>BGP Link-State (LS) is an Address Family Identifier (AFI) and Sub-address Family Identifier (SAFI) defined to carry interior gateway protocol (IGP) link-state database through BGP. The following commands were introduced or modified: <code>address-family link-state link-state</code>, <code>distribute link-state</code>, <code>bgp link-state link-state</code>, <code>show bgp link-state link-state nIri nlri string</code>, <code>show ip ospf database dist-ls-pending</code>, <code>show ip ospf ls-distribution</code>, <code>show isis distribute-ls</code></td>
</tr>
</tbody>
</table>
iBGP Multipath Load Sharing

This feature module describes the iBGP Multipath Load Sharing feature. This feature enables the BGP speaking router to select multiple iBGP paths as the best paths to a destination. The best paths or multipaths are then installed in the IP routing table of the router.

- Finding Feature Information, on page 571
- iBGP Multipath Load Sharing Overview, on page 571
- How to Configure iBGP Multipath Load Sharing, on page 574
- Configuration Examples, on page 577
- Additional References, on page 578
- Feature Information for iBGP Multipath Load Sharing, on page 579

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

iBGP Multipath Load Sharing Overview

When a Border Gateway Protocol (BGP) speaking router with no local policy configured receives multiple network layer reachability information (NLRI) from the internal BGP (iBGP) for the same destination, the router will choose one iBGP path as the best path. The best path is then installed in the IP routing table of the router. For example, in the figure below, although there are three paths to autonomous system 200, Router 2 determines that one of the paths to autonomous system 200 is the best path and uses this path only to reach autonomous system 200.
The iBGP Multipath Load Sharing feature enables the BGP speaking router to select multiple iBGP paths as the best paths to a destination. The best paths or multipaths are then installed in the IP routing table of the router. For example, on router 2 in the figure below, the paths to routers 3, 4, and 5 are configured as multipaths and can be used to reach autonomous system 200, thereby equally sharing the load to autonomous system 200.

The iBGP Multipath Load Sharing feature functions similarly in a Multiprotocol Label Switching (MPLS) Virtual Private Network (VPN) with a service provider backbone. For example, on router PE1 in the figure below, the paths to routers PE2, PE3, and PE4 can be selected as multipaths and can be used to equally share the load to site 2.
For multiple paths to the same destination to be considered as multipaths, the following criteria must be met:

- All attributes must be the same. The attributes include weight, local preference, autonomous system path (entire attribute and not just length), origin code, Multi Exit Discriminator (MED), and Interior Gateway Protocol (IGP) distance.
- The next hop router for each multipath must be different.

Even if the criteria are met and multiple paths are considered multipaths, the BGP speaking router will still designate one of the multipaths as the best path and advertise this best path to its neighbors.

**Benefits of iBGP Multipath Load Sharing**

Configuring multiple iBGP best paths enables a router to evenly share the traffic destined for a particular site.

**Restrictions on iBGP Multipath Load Sharing**

**Route Reflector Limitation**

With multiple iBGP paths installed in a routing table, a route reflector will advertise only one of the paths (one next hop).

**Memory Consumption Restriction**

Each IP routing table entry for a BGP prefix that has multiple iBGP paths uses approximately 350 bytes of additional memory. We recommend not using this feature on a router with a low amount of available memory and especially when the router is carrying a full Internet routing table.
How to Configure iBGP Multipath Load Sharing

Configuring iBGP Multipath Load Sharing

To configure the iBGP Multipath Load Sharing feature, use the following command in router configuration mode:

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device(config-router)# maximum-paths ibgp maximum-number</td>
<td>Controls the maximum number of parallel iBGP routes that can be installed in a routing table.</td>
</tr>
</tbody>
</table>

Verifying iBGP Multipath Load Sharing

To verify that the iBGP Multipath Load Sharing feature is configured correctly, perform the following steps:

**SUMMARY STEPS**

1. Enter the `show ip bgp network-number` EXEC command to display attributes for a network in a non-MPLS topology, or the `show ip bgp vpnv4 all ip-prefix` EXEC command to display attributes for a network in an MPLS VPN:

   Example:

   ```
   Device# show ip bgp 10.22.22.0
   BGP routing table entry for 10.22.22.0/24, version 119
   Paths:(6 available, best #1)
   Multipath:iBGP
   Flag:0x820
   Advertised to non peer-group peers:
   10.1.12.12
   22
   10.2.3.8 (metric 11) from 10.1.3.4 (100.0.0.5)  
   ```

2. In the display resulting from the `show ip bgp network-number` EXEC command or the `show ip bgp vpnv4 all ip-prefix` EXEC command, verify that the intended multipaths are marked as “multipaths.” Notice that one of the multipaths is marked as “best.”

3. Enter the `show ip route ip-address` EXEC command to display routing information for a network in a non-MPLS topology or the `show ip route vrf vrf-name ip-prefix` EXEC command to display routing information for a network in an MPLS VPN:

4. Verify that the paths marked as "multipath" in the display resulting from the `show ip bgp ip-prefix` EXEC command or the `show ip bgp vpnv4 all ip-prefix` EXEC command are included in the routing information. (The routing information is displayed after performing Step 3.)

**DETAILED STEPS**

**Step 1** Enter the `show ip bgp network-number` EXEC command to display attributes for a network in a non-MPLS topology, or the `show ip bgp vpnv4 all ip-prefix` EXEC command to display attributes for a network in an MPLS VPN:

Example:

```
Origin IGP, metric 0, localpref 100, valid, internal, multipath, best
Originator:100.0.0.5, Cluster list:100.0.0.4

22
10.2.1.9 (metric 11) from 10.1.1.2 (100.0.0.9)
Origin IGP, metric 0, localpref 100, valid, internal, multipath
Originator:100.0.0.9, Cluster list:100.0.0.2

22
10.2.5.10 (metric 11) from 10.1.5.6 (100.0.0.10)
Origin IGP, metric 0, localpref 100, valid, internal, multipath
Originator:100.0.0.10, Cluster list:100.0.0.6

22
10.2.4.10 (metric 11) from 10.1.4.5 (100.0.0.10)
Origin IGP, metric 0, localpref 100, valid, internal, multipath
Originator:100.0.0.10, Cluster list:100.0.0.5

22
10.2.6.10 (metric 11) from 10.1.6.7 (100.0.0.10)
Origin IGP, metric 0, localpref 100, valid, internal, multipath
Originator:100.0.0.10, Cluster list:100.0.0.7

Device# show ip bgp vpnv4 all 10.22.22.0

BGP routing table entry for 100:1:10.22.22.0/24, version 50
Paths:(6 available, best #1)
Multipath:iBGP
Advertised to non peer-group peers:
200.1.12.12

22
10.22.7.8 (metric 11) from 10.11.3.4 (100.0.0.8)
Origin IGP, metric 0, localpref 100, valid, internal, multipath, best
Extended Community:RT:100:1
Originator:100.0.0.8, Cluster list:100.1.1.44

22
10.22.1.9 (metric 11) from 10.11.1.2 (100.0.0.9)
Origin IGP, metric 0, localpref 100, valid, internal, multipath
Extended Community:RT:100:1
Originator:100.0.0.9, Cluster list:100.1.1.22

22
10.22.6.10 (metric 11) from 10.11.6.7 (100.0.0.10)
Origin IGP, metric 0, localpref 100, valid, internal, multipath
Extended Community:RT:100:1
Originator:100.0.0.10, Cluster list:100.0.0.7

22
10.22.4.10 (metric 11) from 10.11.4.5 (100.0.0.10)
Origin IGP, metric 0, localpref 100, valid, internal, multipath
Extended Community:RT:100:1
Originator:100.0.0.10, Cluster list:100.0.0.5

22
10.22.5.10 (metric 11) from 10.11.5.6 (100.0.0.10)
Origin IGP, metric 0, localpref 100, valid, internal, multipath
Extended Community:RT:100:1
Originator:100.0.0.10, Cluster list:100.0.0.6

Step 2
In the display resulting from the show ip bgp network-number EXEC command or the show ip bgp vpnv4 all ip-prefix EXEC command, verify that the intended multipaths are marked as “multipaths.” Notice that one of the multipaths is marked as “best.”

Step 3
Enter the show ip route ip-address EXEC command to display routing information for a network in a non-MPLS topology or the show ip route vrf vrf-name ip-prefix EXEC command to display routing information for a network in an MPLS VPN:

Example:

Device# show ip route 10.22.22.0
Routing entry for 10.22.22.0/24
Known via "bgp 1", distance 200, metric 0
Tag 22, type internal
Last update from 10.2.6.10 00:00:03 ago
Routing Descriptor Blocks:
* 10.2.3.8, from 10.1.3.4, 00:00:03 ago
  Route metric is 0, traffic share count is 1
  AS Hops 1
10.2.1.9, from 10.1.1.2, 00:00:03 ago
  Route metric is 0, traffic share count is 1
  AS Hops 1
10.2.5.10, from 10.1.5.6, 00:00:03 ago
  Route metric is 0, traffic share count is 1
  AS Hops 1
10.2.4.10, from 10.1.4.5, 00:00:03 ago
  Route metric is 0, traffic share count is 1
  AS Hops 1
10.2.6.10, from 10.1.6.7, 00:00:03 ago
  Route metric is 0, traffic share count is 1
  AS Hops 1

Device# show ip route vrf PATH 10.22.22.0
Routing entry for 10.22.22.0/24
Known via "bgp 1", distance 200, metric 0
Tag 22, type internal
Last update from 10.22.5.10 00:01:07 ago
Routing Descriptor Blocks:
* 10.22.7.8 (Default-IP-Routing-Table), from 10.11.3.4, 00:01:07 ago
  Route metric is 0, traffic share count is 1
  AS Hops 1
10.22.1.9 (Default-IP-Routing-Table), from 10.11.1.2, 00:01:07 ago
  Route metric is 0, traffic share count is 1
  AS Hops 1
10.22.6.10 (Default-IP-Routing-Table), from 10.11.6.7, 00:01:07 ago
  Route metric is 0, traffic share count is 1
  AS Hops 1
10.22.4.10 (Default-IP-Routing-Table), from 10.11.4.5, 00:01:07 ago
  Route metric is 0, traffic share count is 1
  AS Hops 1
10.22.5.10 (Default-IP-Routing-Table), from 10.11.5.6, 00:01:07 ago
  Route metric is 0, traffic share count is 1
  AS Hops 1

**Step 4** Verify that the paths marked as "multipath" in the display resulting from the `show ip bgp ip-prefix` EXEC command or the `show ip bgp vpnv4 all ip-prefix` EXEC command are included in the routing information. (The routing information is displayed after performing Step 3.)

---

**Monitoring and Maintaining iBGP Multipath Load Sharing**

To display iBGP Multipath Load Sharing information, use the following commands in EXEC mode, as needed:

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device# <code>show ip bgp ip-prefix</code></td>
<td>Displays attributes and multipaths for a network in a non-MPLS topology.</td>
</tr>
</tbody>
</table>
### Configuration Examples

Both examples assume that the appropriate attributes for each path are equal and that the next hop router for each multipath is different.

### Example: iBGP Multipath Load Sharing in a Non-MPLS Topology

Both examples assume that the appropriate attributes for each path are equal and that the next hop router for each multipath is different.

The following example shows how to set up the iBGP Multipath Load Sharing feature in a non-MPLS topology (see the figure below).

*Figure 55: Non-MPLS Topology Example*

![Non-MPLS Topology Example](image)

**Router 2 Configuration**

```
router bgp 100
maximum-paths ibgp 3
```

### Example: iBGP Multipath Load Sharing in an MPLS VPN Topology

The following example shows how to set up the iBGP Multipath Load Sharing feature in an MPLS VPN topology (see the figure below).

---

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device# <code>show ip bgp vpnv4 all ip-prefix</code></td>
<td>Displays attributes and multipaths for a network in an MPLS VPN.</td>
</tr>
<tr>
<td>Device# <code>show ip route ip-prefix</code></td>
<td>Displays routing information for a network in a non-MPLS topology.</td>
</tr>
<tr>
<td>Device# <code>show ip route vrf vrf-name ip-prefix</code></td>
<td>Displays routing information for a network in an MPLS VPN.</td>
</tr>
</tbody>
</table>
Router PE1 Configuration

```
router bgp 100
  address-family ipv4 unicast vrf site2
  maximum-paths ibgp 3
```

## Additional References

### Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
<tr>
<td>BGP multipath load sharing for both eBGP and iBGP in an MPLS-VPN</td>
<td>“BGP Multipath Load Sharing for Both eBGP and iBGP in an MPLS-VPN” module in the IP Routing: BGP Configuration Guide</td>
</tr>
<tr>
<td>Advertising the bandwidth of an autonomous system exit link as an extended community</td>
<td>“BGP Link Bandwidth” module in the IP Routing: BGP Configuration Guide</td>
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</table>

### Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.</td>
<td>—</td>
</tr>
</tbody>
</table>
MIBs

<table>
<thead>
<tr>
<th>MIBs</th>
<th>MIBs Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>No new or modified MIBs are supported by this feature, and support for existing MIBs has not been modified by this feature.</td>
<td>To locate and download MIBs for selected platforms, Cisco IOS XE software releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
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RFCs

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<th>RFC</th>
<th>Title</th>
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<td>No new or modified RFCs are supported by this feature, and support for existing RFCs has not been modified by this feature.</td>
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Technical Assistance

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<th>Description</th>
<th>Link</th>
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<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

Feature Information for iBGP Multipath Load Sharing

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 49: Feature Information for iBGP Multipath Load Sharing

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
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<tbody>
<tr>
<td>iBGP multipath load sharing</td>
<td>Cisco IOS XE Release 2.1</td>
<td>This feature was introduced on the Cisco ASR 1000 Series Routers. The following commands were modified by this feature: maximum paths ibgp, show ip bgp, show ip bgp vpnv4, show ip route, show ip route vrf.</td>
</tr>
</tbody>
</table>
BGP Multipath Load Sharing for Both eBGP and iBGP in an MPLS-VPN

The BGP Multipath Load Sharing for both eBGP and iBGP in an MPLS-VPN feature allows you to configure multipath load balancing with both external BGP (eBGP) and internal BGP (iBGP) paths in Border Gateway Protocol (BGP) networks that are configured to use Multiprotocol Label Switching (MPLS) Virtual Private Networks (VPNs). This feature provides improved load balancing deployment and service offering capabilities and is useful for multihomed autonomous systems and Provider Edge (PE) routers that import both eBGP and iBGP paths from multihomed and stub networks.

• Finding Feature Information, on page 581
• Prerequisites for BGP Multipath Load Sharing for Both eBGP and iBGP in an MPLS-VPN, on page 582
• Restrictions for BGP Multipath Load Sharing for Both eBGP and iBGP in an MPLS-VPN, on page 582
• Information About BGP Multipath Load Sharing for Both eBGP and iBGP in an MPLS-VPN, on page 582
• HOW to COfigure BGP Multipath Load Sharing for Both eBGP and iBGP in an MPLS-VPN, on page 584
• Configuration Examples for BGP Multipath Load Sharing for Both eBGP and iBGP in an MPLS-VPN, on page 586
• Where to Go Next, on page 588
• Additional References, on page 588
• Feature Information for BGP Multipath Load Sharing for Both eBGP and iBGP in an MPLS-VPN, on page 589

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.
Prerequisites for BGP Multipath Load Sharing for Both eBGP and iBGP in an MPLS-VPN

Load Balancing is Configured Under CEF
Cisco Express Forwarding (CEF) or distributed CEF (dCEF) must be enabled on all participating routers.

Restrictions for BGP Multipath Load Sharing for Both eBGP and iBGP in an MPLS-VPN

Address Family Support
This feature is configured on a per VPN routing and forwarding instance (VRF) basis. This feature can be configured under only the IPv4 VRF address family.

Memory Consumption Restriction
Each BGP multipath routing table entry will use additional memory. We recommend that you do not use this feature on a router with a low amount of available memory and especially if router is carries full Internet routing tables.

Route Reflector Limitation
When multiple iBGP paths installed in a routing table, a route reflector will advertise only one path (next hop). If a router is behind a route reflector, all routers that are connected to multihomed sites will not be advertised unless a different route distinguisher is configured for each VRF.

Information About BGP Multipath Load Sharing for Both eBGP and iBGP in an MPLS-VPN

Multipath Load Sharing Between eBGP and iBGP
A BGP routing process will install a single path as the best path in the routing information base (RIB) by default. The maximum-paths command allows you to configure BGP to install multiple paths in the RIB for multipath load sharing. BGP uses the best path algorithm to still select a single multipath as the best path and advertise the best path to BGP peers.

Note
The number of paths of multipaths that can be configured is documented on the maximum-paths command reference page.
Load balancing over the multipaths is performed by CEF. CEF load balancing is configured on a per-packet round robin or on a per session (source and destination pair) basis. For information about CEF, refer to the "Cisco Express Forwarding Overview" documentation:

The BGP Multipath Load Sharing for Both eBGP and iBGP in an MPLS VPN feature is enabled only under the IPv4 VRF address family configuration mode. When enabled, this feature can perform load balancing on eBGP and/or iBGP paths that are imported into the VRF. The number of multipaths is configured on a per VRF basis. Separate VRF multipath configurations are isolated by unique route distinguisher.

**Note**
The BGP Multipath Load Sharing for Both eBGP and iBGP in an MPLS VPN feature operates within the parameters of configured outbound routing policy.

### eBGP and iBGP Multipath Load Sharing in a BGP MPLS Network

The figure below shows a service provider BGP MPLS network that connects two remote networks to PE router 1 and PE router 2. PE router 1 and PE router 2 are both configured for VPNv4 unicast iBGP peering. Network 2 is a multi-homed network that is connected to PE router 1 and PE router 2. Network 2 also has extranet VPN services configured with Network 1. Both Network 1 and Network 2 are configured for eBGP peering with the PE routers.

*Figure 57: A Service Provider BGP MPLS Network*

PE router 1 can be configured with the BGP Multipath Load Sharing for Both eBGP and iBGP in an MPLS VPN feature so that both iBGP and eBGP paths can be selected as multipaths and imported into the VRF of Network 1. The multipaths will be used by CEF to perform load balancing. IP traffic that is sent from Network 2 to PE router 1 and PE router 2 will be sent across the eBGP paths as IP traffic. IP traffic that is sent across the iBGP path will be sent as MPLS traffic, and MPLS traffic that is sent across an eBGP path will be sent as IP traffic. Any prefix that is advertised from Network 2 will be received by PE router 1 through route distinguisher (RD) 21 and RD 22. The advertisement through RD 21 will be carried in IP packets, and the advertisement through RD 22 will be carried in MPLS packets. Both paths can be selected as multipaths for VRF1 and installed into the VRF1 RIB.
eBGP and iBGP Multipath Load Sharing With Route Reflectors

The figure below shows a topology that contains three PE routers and a route reflector, all configured for iBGP peering. PE router 2 and PE router 3 each advertise an equal preference eBGP path to PE router 1. By default, the route reflector will choose only one path and advertise PE router 1.

Figure 58: A Topology with a Route Reflector

For all equal preference paths to PE router 1 to be advertised through the route reflector, you must configure each VRF with a different RD. The prefixes received by the route reflector will be recognized differently and advertised to PE router 1.

Benefits of Multipath Load Sharing for Both eBGP and iBGP

The BGP Multipath Load Sharing for Both eBGP and iBGP in an MPLS VPN feature allows multihomed autonomous systems and PE routers to be configured to distribute traffic across both eBGP and iBGP paths.

How to Configure BGP Multipath Load Sharing for Both eBGP and iBGP in an MPLS-VPN

Configuring Multipath Load Sharing for Both eBGP and iBGP

To configure this feature, perform the steps in this section.

SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. address-family ipv4 vrf vrf-name
5. maximum-paths eibgp number
6. end

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables higher privilege levels, such as privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode to create or configure a BGP routing process.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config)# router bgp 40000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> address-family ipv4 vrf vrf-name</td>
<td>Places the router in address family configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Separate VRF multipath configurations are isolated by unique route distinguisher.</td>
</tr>
<tr>
<td>Device(config-router)# address-family ipv4 vrf RED</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> maximum-paths eibgp number</td>
<td>Configures the number of parallel iBGP and eBGP routes that can be installed into a routing table.</td>
</tr>
<tr>
<td>Example:</td>
<td>Note: The <strong>maximum-paths eibgp</strong> command can be configured only under the IPv4 VRF address family configuration mode and cannot be configured in any other address family configuration mode.</td>
</tr>
<tr>
<td>Device(config-router-af)# maximum-paths eibgp 6</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> end</td>
<td>Exits address family configuration mode, and enters privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config-router-af)# end</td>
<td></td>
</tr>
</tbody>
</table>

Verifying Multipath Load Sharing for Both eBGP an iBGP

**SUMMARY STEPS**

1. enable
2. show ip bgp neighbors [neighbor-address [advertised-routes | dampened-routes | flap-statistics | paths [regexp] | received prefix-filter | received-routes | routes]]
3. show ip bgp vpv4 {all | rd route-distinguisher | vrf vrf-name}
### Detailed Steps

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** | enable  
**Example:** Device> enable | Enables higher privilege levels, such as privileged EXEC mode.  
- Enter your password if prompted. |
| **Step 2** | show ip bgp neighbors [neighbor-address | Displays information about the TCP and BGP connections to neighbors.  
[advertised-routes | dampened-routes | flap-statistics | paths [regexp] | received prefix-filter | received-routes | routes]]  
**Example:** Device# show ip bgp neighbors | |
| **Step 3** | show ip bgp vpnv4 {all | rd route-distinguisher | vrf vrf-name}  
**Example:** Device# show ip bgp vpnv4 vrf RED | Displays VPN address information from the BGP table.  
This command is used to verify that the VRF has been received by BGP. |
| **Step 4** | show ip route vrf vrf-name  
**Example:** Device# show ip route vrf RED | Displays the IP routing table associated with a VRF instance. The show ip route vrf command is used to verify that the VRF is in the routing table. |

### Configuration Examples for BGP Multipath Load Sharing for Both eBGP and iBGP in an MPLS-VPN

#### Example: Configuring eBGP and iBGP Multipath Load Sharing

This following configuration example configures a router in address-family mode to select six BGP routes (eBGP or iBGP) as multipaths:

```bash
Device(config)# router bgp 40000  
Device(config-router)# address-family ipv4 vrf RED  
Device(config-router-af)# maximum-paths eibgp 6  
Device(config-router-af)# end
```
Example: Verifying eBGP and iBGP Multipath Load Sharing

To verify that iBGP and eBGP routes have been configured for load sharing, use the `show ip bgp vpnv4` EXEC command or the `show ip route vrf` EXEC command.

In the following example, the `show ip bgp vpnv4` command is entered to display multipaths installed in the VPNv4 RIB:

```
Device# show ip bgp vpnv4 all 10.22.22.0
BGP routing table entry for 10:1:22.22.22.0/24, version 19
Paths:(5 available, best #5)
Multipath:eiBGP
  Advertised to non peer-group peers:
  10.0.0.2 10.0.0.3 10.0.0.4 10.0.0.5
22
  10.0.0.2 (metric 20) from 10.0.0.4 (10.0.0.4)
    Origin IGP, metric 0, localpref 100, valid, internal, multipath
    Extended Community:0x0:0:0 RT:100:1 0x0:0:0
    Originator:10.0.0.2, Cluster list:10.0.0.4
22
  10.0.0.2 (metric 20) from 10.0.0.5 (10.0.0.5)
    Origin IGP, metric 0, localpref 100, valid, internal, multipath
    Extended Community:0x0:0:0 RT:100:1 0x0:0:0
    Originator:10.0.0.2, Cluster list:10.0.0.5
22
  10.0.0.2 (metric 20) from 10.0.0.2 (10.0.0.2)
    Origin IGP, metric 0, localpref 100, valid, internal, multipath
    Extended Community:RT:100:1
22
  10.0.0.2 (metric 20) from 10.0.0.3 (10.0.0.3)
    Origin IGP, metric 0, localpref 100, valid, internal, multipath
    Extended Community:0x0:0:0 RT:100:1 0x0:0:0
    Originator:10.0.0.2, Cluster list:10.0.0.3
22
  10.1.1.12 from 10.1.1.12 (10.22.22.12)
    Origin IGP, metric 0, localpref 100, valid, external, multipath, best
    Extended Community:RT:100:1
```

In the following example, the `show ip route vrf` command is entered to display multipath routes in the VRF table:

```
Device# show ip route vrf PATH 10.22.22.0
Routing entry for 10.22.22.0/24
  Known via "bgp 1", distance 20, metric 0
  Tag 22, type external
  Last update from 10.1.1.12 01:59:31 ago
  Routing Descriptor Blocks:
    * 10.0.0.2 (Default-IP-Routing-Table), from 10.0.0.4, 01:59:31 ago
      Route metric is 0, traffic share count is 1
      AS Hops 1
    10.0.0.2 (Default-IP-Routing-Table), from 10.0.0.5, 01:59:31 ago
      Route metric is 0, traffic share count is 1
      AS Hops 1
    10.0.0.2 (Default-IP-Routing-Table), from 10.0.0.2, 01:59:31 ago
      Route metric is 0, traffic share count is 1
      AS Hops 1
    10.0.0.2 (Default-IP-Routing-Table), from 10.0.0.3, 01:59:31 ago
      Route metric is 0, traffic share count is 1
      AS Hops 1
    10.0.0.2 (Default-IP-Routing-Table), from 10.1.1.12, 01:59:31 ago
      Route metric is 0, traffic share count is 1
      AS Hops 1
```

Example: Verifying eBGP and iBGP Multipath Load Sharing
Where to Go Next

For information about advertising the bandwidth of an autonomous system exit link as an extended community, refer to the “BGP Link Bandwidth” module.

Additional References

Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP commands: complete command syntax, command mode, command history, defaults, usage guidelines, and examples</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
<tr>
<td>Comprehensive BGP link bandwidth configuration examples and tasks</td>
<td>“BGP Link Bandwidth” module in the IP Routing: BGP Configuration Guide</td>
</tr>
<tr>
<td>CEF configuration tasks</td>
<td>“CEF Overview” module in the IP Switching Cisco Express Forwarding Configuration Guide</td>
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Standards

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<td>No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.</td>
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MIBs

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<th>MIBs</th>
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<tr>
<td>No new or modified MIBs are supported by this feature, and support for existing MIBs has not been modified by this feature.</td>
<td>To obtain lists of supported MIBs by platform and Cisco IOS release, and to download MIB modules, go to the Cisco MIB website on Cisco.com at the following URL: <a href="http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml">http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml</a></td>
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RFCs

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<tbody>
<tr>
<td>RFC 1771</td>
<td>A Border Gateway Protocol 4 (BGP4)</td>
</tr>
<tr>
<td>RFC 2547</td>
<td>BGP/MPLS VPNs</td>
</tr>
</tbody>
</table>
Feature Information for BGP Multipath Load Sharing for Both eBGP and iBGP in an MPLS-VPN

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 50: Feature Information for BGP Multipath Load Sharing for Both eBGP and iBGP in an MPLS-VPN

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP Multipath Load Sharing for Both eBGP and iBGP in an MPLS-VPN</td>
<td>Cisco IOS XE Release 2.1</td>
<td>This feature was introduced on the Cisco ASR 1000 Series Aggregation Services Routers.</td>
</tr>
</tbody>
</table>
Feature Information for BGP Multipath Load Sharing for Both eBGP and iBGP in an MPLS-VPN
CHAPTER 35

Loadsharing IP Packets over More Than Six Parallel Paths

This document describes the Loadsharing IP Packets over More Than Six Parallel Paths feature, which increases the maximum number of parallel routes that can be installed to the routing table for multipath loadsharing.

- Finding Feature Information, on page 591
- Overview of Loadsharing IP Packets over More Than Six Parallel Paths, on page 591
- Additional References, on page 592
- Feature Information for Loadsharing IP Packets over More Than Six Parallel Paths, on page 593

Finding Feature Information

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Overview of Loadsharing IP Packets over More Than Six Parallel Paths

The Loadsharing IP Packets over More Than Six Parallel Paths feature increases the maximum number of parallel routes that can be installed to the routing table. The maximum number has been increased from six to sixteen for the following commands:

- maximum-paths
- maximum-paths eibgp
- maximum-paths ibgp

The output of the show ip route summary command has been updated to display the number of parallel routes supported by the routing table.
The benefits of this feature include the following:

- More flexible configuration of parallel routes in the routing table.
- Ability to configure multipath loadsharing over more links to allow for the configuration of higher-bandwidth aggregation using lower-speed links.

### Additional References

**Related Documents**

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
<tr>
<td>eBGP multipath load sharing</td>
<td>“BGP Multipath Load Sharing for Both eBGP and iBGP in an MPLS-VPN” module</td>
</tr>
<tr>
<td>iBGP multipath load sharing</td>
<td>“iBGP Multipath Load Sharing” module</td>
</tr>
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**MIBs**

<table>
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<tr>
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<th>MIBs Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>No new or modified MIBs are supported by this feature, and support for existing MIBs has not been modified by this feature.</td>
<td>To locate and download MIBs for selected platforms, Cisco IOS XE software releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
</tr>
</tbody>
</table>

**Technical Assistance**

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>
Feature Information for Loadsharing IP Packets over More Than Six Parallel Paths

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

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Table 51: Feature Information for Loadsharing IP Packets over More Than Six Parallel Paths

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
</table>
| Loadsharing IP Packets over More Than Six Parallel Paths | Cisco IOS XE Release 2.1 | This feature was introduced on the Cisco ASR 1000 Series Aggregation Services Routers.  
The following commands were modified by this feature:  
maximum-paths, maximum-paths eibgp,  
maximum-paths ibgp, show ip route summary |
BGP Policy Accounting

Border Gateway Protocol (BGP) policy accounting measures and classifies IP traffic that is sent to, or received from, different peers. Policy accounting is enabled on an input interface, and counters based on parameters such as community list, autonomous system number, or autonomous system path are assigned to identify the IP traffic.

- Finding Feature Information, on page 595
- Prerequisites, on page 595
- Information About BGP Policy Accounting, on page 596
- How to Configure BGP Policy Accounting, on page 597
- Configuration Examples for BGP Policy Accounting, on page 600
- Additional References, on page 601
- Feature Information for BGP Policy Accounting, on page 602

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites

Before using the BGP Policy Accounting feature, you must enable BGP and CEF or dCEF on the router.
Information About BGP Policy Accounting

BGP Policy Accounting Overview

Border Gateway Protocol (BGP) policy accounting measures and classifies IP traffic that is sent to, or received from, different peers. Policy accounting is enabled on an input interface, and counters based on parameters such as community list, autonomous system number, or autonomous system path are assigned to identify the IP traffic.

Using the BGP table-map command, prefixes added to the routing table are classified by BGP attribute, autonomous system number, or autonomous system path. Packet and byte counters are incremented per input interface. A Cisco IOS policy-based classifier maps the traffic into one of eight possible buckets, representing different traffic classes.

Using BGP policy accounting, you can account for traffic according to the route it traverses. Service providers (SPs) can identify and account for all traffic by customer and bill accordingly. In the figure below, BGP policy accounting can be implemented in Router A to measure packet and byte volumes in autonomous system buckets. Customers are billed appropriately for traffic that is routed from a domestic, international, or satellite source.

Figure 59: Sample Topology for BGP Policy Accounting

BGP policy accounting using autonomous system numbers can be used to improve the design of network circuit peering and transit agreements between Internet service providers (ISPs).
Benefits of BGP Policy Accounting

Account for IP Traffic Differentially

BGP policy accounting classifies IP traffic by autonomous system number, autonomous system path, or community list string, and increments packet and byte counters. Service providers can account for traffic and apply billing, according to the route specific traffic traverses.

Efficient Network Circuit Peering and Transit Agreement Design

Implementing BGP policy accounting on an edge router can highlight potential design improvements for peering and transit agreements.

How to Configure BGP Policy Accounting

Specifying the Match Criteria for BGP Policy Accounting

The first task in configuring BGP policy accounting is to specify the criteria that must be matched. Community lists, autonomous system paths, or autonomous system numbers are examples of BGP attributes that can be specified and subsequently matched using a route map.

To specify the BGP attribute to use for BGP policy accounting and create the match criteria in a route map, use the following commands in global configuration mode:

### SUMMARY STEPS

1. Device(config)# ip community-list community-list-number {permit | deny} community-number
2. Device(config)# route-map map-name [permit | deny] [sequence-number]
3. Device(config-route-map)# match community-list community-list-number [exact]
4. Device(config-route-map)# set traffic-index bucket-number

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>Device(config)# ip community-list community-list-number {permit</td>
<td>deny} community-number</td>
</tr>
<tr>
<td>Step 2</td>
<td>Device(config)# route-map map-name [permit</td>
<td>deny] [sequence-number]</td>
</tr>
</tbody>
</table>
The optional sequence-number argument indicates the position a new route map is to have in the list of route maps already configured with the same name.

Step 3  Device(config-route-map)# match community-list community-list-number [exact]
        Matches a BGP community.

Step 4  Device(config-route-map)# set traffic-index bucket-number
        Indicates where to output packets that pass a match clause of a route map for BGP policy accounting.

Classifying the IP Traffic and Enabling BGP Policy Accounting

After a route map has been defined to specify match criteria, you must configure a way to classify the IP traffic before enabling BGP policy accounting.

Using the table-map command, BGP classifies each prefix it adds to the routing table based on the match criteria. When the bgp-policy accounting command is configured on an interface, BGP policy accounting is enabled.

To classify the IP traffic and enable BGP policy accounting, use the following commands beginning in global configuration mode:

**SUMMARY STEPS**

1. Device(config)# router bgp as-number
2. Device(config-router)# table-map route-map-name
3. Device(config-router)# network network-number [mask network-mask]
4. Device(config-router)# neighbor ip-address remote-as as-number
5. Device(config-router)# exit
6. Device(config)# interface interface-type interface-number
7. Device(config-if)# no ip directed-broadcast
8. Device(config-if)# ip address ip-address mask
9. Device(config-if)# bgp-policy accounting

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1  Device(config)# router bgp as-number</td>
<td>Configures a BGP routing process and enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td>Step 2  Device(config-router)# table-map route-map-name</td>
<td>Classifies BGP prefixes entered in the routing table.</td>
</tr>
<tr>
<td>Step 3  Device(config-router)# network network-number [mask network-mask]</td>
<td>Specifies a network to be advertised by the BGP routing process.</td>
</tr>
<tr>
<td>Step 4  Device(config-router)# neighbor ip-address remote-as as-number</td>
<td>Specifies a BGP peer by adding an entry to the BGP routing table.</td>
</tr>
<tr>
<td>Step 5  Device(config-router)# exit</td>
<td>Exits to global configuration mode.</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>Device(config)# interface interface-type interface-number</td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>Device(config-if)# no ip directed-broadcast</td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td>Device(config-if)# ip address ip-address mask</td>
</tr>
<tr>
<td><strong>Step 9</strong></td>
<td>Device(config-if)# bgp-policy accounting</td>
</tr>
</tbody>
</table>

## Verifying BGP Policy Accounting

To verify that BGP policy accounting is operating, perform the following steps:

**SUMMARY STEPS**

1. Enter the `show ip cef` EXEC command with the `detail` keyword to learn which accounting bucket is assigned to a specified prefix.
2. Enter the `show ip bgp` EXEC command for the same prefix used in Step 1--192.168.5.0-- to learn which community is assigned to this prefix.
3. Enter the `show cef interface policy-statistics` EXEC command to display the per-interface traffic statistics.

**DETAILED STEPS**

**Step 1**

Enter the `show ip cef` EXEC command with the `detail` keyword to learn which accounting bucket is assigned to a specified prefix.

In this example, the output is displayed for the prefix 192.168.5.0. It shows that the accounting bucket number 4 (traffic_index 4) is assigned to this prefix.

**Example:**

```
Device# show ip cef 192.168.5.0 detail
192.168.5.0/24, version 21, cached adjacency to POS7/2
  0 packets, 0 bytes, traffic_index 4
    via 10.14.1.1, 0 dependencies, recursive
      next hop 10.14.1.1, POS7/2 via 10.14.1.0/30
      valid cached adjacency
```

**Step 2**

Enter the `show ip bgp` EXEC command for the same prefix used in Step 1--192.168.5.0-- to learn which community is assigned to this prefix.

In this example, the output is displayed for the prefix 192.168.5.0. It shows that the community of 100:197 is assigned to this prefix.

**Example:**

```
Device# show ip bgp 192.168.5.0
BGP routing table entry for 192.168.5.0/24, version 2
```
Paths: (1 available, best #1)
    Not advertised to any peer
    100
    10.14.1.1 from 10.14.1.1 (32.32.32.32)
    Origin IGP, metric 0, localpref 100, valid, external, best
    Community: 100:197

**Step 3**  Enter the `show cef interface policy-statistics` EXEC command to display the per-interface traffic statistics.

In this example, the output shows the number of packets and bytes that have been assigned to each accounting bucket:

**Example:**

```
Device# show cef interface policy-statistics

POS7/0 is up (if_number 8)

<table>
<thead>
<tr>
<th>Bucket</th>
<th>Packets</th>
<th>Bytes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>50</td>
<td>5000</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
<td>10000</td>
</tr>
<tr>
<td>5</td>
<td>100</td>
<td>10000</td>
</tr>
<tr>
<td>6</td>
<td>10</td>
<td>1000</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
```

---

**Monitoring and Maintaining BGP Policy Accounting**

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device# <code>show cef interface [type number] policy-statistics</code></td>
<td>(Optional) Displays detailed CEF policy statistical information for all interfaces.</td>
</tr>
<tr>
<td>Device# <code>show ip bgp [network] [network mask] [longer-prefixes]</code></td>
<td>(Optional) Displays entries in the BGP routing table.</td>
</tr>
<tr>
<td>Device# <code>show ip cef [network [mask]] [detail]</code></td>
<td>(Optional) Displays entries in the Forwarding Information Base (FIB) or FIB summary information.</td>
</tr>
</tbody>
</table>

---

**Configuration Examples for BGP Policy Accounting**

**Example: Specifying the Match Criteria for BGP Policy Accounting**

In the following example, BGP communities are specified in community lists, and a route map named `set_bucket` is configured to match each of the community lists to a specific accounting bucket using the `set traffic-index` command:

```
ip community-list 30 permit 100:190
```
Example: Classifying the IP Traffic and Enabling BGP Policy Accounting

In the following example, BGP policy accounting is enabled on POS interface 7/0 and the `table-map` command is used to modify the bucket number when the IP routing table is updated with routes learned from BGP:

```
router bgp 65000
  table-map set_bucket
  network 10.15.1.0 mask 255.255.255.0
  neighbor 10.14.1.1 remote-as 65100
! ip classless
ip bgp-community new-format
! interface POS7/0
  ip address 10.15.1.2 255.255.255.0
  no ip directed-broadcast
  bgp-policy accounting
  no keepalive
crc 32
clock source internal
```

Additional References

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
<tr>
<td>Cisco Express Forwarding (CEF) and distributed CEF (dCEF) commands</td>
<td>Cisco IOS IP Switching Command Reference</td>
</tr>
<tr>
<td>Cisco Express Forwarding (CEF) and distributed CEF (dCEF) configuration information</td>
<td>“CEF Overview” module of the Cisco IOS Switching Services Configuration Guide</td>
</tr>
</tbody>
</table>
### Feature Information for BGP Policy Accounting

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to [www.cisco.com/go/cfn](http://www.cisco.com/go/cfn). An account on Cisco.com is not required.

#### Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

#### MIBs

<table>
<thead>
<tr>
<th>MIB</th>
<th>MIBs Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>• CISCO-BGP-POLICY-ACCOUNTING-MIB</td>
<td></td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td></td>
</tr>
<tr>
<td>CISCO-BGP-POLICY-ACCOUNTING-MIB is only available in the Cisco IOS Release 12.0(9)S, 12.0(17)ST, and later releases. This MIB is not available on any mainline and T-train release.</td>
<td></td>
</tr>
<tr>
<td>To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL:</td>
<td></td>
</tr>
</tbody>
</table>
Table 52: Feature Information for BGP Policy Accounting

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP Policy Accounting</td>
<td>12.0(9)S</td>
<td>Border Gateway Protocol (BGP) policy accounting measures and classifies IP traffic that is sent to, or received from, different peers. Policy accounting is enabled on an input interface, and counters based on parameters such as community list, autonomous system number, or autonomous system path are assigned to identify the IP traffic.</td>
</tr>
<tr>
<td></td>
<td>12.0(17)ST</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12.2(13)T</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15.0(1)S</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12.2(50)SY</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cisco IOS XE Release 3.8S</td>
<td></td>
</tr>
</tbody>
</table>

The following commands were introduced or modified:

- `bgp-policy`
- `set traffic-index`
- `show cef interface policy-statistics`
- `show ip bgp`
- `show ip cef`
Feature Information for BGP Policy Accounting
CHAPTER 37

BGP Policy Accounting Output Interface Accounting

Border Gateway Protocol (BGP) policy accounting (PA) measures and classifies IP traffic that is sent to, or received from, different peers. Policy accounting was previously available on an input interface only. The BGP Policy Accounting Output Interface Accounting feature introduces several extensions to enable BGP PA on an output interface and to include accounting based on a source address for both input and output traffic on an interface. Counters based on parameters such as community list, autonomous system number, or autonomous system path are assigned to identify the IP traffic.

- Finding Feature Information, on page 605
- Prerequisites for BGP PA Output Interface Accounting, on page 605
- Information About BGP PA Output Interface Accounting, on page 606
- How to Configure BGP PA Output Interface Accounting, on page 607
- Configuration Examples for BGP PA Output Interface Accounting, on page 613
- Additional References, on page 614
- Feature Information for BGP Policy Accounting Output Interface Accounting, on page 615
- Glossary, on page 616

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for BGP PA Output Interface Accounting

Before using the BGP Policy Accounting Output Interface Accounting feature, you must enable BGP and Cisco Express Forwarding or distributed CEF on the router.
Information About BGP PA Output Interface Accounting

BGP PA Output Interface Accounting

Policy accounting using BGP measures and classifies IP traffic that is sent to, or received from, different peers. Originally, BGP PA was available on an input interface only. BGP PA output interface accounting introduces several extensions to enable BGP PA on an output interface and to include accounting based on a source address for both input and output traffic on an interface. Counters based on parameters such as community list, autonomous system number, or autonomous system path are assigned to identify the IP traffic.

Using the BGP `table-map` command, prefixes added to the routing table are classified by BGP attribute, autonomous system number, or autonomous system path. Packet and byte counters are incremented per input or output interface. A Cisco policy-based classifier maps the traffic into one of eight possible buckets that represent different traffic classes.

Using BGP PA, you can account for traffic according to its origin or the route it traverses. Service providers (SPs) can identify and account for all traffic by customer and can bill accordingly. In the figure below, BGP PA can be implemented in Router A to measure packet and byte volumes in autonomous system buckets. Customers are billed appropriately for traffic that is routed from a domestic, international, or satellite source.

*Figure 60: Sample Topology for BGP Policy Accounting*

BGP policy accounting using autonomous system numbers can be used to improve the design of network circuit peering and transit agreements between Internet service providers (ISPs).

Benefits of BGP PA Output Interface Accounting

**Accounting for IP Traffic Differentially**

BGP policy accounting classifies IP traffic by autonomous system number, autonomous system path, or community list string, and increments packet and byte counters. Policy accounting can also be based on the
source address. Service providers can account for traffic and apply billing according to the origin of the traffic or the route that specific traffic traverses.

Efficient Network Circuit Peering and Transit Agreement Design
Implementing BGP policy accounting on an edge router can highlight potential design improvements for peering and transit agreements.

How to Configure BGP PA Output Interface Accounting

Specifying the Match Criteria for BGP PA

The first task in configuring BGP PA is to specify the criteria that must be matched. Community lists, autonomous system paths, or autonomous system numbers are examples of BGP attributes that can be specified and subsequently matched using a route map. Perform this task to specify the BGP attribute to use for BGP PA and to create the match criteria in a route map.

SUMMARY STEPS

1. enable
2. configure terminal
3. ip community-list \{standard-list-number | expanded-list-number [regular-expression] \} \{standard | expanded\} community-list-name \{permit \| deny\} \{community-number | regular-expression\}
4. route-map map-name \{permit \| deny\} [sequence-number]
5. match community-list community-list-name \{exact\}
6. set traffic-index bucket-number
7. exit

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example: Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> ip community-list {standard-list-number</td>
<td>expanded-list-number [regular-expression] } {standard</td>
</tr>
<tr>
<td>Example:</td>
<td>• Repeat this step for each community to be specified.</td>
</tr>
</tbody>
</table>
### Purpose

**Command or Action**

Device(config)# ip community-list 30 permit 100:190

**Step 4**

**route-map**  
**map-name** [**permit** | **deny**] [**sequence-number**]  
**Example:**

Device(config)# route-map set_bucket permit 10

Enters route-map configuration mode and defines the conditions for policy routing.

- The **map-name** argument identifies a route map.
- The optional **permit** and **deny** keywords work with the match and set criteria to control how the packets are accounted for.
- The optional **sequence-number** argument indicates the position that a new route map is to have in the list of route maps already configured with the same name.

**Step 5**

**match community-list**  
**community-list-number** [**exact**]  
**Example:**

Router(config-route-map)# match community-list 30

Matches a BGP community.

**Step 6**

**set traffic-index**  
**bucket-number**  
**Example:**

Device(config-route-map)# set traffic-index 2

Indicates where to output packets that pass a match clause of a route map for BGP policy accounting.

**Step 7**

**exit**  
**Example:**

Device(config-route-map)# exit

Exits route-map configuration mode and returns to global configuration mode.

---

### Classifying the IP Traffic and Enabling BGP PA

After a route map has been defined to specify match criteria, you must configure a way to classify the IP traffic before enabling BGP policy accounting.

Using the **table-map** command, BGP classifies each prefix that it adds to the routing table according to the match criteria. When the **bgp-policy accounting** command is configured on an interface, BGP policy accounting is enabled.

Perform this task to classify the IP traffic and enable BGP policy accounting.

### SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router bgp**  
   **as-number**
4. **table-map**  
   **route-map-name**
5. **network**  
   **network-number**  
   [**mask**  
   **network-mask**]
6. **neighbor**  
   **ip-address**  
   **remote-as**  
   **as-number**
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example: Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp as-number</td>
<td>Configures a BGP routing process and enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td>Example: Device(config)# router bgp 65000</td>
<td>• The <em>as-number</em> argument identifies a BGP autonomous system number.</td>
</tr>
<tr>
<td><strong>Step 4</strong> table-map route-map-name</td>
<td>Classifies BGP prefixes entered in the routing table.</td>
</tr>
<tr>
<td>Example: Device(config-router)# table-map set_bucket</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> network network-number [mask network-mask]</td>
<td>Specifies a network to be advertised by the BGP routing process.</td>
</tr>
<tr>
<td>Example: Device(config-router)# network 10.15.1.0 mask 255.255.255.0</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> neighbor ip-address remote-as as-number</td>
<td>Specifies a BGP peer by adding an entry to the BGP routing table.</td>
</tr>
<tr>
<td>Example: Device(config-router)# neighbor 10.14.1.1 remote-as 65100</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong> exit</td>
<td>Exits router configuration mode and returns to global configuration mode.</td>
</tr>
<tr>
<td>Example: Device(config-router)# exit</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong> interface type number</td>
<td>Specifies the interface type and number and enters interface configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
</tbody>
</table>
### Command or Action

<table>
<thead>
<tr>
<th>Device(config)# interface POS 7/0</th>
</tr>
</thead>
</table>

#### Purpose
- The *type* argument identifies the type of interface.
- The *number* argument identifies the slot and port numbers of the interface. The space between the interface type and number is optional.

### Step 9

<table>
<thead>
<tr>
<th>ip address  <em>ip-address mask</em></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td>Device(config-if)# ip-address 10.15.1.2 255.255.255.0</td>
</tr>
</tbody>
</table>

#### Purpose
Configures the interface with an IP address.

### Step 10

| bgp-policy accounting [input | output] [source] |
|-------------------|
| **Example:**      |
| Device(config-if)# bgp-policy accounting input source |

#### Purpose
Enables BGP policy accounting for the interface.
- Use the optional *input* or *output* keyword to account for traffic either entering or leaving the router. By default, BGP policy accounting is based on traffic entering the router.
- Use the optional *source* keyword to account for traffic based on source address.

### Step 11

<table>
<thead>
<tr>
<th>exit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td>Device(config-if)# exit</td>
</tr>
</tbody>
</table>

#### Purpose
Exits interface configuration mode and returns to global configuration mode.

---

### Verifying BGP Policy Accounting

Perform this task to verify that BGP policy accounting is operating.

#### SUMMARY STEPS

1. `show ip cef [network [mask]] [detail]`
2. `show ip bgp [network] [network-mask] [longer-prefixes]`
3. `show cef interface [type number] policy-statistics [input | output]`
4. `show cef interface [type number] [statistics] [detail]`

#### DETAILED STEPS

**Step 1**  
`show ip cef [network [mask]] [detail]`

Enter the `show ip cef` command with the *detail* keyword to learn which accounting bucket is assigned to a specified prefix.

In this example, the output is displayed for the prefix 192.168.5.0. It shows that accounting bucket number 4 (traffic_index 4) is assigned to this prefix.

**Example:**
Device# show ip cef 192.168.5.0 detail

192.168.5.0/24, version 21, cached adjacency to POS7/2
  0 packets, 0 bytes, traffic_index 4
  via 10.14.1.1, 0 dependencies, recursive
    next hop 10.14.1.1, POS7/2 via 10.14.1.0/30
    valid cached adjacency

Step 2  show ip bgp [network] [network-mask] [longer-prefixes]

Enter the show ip bgp command for the same prefix used in Step 1--192.168.5.0--to learn which community is assigned to this prefix.

In this example, the output is displayed for the prefix 192.168.5.0. It shows that the community of 100:197 is assigned to this prefix.

Example:

Device# show ip bgp 192.168.5.0

BGP routing table entry for 192.168.5.0/24, version 2
Paths: (1 available, best #1)
  Not advertised to any peer
  100
    10.14.1.1 from 10.14.1.1 (32.32.32.32)
      Origin IGP, metric 0, localpref 100, valid, external, best
      Community: 100:197

Step 3  show cef interface [type number] policy-statistics [input | output]

Displays the per-interface traffic statistics.

In this example, the output shows the number of packets and bytes that have been assigned to each accounting bucket:

Example:

Device# show cef interface policy-statistics input

FastEthernet1/0/0 is up (if_number 6)
Corresponding hwidb fast_if_number 6
Corresponding hwidb firstsw->if_number 6
BGP based Policy accounting on input is enabled

<table>
<thead>
<tr>
<th>Index</th>
<th>Packets</th>
<th>Bytes</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>19</td>
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<td>0</td>
</tr>
</tbody>
</table>
Step 4  

**show cef interface  [type number] [statistics] [detail]**

Displays the state of BGP policy accounting on a specified interface.

In this example, the output shows that BGP policy accounting has been configured to be based on input traffic at Fast Ethernet interface 1/0/0:

**Example:**

```
Device# show cef interface Fast Ethernet 1/0/0
FastEthernet1/0/0 is up (if_number 6)
Corresponding hwidb fast_if_number 6
Corresponding hwidb firstsw->if_number 6
Internet address is 10.1.1.1/24
ICMP redirects are always sent
Per packet load-sharing is disabled
IP unicast RPF check is disabled
```

```
Inbound access list is not set
Outbound access list is not set
IP policy routing is disabled
BGP based policy accounting on input is enabled
BGP based policy accounting on output is disabled
Hardware idb is FastEthernet1/0/0 (6)
Software idb is FastEthernet1/0/0 (6)
Fast switching type 1, interface type 18
IP Distributed CEF switching enabled
IP Feature Fast switching turbo vector
IP Feature CEF switching turbo vector
Input fast flags 0x100, Output fast flags 0x0, Flags 0x0
ifindex 7(7)
Slot 1 Slot unit 0 VC -1
Transmit limit accumulator 0xE8001A82 (0xE8001A82)
IP MTU 1500

**Configuration Examples for BGP PA Output Interface Accounting**

**Specifying the Match Criteria for BGP Policy Accounting Example**

In the following example, BGP communities are specified in community lists, and a route map named set_bucket is configured to match each of the community lists to a specific accounting bucket using the `set traffic-index` command:

```plaintext
ip community-list 30 permit 100:190
ip community-list 40 permit 100:198
ip community-list 50 permit 100:197
ip community-list 60 permit 100:296
!
route-map set_bucket permit 10
 match community-list 30
  set traffic-index 2
!
route-map set_bucket permit 20
 match community-list 40
  set traffic-index 3
!
route-map set_bucket permit 30
 match community-list 50
  set traffic-index 4
!
route-map set_bucket permit 40
 match community-list 60
  set traffic-index 5
```

**Classifying the IP Traffic and Enabling BGP Policy Accounting Example**

In the following example, BGP policy accounting is enabled on POS interface 2/0/0. The policy accounting criteria is based on the source address of the input traffic, and the `table-map` command is used to modify the bucket number when the IP routing table is updated with routes learned from BGP.

```plaintext
router bgp 65000
```
table-map set_bucket
network 10.15.1.0 mask 255.255.255.0
neighbor 10.14.1.1 remote-as 65100
! ip classless
ip bgp-community new-format
!
interface POS2/0/0
ip address 10.15.1.2 255.255.255.0
bgp-policy accounting input source
crc 32
clock source internal

Additional References

The following sections provide references related to the BGP policy accounting output interface accounting feature.

Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
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<tr>
<td>BGP commands: complete command syntax, command mode, defaults, usage guidelines, and examples</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
<tr>
<td>Switching commands: complete command syntax, command mode, defaults, usage guidelines, and examples</td>
<td>Cisco IOS IP Switching Command Reference</td>
</tr>
<tr>
<td>Cisco IOS master command list, all releases</td>
<td>Cisco IOS Master Command List, All Releases</td>
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Standards

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MIBs

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<th>MIBs Link</th>
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<tbody>
<tr>
<td>CISCO-BGP-POLICY-ACCOUNTING-MIB</td>
<td>To locate and download MIBs for selected platforms, Cisco IOS XE software releases, and feature sets: use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
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RFCs

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Technical Assistance

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<tr>
<td>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/techsupport">http://www.cisco.com/techsupport</a></td>
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</table>

Feature Information for BGP Policy Accounting Output Interface Accounting

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to [www.cisco.com/go/cfn](http://www.cisco.com/go/cfn). An account on Cisco.com is not required.

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
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<tbody>
<tr>
<td>BGP Policy Accounting</td>
<td>Cisco IOS XE Release 2.1</td>
<td>BGP policy accounting measures and classifies IP traffic that is sent to, or received from, different peers. This feature was introduced on the Cisco ASR 1000 Series Aggregation Services Routers.</td>
</tr>
</tbody>
</table>
### Glossary

**AS** -- autonomous system. An IP term to describe a routing domain that has its own independent routing policy and is administered by a single authority.

**BGP** -- Border Gateway Protocol. Interdomain routing protocol that exchanges reachability information with other BGP systems.

**CEF** -- Cisco Express Forwarding.

**dCEF** -- distributed Cisco Express Forwarding.
CHAPTER 38

BGP Cost Community

The BGP Cost Community feature introduces the cost extended community attribute. The cost community is a non-transitive extended community attribute that is passed to internal BGP (iBGP) and confederation peers but not to external BGP (eBGP) peers. The cost community feature allows you to customize the local route preference and influence the best path selection process by assigning cost values to specific routes.

In Cisco IOS Release 12.0(27)S, 12.3(8)T, 12.2(25)S, and later releases, support was introduced for mixed EIGRP MPLS VPN network topologies that contain VPN and backdoor links.

- Finding Feature Information, on page 617
- Prerequisites for the BGP Cost Community Feature, on page 617
- Restrictions for the BGP Cost Community Feature, on page 618
- Information About the BGP Cost Community Feature, on page 618
- How to Configure the BGP Cost Community Feature, on page 621
- Configuration Examples for the BGP Cost Community Feature, on page 623
- Additional References, on page 625
- Feature Information for BGP Cost Community, on page 626

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for the BGP Cost Community Feature

This document assumes that BGP is configured in your network and that peering has been established.
Restrictions for the BGP Cost Community Feature

- The BGP Cost Community feature can be configured only within an autonomous system or confederation. The cost community is a non-transitive extended community that is passed to iBGP and confederation peers only and is not passed to eBGP peers.

- The BGP Cost Community feature must be supported on all routers in the autonomous system or confederation before cost community filtering is configured. The cost community should be applied consistently throughout the local autonomous system or confederation to avoid potential routing loops.

- Multiple cost community set clauses may be configured with the `set extcommunity cost` command in a single route map block or sequence. However, each set clause must be configured with a different ID value (0-255) for each point of insertion (POI). The ID value determines preference when all other attributes are equal. The lowest ID value is preferred.

Information About the BGP Cost Community Feature

BGP Cost Community Overview

The cost community is a nontransitive, extended community attribute that is passed to iBGP and confederation peers, but not to eBGP peers. The configuration of the BGP Cost Community feature allows you to customize the BGP best path selection process for a local autonomous system or confederation.

The cost community attribute is applied to internal routes by configuring the `set extcommunity cost` command in a route map. The cost community set clause is configured with a cost community ID number (0-255) and cost number (0-4294967295). The cost community ID number determines the preference for the path selection process. The path with the lowest cost community ID number is preferred.

Paths that are not specifically configured with the cost community attribute are assigned a default cost number value of 2147483647 (The midpoint between 0 and 4294967295) and evaluated by the best path selection process accordingly. In the case where two paths have been configured with the same cost community ID number, the path selection process will then prefer the path with the lowest cost number. The cost extended community attribute is propagated to iBGP peers when extended community exchange is enabled with the `neighbor send-community` command.

The following commands can be used to apply a route map that is configured with the cost community set clause:

- `aggregate-address`
- `neighbor default-originate route-map {in | out}`
- `neighbor route-map`
- `network route-map`
- `redistribute route-map`
How the BGP Cost Community Influences the Best Path Selection Process

The cost community attribute influences the BGP best path selection process at the point of insertion (POI). By default, the POI follows the IGP metric comparison. When BGP receives multiple paths to the same destination, it uses the best path selection process to determine which path is the best path. BGP automatically makes the decision and installs the best path into the routing table. The POI allows you to assign a preference to a specific path when multiple equal cost paths are available. If the POI is not valid for local best path selection, the cost community attribute is silently ignored.

Multiple paths can be configured with the cost community attribute for the same POI. The path with the lowest cost community ID is considered first. In other words, all of the cost community paths for a specific POI are considered, starting with the one with the lowest cost community. Paths that do not contain the cost community (for the POI and community ID being evaluated) are assigned the default community cost value (2147483647). If the cost community values are equal, then cost community comparison proceeds to the next lowest community ID for this POI.

Note

Paths that are not configured with the cost community attribute are considered by the best path selection process to have the default cost-value (half of the maximum value [4294967295] or 2147483647).

Applying the cost community attribute at the POI allows you to assign a value to a path originated or learned by a peer in any part of the local autonomous system or confederation. The cost community can be used as a “tie breaker” during the best path selection process. Multiple instances of the cost community can be configured for separate equal cost paths within the same autonomous system or confederation. For example, a lower cost community value can be applied to a specific exit path in a network with multiple equal cost exits points, and the specific exit path will be preferred by the BGP best path selection process. See the scenario described in the “Influencing Route Preference in a Multi-Exit IGP Network” section.

Cost Community Support for Aggregate Routes and Multipaths

Aggregate routes and multipaths are supported by the BGP Cost Community feature. The cost community attribute can be applied to either type of route. The cost community attribute is passed to the aggregate or multipath route from component routes that carry the cost community attribute. Only unique IDs are passed, and only the highest cost of any individual component route will be applied to the aggregate on a per-ID basis.

If multiple component routes contain the same ID, the highest configured cost is applied to the route. For example, the following two component routes are configured with the cost community attribute via an inbound route map:

- 10.0.0.1 (POI=IGP, ID=1, Cost=100)
- 192.168.0.1 (POI=IGP, ID=1, Cost=200)

If these component routes are aggregated or configured as a multipath, the cost value 200 (POI=IGP, ID=1, Cost=200) will be advertised because it is the highest cost.

If one or more component routes does not carry the cost community attribute or if the component routes are configured with different IDs, then the default value (2147483647) will be advertised for the aggregate or multipath route. For example, the following three component routes are configured with the cost community attribute via an inbound route map. However, the component routes are configured with two different IDs.

- 10.0.0.1 (POI=IGP, ID=1, Cost=100)
Influencing Route Preference in a Multi-Exit IGP Network

The single advertised path will include the aggregated cost communities as follows:

- {POI=IGP, ID=1, Cost=2147483647} {POI=IGP, ID=2, Cost=2147483647}

Both paths are considered to be equal by BGP. If multipath loadsharing is configured, both paths will be installed to the routing table and will be used to load balance traffic. If multipath load balancing is not configured, then BGP will select the path that was learned first as the best path and install this path to the routing table. This behavior may not be desirable under some conditions. For example, the path is learned from ISP1 PE2 first, but the link between ISP1 PE2 and ASBR1 is a low-speed link.

The configuration of the cost community attribute can be used to influence the BGP best path selection process by applying a lower cost community value to the path learned by ASBR2. For example, the following configuration is applied to ASBR2.

```
route-map ISP2_PE1 permit 10
set extcommunity cost 1 1
match ip address 13
!
ip access-list 13 permit 10.8.0.0 0.0.255.255
```

The above route map applies a cost community number value of 1 to the 10.8.0.0 route. By default, the path learned from ASBR1 will be assigned a cost community value of 2147483647. Because the path learned from ASBR2 has lower cost community value, this path will be preferred.

BGP Cost Community Support for EIGRP MPLS VPN PE-CE with Backdoor Links

Before EIGRP Site of Origin (SoO) BGP Cost Community support was introduced, BGP preferred locally sourced routes over routes learned from BGP peers. Back door links in an EIGRP MPLS VPN topology will
be preferred by BGP if the back door link is learned first. (A back door link, or a route, is a connection that is configured outside of the VPN between a remote and main site. For example, a WAN leased line that connects a remote site to the corporate network).

The "pre-bestpath" point of insertion (POI) was introduced in the BGP Cost Community feature to support mixed EIGRP VPN network topologies that contain VPN and backdoor links. This POI is applied automatically to EIGRP routes that are redistributed into BGP. The "pre-best path" POI carries the EIGRP route type and metric. This POI influences the best path calculation process by influencing BGP to consider this POI before any other comparison step. No configuration is required. This feature is enabled automatically for EIGRP VPN sites when Cisco IOS Release 12.0(27)S is installed to a PE, CE, or back door router.

For information about configuring EIGRP MPLS VPNs, refer to the MPLS VPN Support for EIGRP Between Provider Edge and Customer Edge document in Cisco IOS Release 12.0(27)S.

For more information about the EIGRP MPLS VPN PE-CE Site of Origin (SoO) feature, refer to the EIGRP MPLS VPN PE-CE Site of Origin (SoO) feature documentation in Cisco IOS Release 12.0(27)S.

How to Configure the BGP Cost Community Feature

Configuring the BGP Cost Community

SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. neighbor ip-address remote-as autonomous-system-number
5. address-family ipv4 [mdt | multicast | tunnel | unicast [vrf vrf-name] | vrf vrf-name] | ipv6 [multicast | unicast] | vpnv4 [unicast]
6. neighbor ip-address route-map map-name {in | out}
7. exit
8. route-map map-name {permit | deny} [sequence-number]
9. set extcommunity cost [igp] community-id cost-value
10. end

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables higher privilege levels, such as privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example: Device# configure terminal</td>
<td></td>
</tr>
</tbody>
</table>
### Configuring the BGP Cost Community

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 3**
router bgp autonomous-system-number
Example: Device(config)# router bgp 50000 | Enters router configuration mode to create or configure a BGP routing process. |
| **Step 4**
neighbor ip-address remote-as autonomous-system-number
Example: Device(config-router)# neighbor 10.0.0.1 remote-as 101 | Establishes peering with the specified neighbor or peer-group. |
| **Step 5**
address-family ipv4 [mdt | multicast | tunnel | unicast [vrf vrf-name] | vrf vrf-name | ipv6 [multicast | unicast] | vpnv4 [unicast] | Example: Device(config-router)# address-family ipv4 | Places the router in address family configuration mode. |
| **Step 6**
neighbor ip-address route-map map-name {in | out}
Example: Device(config-router)# neighbor 10.0.0.1 route-map MAP-NAME in | Applies an incoming or outgoing route map for the specified neighbor or peer-group. |
| **Step 7**
exit
Example: Device(config-router)# exit | Exits router configuration mode and enters global configuration mode. |
| **Step 8**
route-map map-name {permit | deny}
[sequence-number]
Example: Device(config)# route-map MAP-NAME permit 10 | Enters route map configuration mode to create or configure a route map. |
| **Step 9**
set extcommunity cost [igp] community-id cost-value
Example: Device(config-route-map)# set extcommunity cost 1 100 | Creates a set clause to apply the cost community attribute. |

- Multiple cost community set clauses can be configured in each route map block or sequence. Each cost community set clause must have a different ID (0-255). The cost community set clause with the lowest cost-value is preferred by the best path selection process when all other attributes are equal.
- Paths that are not configured with the cost community attribute will be assigned the default cost-value, which is half of the maximum value (4294967295) or 2147483647.
### Purpose

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<th>Command or Action</th>
<th>Purpose</th>
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<tr>
<td><strong>Step 10</strong></td>
<td><strong>end</strong></td>
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<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Device(config-route-map)# end</strong></td>
</tr>
</tbody>
</table>

### Verifying the Configuration of the BGP Cost Community

BGP cost community configuration can be verified locally or for a specific neighbor. To verify the local configuration cost community, use the **show route-map** or **show running-config** command.

To verify that a specific neighbor carries the cost community, use the **show ip bgp ip-address** command. The output from these commands displays the POI (IGP is the default POI), the configured ID, and configured cost. For large cost community values, the output from these commands will also show, with + and - values, the difference between the configured cost and the default cost. See “Example: BGP Cost Community Verification” section for sample output.

### Troubleshooting Tips

The **bgp bestpath cost-community ignore** command can be used to disable the evaluation of the cost community attribute to help isolate problems and troubleshoot issues that relate to BGP best path selection.

The **debug ip bgp updates** command can be used to print BGP update messages. The cost community extended community attribute will be displayed in the output of this command when received from a neighbor. A message will also be displayed if a non-transitive extended community if received from an external peer.

### Configuration Examples for the BGP Cost Community Feature

#### Example: BGP Cost Community Configuration

The following example applies the cost community ID of 1 and cost community value of 100 to routes that are permitted by the route map. This configuration will cause the best path selection process to prefer this route over other equal-cost paths that were not permitted by this route map sequence.

```plaintext
Device(config)# router bgp 50000
Device(config-router)# neighbor 10.0.0.1 remote-as 50000
Device(config-router)# neighbor 10.0.0.1 update-source Loopback 0
Device(config-router)# address-family ipv4
Device(config-router-af)# neighbor 10.0.0.1 activate
Device(config-router-af)# neighbor 10.0.0.1 route-map COST1 in
Device(config-router-af)# neighbor 10.0.0.1 send-community both
Router(config-router-af)# exit
Device(config)# route-map COST1 permit 10
Device(config-route-map)# match ip-address 1
Device(config-route-map)# set extcommunity cost 1 100
```
Example: BGP Cost Community Verification

BGP cost community configuration can be verified locally or for a specific neighbor. To verify the local configuration cost community, use the `show route-map` or `show running-config` command. To verify that a specific neighbor carries the cost community, use the `show ip bgp ip-address` command.

The output of the `show route-map` command will display locally configured route-maps, match, set, continue clauses, and the status and configuration of the cost community attribute. The following sample output is similar to the output that will be displayed:

Device# show route-map

route-map COST1, permit, sequence 10
  Match clauses:
  as-path (as-path filter): 1
  Set clauses:
  extended community Cost:igp:1:100
  Policy routing matches: 0 packets, 0 bytes
route-map COST1, permit, sequence 20
  Match clauses:
  ip next-hop (access-lists): 2
  Set clauses:
  extended community Cost:igp:2:200
  Policy routing matches: 0 packets, 0 bytes
route-map COST1, permit, sequence 30
  Match clauses:
  interface FastEthernet0/0
  extcommunity (extcommunity-list filter):300
  Set clauses:
  extended community Cost:igp:3:300
  Policy routing matches: 0 packets, 0 bytes

The following sample output shows locally configured routes with large cost community values:

Device# show route-map

route-map set-cost, permit, sequence 10
  Match clauses:
  Set clauses:
  RT:700:700 additive
  extended community Cost:igp:1:4294967295 (default+2147483648)
  Cost:igp:7:2147284648 (default-198999)
  Policy routing matches: 0 packets, 0 bytes

The output of the `show running config` command will display match, set, and continue clauses that are configured within a route-map. The following sample output is filtered to show only the relevant part of the running configuration:

Device# show running-config | begin route-map

route-map COST1 permit 20
  match ip next-hop 2
  set extcommunity cost igp 2 200
route-map COST1 permit 30
  match interface FastEthernet0/0
match extcommunity 300
set extcommunity cost igp 3 300
.
.
.

The output of the `show ip bgp ip-address` command can be used to verify if a specific neighbor carries a path that is configured with the cost community attribute. The cost community attribute information is displayed in the “Extended Community” field. The POI, the cost community ID, and the cost community number value are displayed. The following sample output shows that neighbor 172.16.1.2 carries a cost community with an ID of 1 and a cost of 100:

```
Device# show ip bgp 10.0.0.0
BGP routing table entry for 10.0.0.0/8, version 2
Paths: (1 available, best #1)
    Not advertised to any peer
    2 2 2
    172.16.1.2 from 172.16.1.2 (172.16.1.2)
        Origin IGP, metric 0, localpref 100, valid, external, best
        Extended Community: Cost:igp:1:100
```

If the specified neighbor is configured with the default cost community number value or if the default value is assigned automatically for cost community evaluation, “default” with + and - values will be displayed after the cost community number value in the output.

## Additional References

### Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
<tr>
<td>EIGRP MPLS VPN PE-CE Site of Origin (SoO) feature</td>
<td>“EIGRP MPLS VPN PE-CE Site of Origin (SoO)” module in the IP Routing: EIGRP Configuration Guide</td>
</tr>
</tbody>
</table>

### Standards

<table>
<thead>
<tr>
<th>Standards</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.</td>
<td>—</td>
</tr>
</tbody>
</table>
MIBs

<table>
<thead>
<tr>
<th>MB</th>
<th>MIBs Link</th>
</tr>
</thead>
</table>
|    | To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL:  
  http://www.cisco.com/go/mibs |

RFCs

<table>
<thead>
<tr>
<th>RFCs</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>draft-retana-bgp-custom-decision-00.txt</td>
<td>BGP Custom Decision Process</td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
<tr>
<td>download documentation, software, and tools. Use these resources to</td>
<td></td>
</tr>
<tr>
<td>install and configure the software and to troubleshoot and resolve</td>
<td></td>
</tr>
<tr>
<td>technical issues with Cisco products and technologies. Access to most</td>
<td></td>
</tr>
<tr>
<td>tools on the Cisco Support and Documentation website requires a Cisco.com</td>
<td></td>
</tr>
<tr>
<td>user ID and password.</td>
<td></td>
</tr>
</tbody>
</table>

Feature Information for BGP Cost Community

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 54: Feature Information for BGP Cost Community

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP Cost Community</td>
<td>12.0(24)S</td>
<td>The BGP Cost Community feature introduces the cost extended community attribute. The cost community is a non-transitive extended community attribute that is passed to internal BGP (iBGP) and confederation peers but not to external BGP (eBGP) peers. The cost community feature allows you to customize the local route preference and influence the best path selection process by assigning cost values to specific routes.</td>
</tr>
<tr>
<td></td>
<td>12.3(2)T</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12.2(18)S</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12.2(27)SBC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15.0(1)S</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>The following commands were introduced or modified: <strong>bgp bestpath cost-community ignore</strong>, <strong>debug ip bgp updates</strong>, and <strong>set extcommunity cost</strong>.</td>
</tr>
</tbody>
</table>
Feature Information

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
</table>
| BGP Cost Community Support for EIGRP MPLS VPN PE-CE with Backdoor Links | 12.0(27)S  
12.3(8)T  
12.2(25)S | Back door links in an EIGRP MPLS VPN topology will be preferred by BGP if the back door link is learned first. The "pre-bestpath" point of insertion (POI) was introduced in the BGP Cost Community feature to support mixed EIGRP VPN network topologies that contain VPN and backdoor links. This POI is applied automatically to EIGRP routes that are redistributed into BGP and the POI influences the best path calculation process by influencing BGP to consider this POI before any other comparison step. No configuration is required. This feature is enabled automatically for EIGRP VPN sites when Cisco IOS Release 12.0(27)S, 12.3(8)T, 12.2(25)S or later releases, is installed to a PE, CE, or back door router. No commands were introduced or modified. |
BGP Support for IP Prefix Import from Global Table into a VRF Table

The BGP Support for IP Prefix Import from Global Table into a VRF Table feature introduces the capability to import IPv4 unicast prefixes from the global routing table into a Virtual Private Network (VPN) routing/forwarding (VRF) instance table using an import route map.

- Finding Feature Information, on page 629
- Prerequisites for BGP Support for IP Prefix Import from Global Table into a VRF Table, on page 629
- Restrictions for BGP Support for IP Prefix Import from Global Table into a VRF Table, on page 630
- Information About BGP Support for IP Prefix Import from Global Table into a VRF Table, on page 630
- How to Import IP Prefixes from Global Table into a VRF Table, on page 631
- Configuration Examples for BGP Support for IP Prefix Import from Global Table into a VRF Table, on page 637
- Additional References for Internal BGP Features, on page 638
- Feature Information for BGP Support for IP Prefix Import from Global Table into a VRF Table, on page 639

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for BGP Support for IP Prefix Import from Global Table into a VRF Table

- Border Gateway Protocol (BGP) peering sessions are established.
- CEF or dCEF (for distributed platforms) is enabled on all participating routers.
Restrictions for BGP Support for IP Prefix Import from Global Table into a VRF Table

- Only IPv4 unicast and multicast prefixes can be imported into a VRF with this feature.
- IPv4 prefixes imported into a VRF using this feature cannot be imported into a VPNv4 VRF.
- The global prefixes should be in the BGP table, so that this feature can import them into the BGP VRF table.
- IPv4 prefixes imported into a VRF using this feature cannot be imported into a second VPNv4 VRF.

Information About BGP Support for IP Prefix Import from Global Table into a VRF Table

Importing IPv4 Prefixes into a VRF

The BGP Support for IP Prefix Import from Global Table into a VRF Table feature introduces the capability to import IPv4 unicast prefixes from the global routing table into a Virtual Private Network (VPN) routing/forwarding instance (VRF) table using an import route map. This feature extends the functionality of VRF import-map configuration to allow IPv4 prefixes to be imported into a VRF based on a standard community. Both IPv4 unicast and multicast prefixes are supported. No Multiprotocol Label Switching (MPLS) or route target (import/export) configuration is required.

IP prefixes are defined as match criteria for the import map through standard Cisco filtering mechanisms. For example, an IP access-list, an IP prefix-list, or an IP as-path filter is created to define an IP prefix or IP prefix range, and then the prefix or prefixes are processed through a match clause in a route map. Prefixes that pass through the route map are imported into the specified VRF per the import map configuration.

Black Hole Routing

The BGP Support for IP Prefix Import from Global Table into a VRF Table feature can be configured to support Black Hole Routing (BHR). BHR is a method that allows the administrator to block undesirable traffic, such as traffic from illegal sources or traffic generated by a Denial of Service (DoS) attack, by dynamically routing the traffic to a dead interface or to a host designed to collect information for investigation, mitigating the impact of the attack on the network. Prefixes are looked up, and packets that come from unauthorized sources are blackholed by the ASIC at line rate.

Classifying Global Traffic

The BGP Support for IP Prefix Import from Global Table into a VRF Table feature can be used to classify global IP traffic based on physical location or class of service. Traffic is classified based on administration policy and then imported into different VRFs. On a college campus, for example, network traffic could be divided into an academic network and residence network traffic, a student network and faculty network, or a dedicated network for multicast traffic. After the traffic is divided along administration policy, routing decisions
can be configured with the MPLS VPN--VRF Selection Using Policy Based Routing feature or the MPLS VPN--VRF Selection Based on Source IP Address feature.

**Unicast Reverse Path Forwarding**

Unicast Reverse Path Forwarding (Unicast RPF) can be optionally configured with the BGP Support for IP Prefix Import from Global Table into a VRF Table feature. Unicast RPF is used to verify that the source address is in the Forwarding Information Base (FIB). The `ip verify unicast vrf` command is configured in interface configuration mode and is enabled for each VRF. This command has `permit` and `deny` keywords that are used to determine if the traffic is forwarded or dropped after Unicast RPF verification.

**How to Import IP Prefixes from Global Table into a VRF Table**

**Defining IPv4 IP Prefixes to Import**

IPv4 unicast or multicast prefixes are defined as match criteria for the import route map using standard Cisco filtering mechanisms. This task uses an IP access-list and an IP prefix-list.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `access-list access-list-number {deny | permit} source [source-wildcard] [log]`
4. `ip prefix-list prefix-list-name [seq seq-value] {deny network/length | permit network/length} [ge ge-value] [le le-value]`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td><code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>configure terminal</code></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td>`access-list access-list-number {deny</td>
<td>permit} source [source-wildcard] [log]`</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config)# access-list 50 permit 10.1.1.0 0.0.0.255</td>
<td></td>
</tr>
<tr>
<td></td>
<td>`ip prefix-list prefix-list-name [seq seq-value] {deny network/length</td>
<td>permit network/length} [ge ge-value] [le le-value]`</td>
</tr>
</tbody>
</table>
Creating the VRF and the Import Route Map

The IP prefixes that are defined for import are then processed through a match clause in a route map. IP prefixes that pass through the route map are imported into the VRF. A maximum of 5 VRFs per router can be configured to import IPv4 prefixes from the global routing table. By default, a maximum of 1000 prefixes per VRF can be imported. You can change the limit to be from 1 to 2,147,483,647 prefixes for each VRF. We recommend that you use caution if you increase the prefix import limit above 1000. Configuring the router to import too many prefixes can interrupt normal router operation.

No MPLS or route target (import/export) configuration is required.

Import actions are triggered when a new routing update is received or when routes are withdrawn. During the initial BGP update period, the import action is postponed to allow BGP to convergence more quickly. Once BGP converges, incremental BGP updates are evaluated immediately and qualified prefixes are imported as they are received.

The following syslog message is introduced by the BGP Support for IP Prefix Import from Global Table into a VRF Table feature. It will be displayed when more prefixes are available for import than the user-defined limit:

```
00:00:33: %BGP-3-AFIMPORT_EXCEED: IPv4 Multicast prefixes imported to multicast vrf exceed the limit 2
```

You can either increase the prefix limit or fine-tune the import route map filter to reduce the number of candidate routes.

**Note**

- Only IPv4 unicast and multicast prefixes can be imported into a VRF with this feature.
- A maximum of five VRF instances per router can be created to import IPv4 prefixes from the global routing table.
- IPv4 prefixes imported into a VRF using this feature cannot be imported into a VPNv4 VRF.

**Summary Steps**

1. enable
2. configure terminal
3. ip vrf vrf-name
4. rd route-distinguisher
5. import ipv4 {unicast | multicast} [prefix-limit] map route-map
6. exit
7. **route-map** *map-tag* [permit | deny] [sequence-number]
8. **match ip address** {acl-number acl-number | acl-name | acl-name acl-number | prefix-list prefix-list-name | prefix-list-name}
9. **end**

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** | enable | Enables privileged EXEC mode.  
**Example:**
Router> enable | 
| | | • Enter your password if prompted. |
| **Step 2** | configure terminal | Enters global configuration mode.  
**Example:**
Router# configure terminal | 
| **Step 3** | ip vrf vrf-name | Creates a VRF routing table and specifies the VRF name (or tag).  
**Example:**
Router(config)# ip vrf GREEN | 
| | | • The **ip vrf vrf-name** command creates a VRF routing table and a CEF table, and both are named using the *vrf-name* argument. Associated with these tables is the default route distinguisher value. |
| **Step 4** | rd route-distinguisher | Creates routing and forwarding tables for the VRF instance.  
**Example:**
Router(config-vrf)# rd 100:10 | 
| | | • There are two formats for configuring the route distinguisher argument. It can be configured in the as-number:network number (ASN:nn) format, as shown in the example, or it can be configured in the IP address:network number format (IP-address:nn). |
| **Step 5** | import ipv4 {unicast | multicast} [prefix-limit] map route-map | Imports IPv4 prefixes from the global routing table to a VRF table, filtered by the specified route map.  
**Example:**
Router(config-vrf)# import ipv4 unicast 1000 map UNICAST | 
| | | • Unicast or multicast prefixes are specified. |
| | | • Up to a 1000 prefixes will be imported by default. The *prefix-limit* argument is used to specify a limit from 1 to 2,147,483,647 prefixes. |
| | | • The example references a route map that will import up to 1000 unicast prefixes that pass through the route map. |
| **Step 6** | exit | Exits VRF configuration mode and enters global configuration mode.  
**Example:**
Router(config-vrf)# exit |
PurposeCommand or Action

Step 7 route-map map-tag [permit | deny] [sequence-number]
Example:
Router(config)# route-map UNICAST permit 10

Purpose
Defines the conditions for redistributing routes from one routing protocol into another, or enables policy routing.
- The route map name must match the route map specified in Step 5.
- The example creates a route map named UNICAST.

Step 8 match ip address {acl-number [acl-number | acl-name] | acl-name [acl-name | acl-number] | prefix-list prefix-list-name [prefix-list-name]}
Example:
Router(config-route-map)# match ip address 50

Purpose
Distributes any routes that have a destination network number address that is permitted by a standard or extended access list, and performs policy routing on matched packets.
- Both IP access lists and IP prefix lists are supported.
- The example configures the route map to use standard access list 50 to define match criteria.

Step 9 end
Example:
Router(config-route-map)# end

Purpose
Exits route-map configuration mode and returns to privileged EXEC mode.

Filtering on the Ingress Interface

The BGP Support for IP Prefix Import from Global Table into a VRF Table feature can be configured globally or on a per-interface basis. We recommend that you apply it to ingress interfaces to maximize performance.

SUMMARY STEPS
1. enable
2. configure terminal
3. interface type number [name-tag]
4. ip policy route-map map-tag
5. ip verify unicast vrf vrf-name {deny | permit}
6. end

DETAILED STEPS

Command or Action

Step 1 enable
Example: 
Router> enable

Purpose
Enables privileged EXEC mode.
- Enter your password if prompted.

Step 2 configure terminal
Example:

Purpose
Enters global configuration mode.
### Command or Action

**Router# configure terminal**

**Step 3**

<table>
<thead>
<tr>
<th>interface</th>
<th>type number [name-tag]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Configures an interface and enters interface configuration mode.

Example:

```
Router(config)# interface Ethernet0/0
```

**Step 4**

<table>
<thead>
<tr>
<th>ip policy route-map map-tag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Identifies a route map to use for policy routing on an interface.

- The example attaches the route map named UNICAST to the interface.

Example:

```
Step 4
Router(config-if)# ip policy route-map UNICAST
```

**Step 5**

| ip verify unicast vrf vrf-name {deny | permit} |
|-----------------------------------------------|
| Example:                                      |
| Router(config-if)# ip verify unicast vrf GREEN permit |

(Optional) Enables Unicast Reverse Path Forwarding verification for the specified VRF.

- The example enables verification for the VRF named GREEN. Traffic that passes verification will be forwarded.

Example:

```
Step 5
Router(config-if)# ip verify unicast vrf GREEN permit
```

**Step 6**

<table>
<thead>
<tr>
<th>end</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
</tr>
<tr>
<td>Router(config-if)# end</td>
</tr>
</tbody>
</table>

Exits interface configuration mode and returns to privileged EXEC mode.

### Verifying Global IP Prefix Import

Perform the steps in this task to display information about the VRFs that are configured with the BGP Support for IP Prefix Import from Global Table into a VRF Table feature and to verify that global IP prefixes are imported into the specified VRF table.

#### SUMMARY STEPS

1. **enable**
2. **show ip bgp vpnv4 {all | rd route-distinguisher | vrf vrf-name}**
3. **show ip vrf {brief | detail | interfaces | id} [vrf-name]**

#### DETAILED STEPS

**Step 1**

**enable**

Enables privileged EXEC mode. Enter your password if prompted.

**Example:**

```
Device# enable
```

**Step 2**

**show ip bgp vpnv4 {all | rd route-distinguisher | vrf vrf-name}**
Displays VPN address information from the BGP table. The output displays the import route map, the traffic type (unicast or multicast), the default or user-defined prefix import limit, the actual number of prefixes that are imported, and individual import prefix entries.

Example:

Device# show ip bgp vpnv4 all

BGP table version is 15, local router ID is 10.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

Network Next Hop Metric LocPrf Weight Path
Route Distinguisher: 100:1 (default for vrf academic)
Import Map: ACADEMIC, Address-Family: IPv4 Unicast, Pfx Count/Limit: 6/1000
*> 10.50.1.0/24 172.17.2.2 0 2 3 ?
*> 10.50.2.0/24 172.17.2.2 0 2 3 ?
*> 10.50.3.0/24 172.17.2.2 0 2 3 ?
*> 10.60.1.0/24 172.17.2.2 0 2 3 ?
*> 10.60.2.0/24 172.17.2.2 0 2 3 ?
*> 10.60.3.0/24 172.17.2.2 0 2 3 ?

Route Distinguisher: 200:1 (default for vrf residence)
Import Map: RESIDENCE, Address-Family: IPv4 Unicast, Pfx Count/Limit: 3/1000
*> 10.30.1.0/24 172.17.2.2 0 0 2 i
*> 10.30.2.0/24 172.17.2.2 0 0 2 i
*> 10.30.3.0/24 172.17.2.2 0 0 2 i

Route Distinguisher: 300:1 (default for vrf BLACKHOLE)
Import Map: BLACKHOLE, Address-Family: IPv4 Unicast, Pfx Count/Limit: 3/1000
*> 10.40.1.0/24 172.17.2.2 0 0 2 i
*> 10.40.2.0/24 172.17.2.2 0 0 2 i
*> 10.40.3.0/24 172.17.2.2 0 0 2 i

Route Distinguisher: 400:1 (default for vrf multicast)
Import Map: MCAST, Address-Family: IPv4 Multicast, Pfx Count/Limit: 2/2
*> 10.70.1.0/24 172.17.2.2 0 0 2 i
*> 10.70.2.0/24 172.17.2.2 0 0 2 i

Step 3

show ip vrf [brief | detail | interfaces | id] [vrf-name]

Displays defined VRFs and their associated interfaces. The output displays the import route map, the traffic type (unicast or multicast), and the default or user-defined prefix import limit. The following example output shows that the import route map named UNICAST is importing IPv4 unicast prefixes and that the prefix import limit is 1000.

Example:

Device# show ip vrf detail

VRF academic; default RD 100:10; default VPNID <not set>
VRF Table ID = 1
No interfaces
Connected addresses are not in global routing table
Export VPN route-target communities
RT:100:10
Import VPN route-target communities
RT:100:10
Import route-map for ipv4 unicast: UNICAST (prefix limit: 1000)
No export route-map
Configuration Examples for BGP Support for IP Prefix Import from Global Table into a VRF Table

Example: Importing IP Prefixes from Global Table into a VRF Table

The following example imports unicast prefixes into the VRF named green by using an IP prefix list and a route map:

This example starts in global configuration mode:

```plaintext
! ip prefix-list COLORADO seq 5 permit 10.131.64.0/19
ip prefix-list COLORADO seq 10 permit 172.31.2.0/30
ip prefix-list COLORADO seq 15 permit 172.31.1.1/32
!
ip vrf green
  rd 200:1
  import ipv4 unicast map UNICAST
  route-target export 200:10
  route-target import 200:10
!
exit
!
routemap UNICAST permit 10
  match ip address prefix-list COLORADO
!
exit
```

Example: Verifying IP Prefix Import to a VRF Table

The `show ip vrf` command or the `show ip bgp vpnv4` command can be used to verify that prefixes are imported from the global routing table to the VRF table.

The following sample output shows that the import route map named UNICAST is importing IPv4 unicast prefixes and the prefix import limit is 1000:

```
Device# show ip vrf detail
VRF green; default RD 200:1; default VPNID <not set>
  Interfaces:
  Se2/0
VRF Table ID = 1
  Import VPN route-target communities
  RT:200:10
  Import VPN route-target communities
  RT:200:10
  Import route-map for ipv4 unicast: UNICAST (prefix limit: 1000)
VRF red; default RD 200:2; default VPNID <not set>
  Interfaces:
  Se3/0
VRF Table ID = 2
```
Export VPN route-target communities
RT:200:20
Import VPN route-target communities
RT:200:20
No import route-map
No export route-map
VRF label distribution protocol: not configured
VRF label allocation mode: per-prefix

The following sample output displays the import route map names, the prefix import limit and the actual number of imported prefixes, and the individual import entries:

Device# show ip bgp vpnv4 all

BGP table version is 18, local router ID is 10.131.127.252
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal, r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete
Route Distinguisher: 200:1 (default for vrf green)
Import Map: UNICAST, Address-Family: IPv4 Unicast, Pfx Count/Limit: 1/1000
*>i 10.131.64.0/19 10.131.95.252 0 100 0 i
*> 172.16.1.1/32 172.16.2.1 0 32768 i
*> 172.16.2.0/30 0.0.0.0 0 32768 i
*>i 172.31.1.1/32 10.131.95.252 0 100 0 i
*>i 172.31.2.0/30 10.131.95.252 0 100 0 i
Route Distinguisher: 200:2 (default for vrf red)
*> 172.16.1.1/32 172.16.2.1 0 32768 i
*> 172.16.2.0/30 0.0.0.0 0 32768 i
*>i 172.31.1.1/32 10.131.95.252 0 100 0 i
*>i 172.31.2.0/30 10.131.95.252 0 100 0 i

Additional References for Internal BGP Features

Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Commands List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
<tr>
<td>BGP overview</td>
<td>“Cisco BGP Overview” module</td>
</tr>
<tr>
<td>Basic BGP configuration tasks</td>
<td>“Configuring a Basic BGP Network” module</td>
</tr>
<tr>
<td>iBGP multipath load sharing</td>
<td>“iBGP Multipath Load Sharing” module</td>
</tr>
<tr>
<td>Connecting to a service provider</td>
<td>“Connecting to a Service Provider Using External BGP” module</td>
</tr>
<tr>
<td>Configuring features that apply to multiple IP routing protocols</td>
<td>IP Routing: Protocol-Independent Configuration Guide</td>
</tr>
</tbody>
</table>
RFCs

<table>
<thead>
<tr>
<th>RFC</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFC 1772</td>
<td>Application of the Border Gateway Protocol in the Internet</td>
</tr>
<tr>
<td>RFC 1773</td>
<td>Experience with the BGP Protocol</td>
</tr>
<tr>
<td>RFC 1774</td>
<td>BGP-4 Protocol Analysis</td>
</tr>
<tr>
<td>RFC 1930</td>
<td>Guidelines for Creation, Selection, and Registration of an Autonomous System (AS)</td>
</tr>
<tr>
<td>RFC 2519</td>
<td>A Framework for Inter-Domain Route Aggregation</td>
</tr>
<tr>
<td>RFC 2858</td>
<td>Multiprotocol Extensions for BGP-4</td>
</tr>
<tr>
<td>RFC 2918</td>
<td>Route Refresh Capability for BGP-4</td>
</tr>
<tr>
<td>RFC 3392</td>
<td>Capabilities Advertisement with BGP-4</td>
</tr>
<tr>
<td>RFC 4271</td>
<td>A Border Gateway Protocol 4 (BGP-4)</td>
</tr>
<tr>
<td>RFC 4893</td>
<td>BGP Support for Four-octet AS Number Space</td>
</tr>
<tr>
<td>RFC 5396</td>
<td>Textual Representation of Autonomous system (AS) Numbers</td>
</tr>
<tr>
<td>RFC 5398</td>
<td>Autonomous System (AS) Number Reservation for Documentation Use</td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

Feature Information for BGP Support for IP Prefix Import from Global Table into a VRF Table

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.
The BGP Support for IP Prefix Import from Global Table into a VRF Table feature introduces the capability to import IPv4 unicast prefixes from the global routing table into a Virtual Private Network (VPN) routing/forwarding (VRF) instance table using an import route map.

This feature was introduced on the Cisco ASR 1000 Series Aggregation Services Routers.

The following commands were introduced or modified by this feature: `debug ip bgp import`, `import ipv4`, `ip verify unicast vrf`.

### Table 55: Feature Information for BGP Support for IP Prefix Import from Global Table into a VRF Table

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP Support for IP Prefix Import from Global Table</td>
<td>Cisco IOS XE Release 2.1</td>
<td>The BGP Support for IP Prefix Import from Global Table into a VRF Table feature introduces the capability to import IPv4 unicast prefixes from the global routing table into a Virtual Private Network (VPN) routing/forwarding (VRF) instance table using an import route map. This feature was introduced on the Cisco ASR 1000 Series Aggregation Services Routers. The following commands were introduced or modified by this feature: <code>debug ip bgp import</code>, <code>import ipv4</code>, <code>ip verify unicast vrf</code>.</td>
</tr>
</tbody>
</table>
CHAPTER 40

BGP Support for IP Prefix Export from a VRF Table into the Global Table

This feature allows a network administrator to export IP prefixes from a VRF table into the global routing table.

• Finding Feature Information, on page 641
• Information About IP Prefix Export from a VRF Table into the Global Table, on page 641
• How to Export IP Prefixes from a VRF Table into the Global Table, on page 643
• Configuration Examples for IP Prefix Export from a VRF Table into the Global Table, on page 649
• Additional References, on page 650
• Feature Information for IP Prefix Export from a VRF Table into the Global Table, on page 650

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About IP Prefix Export from a VRF Table into the Global Table

Benefits of IP Prefix Export from a VRF Table into the Global Table

• You can manage some network resources inside a VRF by using a network management node residing in the global table.

• You own some internet public IP address space, but prefer to have a VRF to manage those IP addresses.
How IP Prefix Export from a VRF Table into the Global Table Works

MPLS-VPN using Multiprotocol BGP (MP-BGP) provides a very flexible but secured VPN provisioning mechanism for service providers and customers. However, some customers prefer to relax the boundary so that some specific prefixes can be reachable in a VRF as well as in the global routing table.

Prior to the BGP Support for IP Prefix Export from a VRF Table into Global Table feature, BGP already supported the global-to-VRF import of prefixes. See the “BGP Support for IP Prefix Import from Global Table into a VRF Table” module for complete documentation of that feature. Together, the import feature and export feature provide L3VPN dynamic route leaking.

The BGP Support for IP Prefix Export from a VRF Table into the Global Table feature provides the reverse mechanism of the import feature referenced above; it supports the export of prefixes from a VRF table to the global routing table. It is achieved with an `export {ipv4 | ipv6} {unicast | multicast} map` command, which specifies a route map to control the prefixes that are exported from a VRF table to the global routing table.

Caution

The IP Prefix Export from a VRF Table into Global Table feature leaks VRF routes into the global BGP routing table; those routes will be installed into the IPv4 or IPv6 routing table. Use extreme caution to design the network so that such leaking does not affect the normal Internet routing.

Export actions are triggered when a new routing update is received or when routes are withdrawn. During the initial BGP update period, the export action is postponed to allow BGP to converge more quickly. Once BGP converges, incremental BGP updates are evaluated immediately and qualified prefixes are exported as they are received.

Each VRF can export to only one of the global topologies in IPv4 (unicast or multicast) and can export to only one of the global topologies in IPv6 (unicast or multicast).

There is no limit to the number of VRFs per router that can be configured to export IPv4 or IPv6 prefixes to the global routing table.

By default, the software limits the number of prefixes that can be exported per VRF to 1000 prefixes. You can change that limit to a number in the range from 1 to 2,147,483,647 prefixes for each VRF. We recommend that you use caution if you increase the prefix limit above 1000. Configuring the device to export too many prefixes can interrupt normal router operation.

The following `match` and `set` commands are supported in this feature:

- `match as-path`
- `match community [exact-match]`
- `match extcommunity`
- `match ip address [prefix-list]`
- `match ip next-hop`
- `match ip route-source`
- `match ipv6 address [prefix-list]`
- `match ipv6 route-source`
- `match ipv6 next-hop`
How to Export IP Prefixes from a VRF Table into the Global Table

Creating the VRF and the Export Route Map for an Address Family

The IP prefixes that are defined for export are processed through a match clause in a route map. IP prefixes that pass through the route map are exported into the global routing table.

**SUMMARY STEPS**

1. enable
2. configure terminal
3. vrf definition vrf-name
4. rd route-distinguisher
5. address-family {ipv4 | ipv6}
6. export {ipv4 | ipv6} {unicast | multicast} [prefix-limit] map map-name
7. route-target import route-target-ext-community
8. route-target export route-target-ext-community
9. exit
10. exit
11. route-map map-tag [permit | deny] [sequence-number]
12. match ip address {acl-number [acl-number | acl-name] | acl-name [acl-name | acl-number] | prefix-list prefix-list-name [prefix-list-name]}

The `set ip vrf next-hop` and `set ipv6 vrf next-hop` commands are not supported in this feature.
## DETAILED STEPS

<table>
<thead>
<tr>
<th><strong>Step</strong></th>
<th><strong>Command or Action</strong></th>
<th><strong>Purpose</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>vrf definition vrf-name</td>
<td>Creates a VRF routing table and specifies the VRF name (or tag).</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config)# vrf definition vpn1</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>rd route-distinguisher</td>
<td>Creates routing and forwarding tables for the VRF instance.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-vrf)# rd 100:100</td>
<td>• There are two formats for configuring the argument. It can be configured in the <code>as-number:network number</code> (ASN:nn) format, as shown in the example, or it can be configured in the <code>IP address:network number</code> format (IP-address:nn).</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>address-family {ipv4</td>
<td>ipv6}</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-vrf)# address-family ipv4</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>export {ipv4</td>
<td>ipv6} {unicast</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-vrf-af)# export ipv4 unicast 500 map UNICAST</td>
<td>• Specify <code>ipv4</code> or <code>ipv6</code>, which you specified in Step 5. This example exports IPv4 unicast prefixes.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Based on this example, no more than 500 prefixes will be exported.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The prefixes exported are those that pass the route map.</td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>route-target import route-target-ext-community</td>
<td>Creates a route-target extended community for a VRF instance.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-vrf-af)# route-target import 100:100</td>
<td>• For information about route-target import or export, see the <em>MPLS: Layer 3 VPNs Configuration Guide</em>.</td>
</tr>
<tr>
<td>Step 8</td>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>--------</td>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td></td>
<td>route-target export</td>
<td>Creates a route-target extended community for a VRF instance.</td>
</tr>
<tr>
<td>Example:</td>
<td>route-target-ext-community</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config-vrf-af)# route-target export 100:100</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 9</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>exit</td>
<td>Exits address family configuration mode and enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config-vrf-af)# exit</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 10</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>exit</td>
<td>Exits VRF configuration mode and enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config-vrf)# exit</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 11</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>route-map map-tag [permit</td>
<td>Enables policy routing.</td>
</tr>
<tr>
<td></td>
<td>deny] [sequence-number]</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td>• The example creates a route map named UNICAST.</td>
</tr>
<tr>
<td></td>
<td>Device(config)# route-map UNICAST permit 10</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 12</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>match ip address {acl-number</td>
<td>Distributes any routes that have a destination network number address that is permitted by a standard or extended access list, and performs policy routing on matched packets.</td>
</tr>
<tr>
<td></td>
<td>acl-name}</td>
<td>• Both IP access lists and IP prefix lists are supported.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The example configures the route map to use standard access list 50 to define match criteria.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Define the access list (not shown in this task); for example, access-list 50 permit 192.168.1.0 255.255.255.0.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config-route-map)# match ip address 50</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 13</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>end</td>
<td>Exits route-map configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config-route-map)# end</td>
<td></td>
</tr>
</tbody>
</table>

## Creating the VRF and the Export Route Map for a VRF (IPv4 only)

The IP prefixes that are defined for export are processed through a match clause in a route map. IP prefixes that pass through the route map are exported into the global routing table.
Creating the VRF and the Export Route Map for a VRF (IPv4 only)

Note
- Only IPv4 unicast and multicast prefixes can be exported from a VRF table to the global routing table under the `ip vrf` command, as shown in this task. To export IPv6 prefixes, you must do so under the IPv6 address family; see the section “Creating the VRF and the Export Route Map Per Address Family.”
- IPv4 prefixes exported into the global routing table using this feature cannot be exported into a VPNv4 VRF.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `ip vrf vrf-name`
4. `rd route-distinguisher`
5. `export ipv4 {unicast | multicast} [prefix-limit] map map-tag`
6. `route-target import route-target-ext-community`
7. `route-target export route-target-ext-community`
8. `exit`
9. `route-map map-tag [permit | deny] [sequence-number]`
10. `match ip address {acl-number acl-number | acl-name | acl-name acl-name acl-number} [prefix-list prefix-list-name [prefix-list-name]}
11. `end`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example: Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> ip vrf vrf-name</td>
<td>Creates a VRF routing table and specifies the VRF name (or tag).</td>
</tr>
<tr>
<td>Example: Device(config)# ip vrf GREEN</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> rd route-distinguisher</td>
<td>Creates routing and forwarding tables for the VRF instance.</td>
</tr>
<tr>
<td>Example: Device(config-vrf)# rd 100:10</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> export ipv4</td>
<td></td>
</tr>
<tr>
<td>Example: Device(config-vrf)# export ipv4 unicast map exportmap</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> route-target import</td>
<td></td>
</tr>
<tr>
<td>Example: Device(config-vrf)# route-target import route-target-ext-community</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong> route-target export</td>
<td></td>
</tr>
<tr>
<td>Example: Device(config-vrf)# route-target export route-target-ext-community</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong> exit</td>
<td></td>
</tr>
<tr>
<td><strong>Step 9</strong> route-map</td>
<td></td>
</tr>
<tr>
<td>Example: Device(config-vrf)# route-map map-tag [permit</td>
<td>deny] [sequence-number]</td>
</tr>
<tr>
<td><strong>Step 10</strong> match ip address</td>
<td></td>
</tr>
<tr>
<td>Example: Device(config-vrf)# match ip address {acl-number acl-number</td>
<td>acl-name</td>
</tr>
<tr>
<td><strong>Command or Action</strong></td>
<td><strong>Purpose</strong></td>
</tr>
<tr>
<td>-----------------------</td>
<td>-------------</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>Exports IPv4 prefixes from the VRF table to the global routing table, filtered by the specified route map.</td>
</tr>
<tr>
<td><strong>export ipv4</strong></td>
<td>be configured in the IP-address: network number format (IP-address:nn).</td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>Creates a route-target extended community for a VRF instance.</td>
</tr>
<tr>
<td><strong>route-target import</strong></td>
<td>For information about route-target import or export, see the MPLS: Layer 3 VPNs Configuration Guide.</td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>Creates a route-target extended community for a VRF instance.</td>
</tr>
<tr>
<td><strong>route-target export</strong></td>
<td>Device(config-vrf)# export ipv4 unicast 500 map UNICAST</td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td>Exits VRF configuration mode and enters global configuration mode.</td>
</tr>
<tr>
<td><strong>exit</strong></td>
<td>Device(config-vrf)# exit</td>
</tr>
<tr>
<td><strong>Step 9</strong></td>
<td>Defines the conditions for redistributing routes from one routing protocol into another, or enables policy routing.</td>
</tr>
<tr>
<td><strong>route-map</strong></td>
<td>• The route map name must match the route map specified in Step 5.</td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td>Distributes any routes that have a destination network number address that is permitted by a standard or extended access list, and performs policy routing on matched packets.</td>
</tr>
<tr>
<td><strong>match ip address</strong></td>
<td>• Both IP access lists and IP prefix lists are supported.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>• The example configures the route map to use standard access list 50 to define match criteria.</td>
</tr>
</tbody>
</table>
Displaying Information About IP Prefix Export from a VRF into the Global Table

Perform any of the steps in this task to see information about the prefixes exported from a VRF table into the global table.

**SUMMARY STEPS**

1. `enable`
2. `show ip bgp {ipv4 | ipv6} {unicast | multicast} [prefix]`
3. `debug ip bgp import event`
4. `debug ip bgp import update`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td><code>enable</code> Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Enter your password if prompted.</td>
</tr>
<tr>
<td><code>Device&gt; enable</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>`show ip bgp {ipv4</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><code>Device# show ip bgp ipv4 unicast 192.168.1.1</code></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td><code>debug ip bgp import event</code> Displays messages related to IPv4 prefix import events.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><code>Device# debug ip bgp import event</code></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td><code>debug ip bgp import update</code> Displays messages related to IPv4 prefix import updates.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><code>Device# debug ip bgp import update</code></td>
</tr>
</tbody>
</table>

---

**Purpose**

**Step 11**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>end</strong></td>
<td>Exits route-map configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><code>Device(config-route-map)# end</code></td>
</tr>
</tbody>
</table>
Configuration Examples for IP Prefix Export from a VRF Table into the Global Table

**Example: Exporting IP Prefixes from a VRF Table into the Global Table Using IPv6 Address Family**

```
vrf definition X
  rd 100:100
  address-family ipv6
    export ipv6 unicast map OnlyNet2000
    route-target import 100:100
    route-target export 100:100
!ipv6 prefix-list net2000 permit 2000::/16
!route-map OnlyNet2000 permit 10
  match ipv6 address prefix-list net2000
```

**Example: Exporting IP Prefixes from a VRF Table into the Global Table Using IPv4 Address Family**

```
vrf definition X
  rd 100:100
  address-family ipv4
    export ipv4 unicast map OnlyNet200
    route-target import 100:100
    route-target export 100:100
!ip prefix-list net200 permit 200.0.0.0/8
!route-map OnlyNet200 permit 10
  match ip address prefix-list net200
```

**Example: Exporting IP Prefixes from a VRF Table into the Global Table Using IP VRF (IPv4 Only)**

```
ip vrf vrfname
  rd 100:100
  export ipv4 unicast map OnlyNet200
  route-target import 100:100
  route-target export 100:100
!ip prefix-list net200 permit 200.0.0.0/8
!route-map OnlyNet200 permit 10
  match ip address prefix-list net200
```
Additional References

Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Commands List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS BGP Command Reference</td>
</tr>
<tr>
<td>Use of route-target import and export</td>
<td>MPLS: Layer 3 VPNs Configuration Guide</td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

Feature Information for IP Prefix Export from a VRF Table into the Global Table

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.
Table 56: Feature Information for BGP Support for IP Prefix Export from a VRF Table into the Global Table

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
</table>
| BGP Support for IP Prefix Export from a VRF Table into the Global Table | Cisco IOS XE Release 3.7S | This feature allows a network administrator to export IP prefixes from a VRF routing table into the global routing table.

The following command was introduced: **export map (VRF table to global table)**.

The following commands were modified: **debug ip bgp import** and **show ip bgp**. |
Feature Information for IP Prefix Export from a VRF Table into the Global Table
BGP per Neighbor SoO Configuration

The BGP per Neighbor SoO Configuration feature simplifies the configuration of the site-of-origin (SoO) value. Per neighbor SoO configuration introduces two new commands that can be configured in submodes under router configuration mode to set the SoO value.

- Finding Feature Information, on page 653
- Prerequisites for BGP per Neighbor SoO Configuration, on page 653
- Restrictions for BGP per Neighbor SoO Configuration, on page 653
- Information About Configuring BGP per Neighbor SoO, on page 654
- How to Configure BGP per Neighbor SoO, on page 656
- Configuration Examples for BGP per Neighbor SoO Configuration, on page 665
- Where to Go Next, on page 667
- Additional References, on page 667
- Feature Information for BGP per Neighbor SoO Configuration, on page 668

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for BGP per Neighbor SoO Configuration

This feature assumes that a Border Gateway Protocol (BGP) network is configured and that Cisco Express Forwarding is enabled in your network.

Restrictions for BGP per Neighbor SoO Configuration

A BGP neighbor or peer policy template-based SoO configuration takes precedence over the SoO value configured in an inbound route map.
Information About Configuring BGP per Neighbor SoO

Site of Origin BGP Community Attribute

The site-of-origin (SoO) extended community is a BGP extended community attribute that is used to identify routes that have originated from a site so that the readvertisement of that prefix back to the source site can be prevented. The SoO extended community uniquely identifies the site from which a router has learned a route. BGP can use the SoO value associated with a route to prevent routing loops.

Route Distinguisher

A route distinguisher (RD) creates routing and forwarding tables and specifies the default route distinguisher for a VPN. The RD is added to the beginning of an IPv4 prefix to change it into a globally unique VPN-IPv4 prefix. An RD can be composed in one of two ways: with an autonomous system number and an arbitrary number or with an IP address and an arbitrary number.

You can enter an RD in either of these formats:

- Enter a 16-bit autonomous system number, a colon, and a 32-bit number. For example:

  45000:3

- Enter a 32-bit IP address, a colon, and a 16-bit number. For example:

  192.168.10.15:1

BGP per Neighbor Site of Origin Configuration

There are three ways to configure an SoO value for a BGP neighbor:

- **BGP peer policy template**--A peer policy template is created, and an SoO value is configured as part of the peer policy. Under address family IPv4 VRF, a neighbor is identified and is configured to inherit the peer policy that contains the SoO value.

- **BGP neighbor** command--Under address family IPv4 VRF, a neighbor is identified, and an SoO value is configured for the neighbor.

- **BGP peer group**--Under address family IPv4 VRF, a BGP peer group is configured, an SoO value is configured for the peer group, a neighbor is identified, and the neighbor is configured as a member of the peer group.

Note

A BGP neighbor or peer policy template-based SoO configuration takes precedence over the SoO value configured in an inbound route map.

The configuration of SoO values for BGP neighbors is performed on a provider edge (PE) router, which is the VPN entry point. When SoO is enabled, the PE router forwards prefixes to the customer premises equipment (CPE) only when the SoO tag of the prefix does not match the SoO tag configured for the CPE.
For example, in the figure below, an SoO tag is set as 65000:1 for the customer site that includes routers CPE1 and CPE2 with an autonomous system number of 65000. When CPE1 sends prefixes to PE1, PE1 tags the prefixes with 65000:1, which is the SoO tag for CPE1 and CPE2. When PE1 sends the tagged prefixes to PE2, PE2 performs a match against the SoO tag from CPE2. Any prefixes with the tag value of 65000:1 are not sent to CPE2 because the SoO tag matches the SoO tag of CPE2, and a routing loop is avoided.

Figure 62: Network Diagram for SoO Example

Benefits of BGP per Neighbor Site of Origin

In releases prior to the introduction of this feature, the SoO extended community attribute is configured using an inbound route map that sets the SoO value during the update process. With the introduction of the BGP per Neighbor Site of Origin feature, two new commands configured in submodes under router configuration mode simplify the SoO value configuration.

BGP Peer Policy Templates

Peer policy templates are used to configure BGP policy commands that are configured for neighbors that belong to specific address families. Peer policy templates are configured once and then applied to many neighbors through the direct application of a peer policy template or through inheritance from peer policy templates. The configuration of peer policy templates simplifies the configuration of BGP policy commands that are applied to all neighbors within an autonomous system.

Peer policy templates support inheritance. A directly applied peer policy template can directly or indirectly inherit configurations from up to seven peer policy templates. So, a total of eight peer policy templates can be applied to a neighbor or neighbor group.

The configuration of peer policy templates simplifies and improves the flexibility of BGP configuration. A specific policy can be configured once and referenced many times. Because a peer policy supports up to eight levels of inheritance, very specific and very complex BGP policies can be created.
For more details about BGP peer policy templates, see the "Configuring a Basic BGP Network" module.

How to Configure BGP per Neighbor SoO

Enabling Cisco Express Forwarding and Configuring VRF Instances

Perform this task on both of the PE routers in the figure above to configure Virtual Routing and Forwarding (VRF) instances to be used with the per-VRF assignment tasks. In this task, Cisco Express Forwarding is enabled, and a VRF instance named SOO_VRF is created. To make the VRF functional, a route distinguisher is created, and the VRF is associated with an interface. When the route distinguisher is created, the routing and forwarding tables are created for the VRF instance named SOO_VRF. After associating the VRF with an interface, the interface is configured with an IP address.

SUMMARY STEPS

1. enable
2. configure terminal
3. ip cef
4. ip vrf vrf-name
5. rd route-distinguisher
6. route-target {export | both} route-target-ext-community
7. route-target {import | both} route-target-ext-community
8. exit
9. interface type number
10. ip vrf forwarding vrf-name [downstream vrf-name2]
11. ip address ip-address mask [secondary]
12. end
13. show ip vrf [brief | detail | interfaces | id] [vrf-name] [output-modifiers]

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> ip cef</td>
<td>Enables Cisco Express Forwarding on the route processor.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# ip cef</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Step 4</strong> ip vrf vrf-name</td>
<td>Defines a VRF instance and enters VRF configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config)# ip vrf SOO_VRF</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> rd route-distinguisher</td>
<td>Creates routing and forwarding tables for a VRF and specifies the default RD for a VPN.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config-vrf)# rd 1:1</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> route-target {export</td>
<td>both} route-target-ext-community</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config-vrf)# route-target export 1:1</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong> route-target {import</td>
<td>both} route-target-ext-community</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config-vrf)# route-target import 1:1</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong> exit</td>
<td>Exits VRF configuration mode and returns to global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Note** Only the syntax applicable to this step is displayed. For a different use of this syntax, see Step 7.

- Use the `route-distinguisher` argument to specify the default RD for a VPN. There are two formats that you can use to specify an RD:
  - A 16-bit autonomous system number, a colon, and a 32-bit number, for example: 65000:3
  - A 32-bit IP address, a colon, and a 16-bit number, for example: 192.168.1.2:51
  - In this example, the RD uses an autonomous system number with the number 1 after the colon.

- Use the `export` keyword to export routing information to the target VPN extended community.
- Use the `both` keyword to both import routing information from, and export routing information to, the target VPN extended community.
- Use the `route-target-ext-community` argument to specify the VPN extended community.
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device(config-vrf)# exit</td>
<td>Configures an interface type and enters interface configuration mode.</td>
</tr>
</tbody>
</table>

**Step 9**

**interface**  *type number*

**Example:**

Device(config)# interface GigabitEthernet 1/0/0

**Purpose:**

Associates a VRF with an interface or subinterface.

- In this example, the VRF named SOO_VRF is associated with Gigabit Ethernet interface 1/0/0.

**Note**

Executing this command on an interface removes the IP address, so the IP address should be reconfigured.

**Step 10**

**ip vrf forwarding**  *vrf-name* [downstream *vrf-name2*]

**Example:**

Device(config-if)# ip vrf forwarding SOO_VRF

**Purpose:**

Configures an IP address.

- In this example, Gigabit Ethernet interface 1/0/0 is configured with an IP address of 192.168.1.2.

**Step 11**

**ip address**  *ip-address mask* [secondary]

**Example:**

Device(config-if)# ip address 192.168.1.2 255.255.255.0

**Purpose:**

Exits interface configuration mode and returns to privileged EXEC mode.

**Step 12**

**end**

**Example:**

Device(config-if)# end

**Step 13**

**show ip vrf** [brief | detail | interfaces | id] [vrf-name] [output-modifiers]

**Example:**

Device# show ip vrf

**Purpose:**

Displays the configured VRFs.

- Use this command to verify the configuration of this task.

**Examples**

The following output of the **show ip vrf** command displays the VRF named SOO_VRF configured in this task.

```
Device# show ip vrf
Name                  Default RD  Interfaces
SOO_VRF               1:1            GE1/0/0
```

**Configuring a per Neighbor SoO Value Using a BGP Peer Policy Template**

Perform this task on router PE1 in the figure above to configure an SoO value for a BGP neighbor at the router CPE1 in the figure above using a peer policy template. In this task, a peer policy template is created, and the
SoO value is configured for the peer policy. Under address family IPv4 VRF, a neighbor is identified and is configured to inherit the peer policy that contains the SoO value.

If a BGP peer inherits from several peer policy templates that specify different SoO values, the SoO value in the last template applied takes precedence and is applied to the peer. However, direct configuration of the SoO value on the BGP neighbor overrides any inherited template configurations of the SoO value.

**Before you begin**

This task assumes that the task described in the Enabling Cisco Express Forwarding and Configuring VRF Instances, on page 656 has been performed.

---

**Note**

A BGP peer cannot inherit from a peer policy or session template and be configured as a peer group member at the same. BGP templates and BGP peer groups are mutually exclusive.

---

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `template peer-policy policy-template-name`
5. `soo extended-community-value`
6. `exit-peer-policy`
7. `address-family ipv4 [unicast | multicast | vrf vrf-name]`
8. `neighbor ip-address remote-as autonomous-system-number`
9. `neighbor ip-address activate`
10. `neighbor ip-address inherit peer-policy policy-template-name`
11. `end`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 <code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Router&gt; enable</code></td>
<td></td>
</tr>
<tr>
<td>Step 2 <code>configure terminal</code></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Router# configure terminal</code></td>
<td></td>
</tr>
<tr>
<td>Step 3 <code>router bgp autonomous-system-number</code></td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
</tbody>
</table>
### Purpose

**Command or Action**

- `Router(config)# router bgp 50000`

**Step 4**

**template peer-policy** `policy-template-name`

**Example:**

`Router(config-router)# template peer-policy SOO_POLICY`

**Step 5**

**soo** `extended-community-value`

**Example:**

`Router(config-router-ptmp)# soo 65000:1`

**Step 6**

**exit-peer-policy**

**Example:**

`Router(config-router-ptmp)# exit-peer-policy`

**Step 7**

**address-family ipv4** `[unicast | multicast] vrf vrf-name`

**Example:**

`Router(config-router)# address-family ipv4 vrf SOO_VRF`

**Step 8**

**neighbor** `ip-address remote-as autonomous-system-number`

**Example:**

`Router(config-router-af)# neighbor 192.168.1.1 remote-as 65000`

**Purpose**

- Creates a peer policy template and enters policy-template configuration mode.

- Sets the SoO value for a BGP peer policy template.
  - Use the `extended-community-value` argument to specify the VPN extended community value. The value takes one of the following formats:
    - A 16-bit autonomous system number, a colon, and a 32-bit number, for example: 45000:3
    - A 32-bit IP address, a colon, and a 16-bit number, for example: 192.168.10.2:51
    - In this example, the SoO value is set at 65000:1.

- Exits policy-template configuration mode and returns to router configuration mode.

- Specifies the IPv4 address family and enters address family configuration mode.
  - Use the `unicast` keyword to specify the IPv4 unicast address family. By default, the router is placed in configuration mode for the IPv4 unicast address family if the `unicast` keyword is not specified with the `address-family ipv4` command.
  - Use the `multicast` keyword to specify IPv4 multicast address prefixes.
  - Use the `vrf` keyword and `vrf-name` argument to specify the name of the VRF instance to associate with subsequent IPv4 address family configuration mode commands.

- Adds the IP address of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local router.
### Command or Action

<table>
<thead>
<tr>
<th>Step</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 9</strong></td>
<td>Enable the neighbor to exchange prefixes for the IPv4 VRF address family with the local router.</td>
</tr>
<tr>
<td>neighbor ip-address activate</td>
<td>Enables the neighbor to exchange prefixes for the IPv4 VRF address family with the local router.</td>
</tr>
<tr>
<td>Example: Router(config-router-af)# neighbor 192.168.1.1 activate</td>
<td>Enables the neighbor to exchange prefixes for the IPv4 VRF address family with the local router.</td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td>Sends a peer policy template to a neighbor so that the neighbor can inherit the configuration.</td>
</tr>
<tr>
<td>neighbor ip-address inherit peer-policy policy-template-name</td>
<td>Sends a peer policy template to a neighbor so that the neighbor can inherit the configuration.</td>
</tr>
<tr>
<td>Example: Router(config-router-af)# neighbor 192.168.1.1 inherit peer-policy SOO_POLICY</td>
<td>Sends a peer policy template to a neighbor so that the neighbor can inherit the configuration.</td>
</tr>
<tr>
<td><strong>Step 11</strong></td>
<td>Exits address family configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td>end</td>
<td>Exits address family configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Router(config-router-af)# end</td>
<td>Exits address family configuration mode and returns to privileged EXEC mode.</td>
</tr>
</tbody>
</table>

### Configuring a per Neighbor SoO Value Using a BGP neighbor Command

Perform this task on router PE2 in the figure above to configure an SoO value for the BGP neighbor at router CPE2 in the figure above using a neighbor command. For the IPv4 VRF address family, a neighbor is identified, and an SoO value is configured for the neighbor.

Direct configuration of the SoO value on a BGP neighbor overrides any inherited peer policy template configurations of the SoO value.

**Before you begin**

This task assumes that the task described in the “Verifying CEF and Configuring VRF Instances” section has been performed with appropriate changes to interfaces and IP addresses.

**SUMMARY STEPS**

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. address-family ipv4 [unicast | multicast] [vrfs vrf-name]
5. neighbor {ip-address | peer-group-name} remote-as autonomous-system-number
6. neighbor ip-address activate
7. neighbor {ip-address | peer-group-name} soo extended-community-value
8. end
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** enable | Enables privileged EXEC mode.  
Example:  
Device> enable  
- Enter your password if prompted. |
| **Step 2** configure terminal | Enters global configuration mode.  
Example:  
Device# configure terminal |
| **Step 3** router bgp autonomous-system-number | Enters router configuration mode for the specified routing process.  
Example:  
Device(config)# router bgp 50000 |
| **Step 4** address-family ipv4 [unicast | multicast | vrf vrf-name] | Specifies the IPv4 address family and enters address family configuration mode.  
Example:  
Device(config-router)# address-family ipv4 vrf SOO_VRF  
- Use the **unicast** keyword to specify the IPv4 unicast address family. By default, the router is placed in configuration mode for the IPv4 unicast address family if the **unicast** keyword is not specified with the **address-family ipv4** command.  
- Use the **multicast** keyword to specify IPv4 multicast address prefixes.  
- Use the **vrf** keyword and **vrf-name** argument to specify the name of the VRF instance to associate with subsequent IPv4 address family configuration mode commands. |
| **Step 5** neighbor {ip-address | peer-group-name} remote-as autonomous-system-number | Adds the IP address of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local router.  
Example:  
Device(config-router-af)# neighbor 192.168.2.1 remote-as 65000 |
| **Step 6** neighbor ip-address activate | Enables the neighbor to exchange prefixes for the IPv4 VRF address family with the local router.  
Example:  
Device(config-router-af)# neighbor 192.168.2.1 activate  
- In this example, the external BGP peer at 192.168.2.1 is activated. |
### Configuring a per Neighbor SoO Value Using a BGP Peer Group

Perform this task on router PE1 in the figure above to configure an SoO value for the BGP neighbor at router CPE1 in the figure above using a `neighbor` command with a BGP peer group. Under address family IPv4 VRF, a BGP peer group is created and an SoO value is configured using a BGP `neighbor` command, and a neighbor is then identified and added as a peer group member. A BGP peer group member inherits the configuration associated with a peer group, which in this example, includes the SoO value.

Direct configuration of the SoO value on a BGP neighbor overrides any inherited peer group configurations of the SoO value.

**Before you begin**

This task assumes that the task described in “Enabling Cisco Express Forwarding and Configuring VRF Instances” has been performed.

---

**Note**

A BGP peer cannot inherit from a peer policy or session template and be configured as a peer group member at the same. BGP templates and BGP peer groups are mutually exclusive.

### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `address-family ipv4 [unicast | multicast | vrf vrf-name]`
5. `neighbor peer-group-name peer-group`
6. `neighbor {ip-address | peer-group-name} soo extended-community-value`
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example: Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td>Example: Device(config)# router bgp 50000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> address-family ipv4 [unicast</td>
<td>multicast</td>
</tr>
<tr>
<td>Example: Device(config-router)# address-family ipv4 vrf SOO_VRF</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> neighbor peer-group-name peer-group</td>
<td>Creates a BGP peer group.</td>
</tr>
<tr>
<td>Example: Device(config-router-af)# neighbor SOO_group peer-group</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> neighbor {ip-address</td>
<td>peer-group-name} soo extended-community-value</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• In this example, the BGP peer group, SOO_group, is configured with an SoO value of 65000:1.</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>------------------</td>
<td>---------</td>
</tr>
<tr>
<td><code>Device(config-router-af)# neighbor SOO_group soo 65000:1</code></td>
<td>Adds the IP address of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local router.</td>
</tr>
</tbody>
</table>

**Step 7**
`neighbor ip-address remote-as autonomous-system-number`  
**Example:**  
`Device(config-router-af)# neighbor 192.168.1.1 remote-as 65000`

**Step 8**
`neighbor ip-address activate`  
**Example:**  
`Device(config-router-af)# neighbor 192.168.1.1 activate`

**Step 9**
`neighbor ip-address peer-group peer-group-name`  
**Example:**  
`Device(config-router-af)# neighbor 192.168.1.1 peer-group SOO_group`

**Step 10**
`end`  
**Example:**  
`Device(config-router-af)# end`

---

**Configuration Examples for BGP per Neighbor SoO Configuration**

**Example: Configuring a per Neighbor SoO Value Using a BGP Peer Policy Template**

The following example shows how to create a peer policy template and configure an SoO value as part of the peer policy. After enabling Cisco Express Forwarding and configuring a VRF instance named SOO_VRF, a peer policy template is created and an SoO value is configured as part of the peer policy. Under the IPv4 VRF address family, a neighbor is identified and configured to inherit the peer policy that contains the SoO value.

```
ip cef
ip vrf SOO_VRF
    rd 1:1
    route-target export 1:1
    route-target import 1:1
exit
interface GigabitEthernet 1/0/0
    ip vrf forwarding SOO_VRF
    ip address 192.168.1.2 255.255.255.0
exit
```

---

**IP Routing: BGP Configuration Guide, Cisco IOS XE 17**
Example: Configuring a per Neighbor SoO Value Using a BGP neighbor Command

The following example shows how to configure an SoO value for a BGP neighbor. After enabling Cisco Express Forwarding and configuring a VRF instance named SOO_VRF, a neighbor is identified in the IPv4 VRF address family and an SoO value is configured for the neighbor.

```
ip cef
ip vrf SOO_VRF
  rd 1:1
  route-target export 1:1
  route-target import 1:1
exit
interface GigabitEthernet 1/0/0
  ip vrf forwarding SOO_VRF
  ip address 192.168.2.2 255.255.255.0
exit
router bgp 50000
  address-family ipv4 vrf SOO_VRF
  neighbor 192.168.2.1 remote-as 65000
  neighbor 192.168.2.1 activate
  neighbor 192.168.2.1 soo 65000:1
end
```

Example: Configuring a per Neighbor SoO Value Using a BGP Peer Group

The following example shows how to configure an SoO value for a BGP peer group. After enabling Cisco Express Forwarding and configuring a VRF instance named SOO_VRF, a BGP peer group is configured in the IPv4 VRF address family, an SoO value is configured for the peer group, a neighbor is identified, and the neighbor is configured as a member of the peer group.

```
ip cef
ip vrf SOO_VRF
  rd 1:1
  route-target export 1:1
  route-target import 1:1
exit
interface GigabitEthernet 1/0/0
  ip vrf forwarding SOO_VRF
  ip address 192.168.1.2 255.255.255.0
exit
router bgp 50000
  address-family ipv4 vrf SOO_VRF
  neighbor SOO_GROUP peer-group
  neighbor SOO_GROUP soo 65000:65
  neighbor 192.168.1.1 remote-as 65000
  neighbor 192.168.1.1 activate
```
Where to Go Next

- To read an overview of BGP, proceed to the "Cisco BGP Overview" module.
- To perform basic BGP feature tasks, proceed to the "Configuring a Basic BGP Network" module.
- To perform advanced BGP feature tasks, proceed to the "Configuring Advanced BGP Features" module.
- To configure BGP neighbor session options, proceed to the "Configuring BGP Neighbor Session Options" module.
- To perform internal BGP tasks, proceed to the "Configuring Internal BGP Features" module.

Additional References

### Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
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</thead>
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<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
<tr>
<td>IP Switching commands</td>
<td>Cisco IOS IP Switching Command Reference</td>
</tr>
</tbody>
</table>

### MIBs

<table>
<thead>
<tr>
<th>MIB</th>
<th>MIBs Link</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
</tr>
</tbody>
</table>

### Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>
Feature Information for BGP per Neighbor SoO Configuration

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

**Table 57: Feature Information for BGP per Neighbor SoO Configuration**

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
</table>
| BGP per Neighbor SoO Configuration | Cisco IOS XE Release 2.1 | The BGP per neighbor SOO configuration feature simplifies the configuration of the site-of-origin (SoO) parameter. The per neighbor SoO configuration introduces two new commands that can be configured in submodes under router configuration mode to set the SoO value.  
This feature was introduced on the Cisco ASR 1000 Series Aggregation Services Routers.  
The following commands were introduced by this feature: `neighbor soo, soo`. |
The Per-VRF Assignment of BGP Router ID feature introduces the ability to have VRF-to-VRF peering in Border Gateway Protocol (BGP) on the same router. BGP is designed to refuse a session with itself because of the router ID check. The per-VRF assignment feature allows a separate router ID per VRF using a new keyword in the existing `bgp router-id` command. The router ID can be manually configured for each VRF or can be assigned automatically either globally under address family configuration mode or for each VRF.

- Finding Feature Information, on page 669
- Prerequisites for Per-VRF Assignment of BGP Router ID, on page 669
- Information About Per-VRF Assignment of BGP Router ID, on page 670
- How to Configure Per-VRF Assignment of BGP Router ID, on page 670
- Configuration Examples for Per-VRF Assignment of BGP Router ID, on page 686
- Additional References, on page 692
- Feature Information for Per-VRF Assignment of BGP Router ID, on page 693

### Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

### Prerequisites for Per-VRF Assignment of BGP Router ID

Before you configure this feature, Cisco Express Forwarding or distributed Cisco Express Forwarding must be enabled in the network, and basic BGP peering is assumed to be running in the network.
Information About Per-VRF Assignment of BGP Router ID

BGP Router ID

The BGP router identifier (ID) is a 4-byte field that is set to the highest IP address on the router. Loopback interface addresses are considered before physical interface addresses because loopback interfaces are more stable than physical interfaces. The BGP router ID is used in the BGP algorithm for determining the best path to a destination where the preference is for the BGP router with the lowest router ID. It is possible to manually configure the BGP router ID using the `bgp router-id` command to influence the best path algorithm.

Per-VRF Router ID Assignment

In Cisco IOS XE Release 2.1 and later releases, support for configuring separate router IDs for each Virtual Private Network (VPN) routing/forwarding (VRF) instance was introduced. The Per-VRF Assignment of BGP Router ID feature introduces the ability to have VRF-to-VRF peering in Border Gateway Protocol (BGP) on the same router. BGP is designed to refuse a session with itself because of the router ID check. The per-VRF assignment feature allows a separate router ID per VRF using a new keyword in the existing `bgp router-id` command. The router ID can be manually configured for each VRF or can be assigned automatically either globally under address family configuration mode or for each VRF.

Route Distinguisher

A route distinguisher (RD) creates routing and forwarding tables and specifies the default route distinguisher for a VPN. The RD is added to the beginning of an IPv4 prefix to change it into a globally unique VPN-IPv4 prefix. An RD can be composed in one of two ways: with an autonomous system number and an arbitrary number or with an IP address and an arbitrary number.

You can enter an RD in either of these formats:

- Enter a 16-bit autonomous system number, a colon, and a 32-bit number. For example:
  45000:3
- Enter a 32-bit IP address, a colon, and a 16-bit number. For example:
  192.168.10.15:1

How to Configure Per-VRF Assignment of BGP Router ID

Configuring VRF Instances

Perform this task to configure VRF instances to be used with the per-VRF assignment tasks. In this task, a VRF instance named vrf_trans is created. To make the VRF functional, a route distinguisher is created. When the route distinguisher is created, the routing and forwarding tables are created for the VRF instance named vrf_trans.
Before you begin

This task assumes that you have Cisco Express Forwarding or distributed Cisco Express Forwarding enabled.

SUMMARY STEPS

1. enable
2. configure terminal
3. ip vrf vrf-name
4. rd route-distinguisher
5. route-target {import | both} route-target-ext-community
6. route-target {export | both} route-target-ext-community
7. exit
8. Repeat Step 3 through Step 7 for each VRF to be defined.

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** enable | Enables privileged EXEC mode.  
| Example: Router> enable | • Enter your password if prompted. |
| **Step 2** configure terminal | Enters global configuration mode. |
| Example: Router# configure terminal | |
| **Step 3** ip vrf vrf-name | Defines a VRF instance and enters VRF configuration mode. |
| Example: Router(config)# ip vrf vrf_trans | |
| **Step 4** rd route-distinguisher | Creates routing and forwarding tables for a VRF and specifies the default RD for a VPN.  
| Example: Router(config-vrf)# rd 45000:2 | • Use the route-distinguisher argument to specify the default RD for a VPN. There are two formats you can use to specify an RD. For more details, see the "Route Distinguisher" section.  
| | • In this example, the RD uses an autonomous system number with the number 2 after the colon. |
| **Step 5** route-target {import | both} route-target-ext-community | Creates a route-target extended community for a VRF.  
| Example: Router(config-vrf)# route-target import 55000:5 | • Use the import keyword to import routing information from the target VPN extended community. |
### Purpose

- Use the `both` keyword to both import routing information from and export routing information to the target VPN extended community.
- Use the `route-target-ext-community` argument to specify the VPN extended community.

### Step 6

**Command or Action:**
- `route-target {export | both} route-target-ext-community`

**Example:**
- `Router(config-vrf)# route-target export 55000:1`

**Purpose:**
- Creates a route-target extended community for a VRF.
- Use the `export` keyword to export routing information to the target VPN extended community.
- Use the `both` keyword to both import routing information from and export routing information to the target VPN extended community.
- Use the `route-target-ext-community` argument to specify the VPN extended community.

### Step 7

**Command or Action:**
- `exit`

**Example:**
- `Router(config-vrf)# exit`

**Purpose:**
- Exits VRF configuration mode and returns to global configuration mode.

### Step 8

Repeat Step 3 through Step 7 for each VRF to be defined.

---

### Associating VRF Instances with Interfaces

Perform this task to associate VRF instances with interfaces to be used with the per-VRF assignment tasks. In this task, a VRF instance named `vrf_trans` is associated with a serial interface.

Make a note of the IP addresses for any interface to which you want to associate a VRF instance because the `ip vrf forwarding` command removes the IP address. Step 8 allows you to reconfigure the IP address.

#### Before you begin

- This task assumes that you have Cisco Express Forwarding or distributed Cisco Express Forwarding enabled.
- This task assumes that VRF instances have been configured in the [Configuring VRF Instances, on page 670](#).

#### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `interface type number`
4. `ip address ip-address mask [secondary]`
5. `exit`
6. `interface type number`

7. `ip vrf forwarding vrf-name [downstream vrf-name2]`

8. `ip address ip-address mask [secondary]`

9. Repeat Step 5 through Step 8 for each VRF to be associated with an interface.

10. `end`

11. `show ip vrf [brief | detail | interfaces | id] [vrf-name]`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Router&gt; enable</code></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Router# configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> interface type number</td>
<td>Configures an interface type and enters interface configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Router(config)# interface loopback0</code></td>
<td>• In this example, loopback interface 0 is configured.</td>
</tr>
<tr>
<td><strong>Step 4</strong> ip address ip-address mask [secondary]</td>
<td>Configures an IP address.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Router(config-if)# ip address 172.16.1.1 255.255.255.255</code></td>
<td>• In this example, the loopback interface is configured with an IP address of 172.16.1.1.</td>
</tr>
<tr>
<td><strong>Step 5</strong> exit</td>
<td>Exits interface configuration mode and returns to global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Router(config-if)# exit</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> interface type number</td>
<td>Configures an interface type and enters interface configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Router(config)# interface serial2/0/0</code></td>
<td>• In this example, serial interface 2/0/0 is configured.</td>
</tr>
<tr>
<td><strong>Step 7</strong> ip vrf forwarding vrf-name [downstream vrf-name2]</td>
<td>Associates a VRF with an interface or subinterface.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Router(config-if)# ip vrf forwarding vrf_trans</code></td>
<td>• In this example, the VRF named vrf_trans is associated with serial interface 2/0/0.</td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td>Executing this command on an interface removes the IP address. The IP address should be reconfigured.</td>
</tr>
<tr>
<td>Step</td>
<td>Command or Action</td>
</tr>
<tr>
<td>------</td>
<td>-------------------</td>
</tr>
</tbody>
</table>
| 8    | `ip address ip-address mask [secondary]` | Configures an IP address.  
  - In this example, serial interface 2/0/0 is configured with an IP address of 192.168.4.1. |
| 9    | Repeat Step 5 through Step 8 for each VRF to be associated with an interface. | -- |
| 10   | `end` | Exits interface configuration mode and returns to privileged EXEC mode. |
| 11   | `show ip vrf [brief | detail | interfaces | id] [vrf-name]` | (Optional) Displays the set of defined VRFs and associated interfaces.  
  - In this example, the output from this command shows the VRFs that have been created and their associated interfaces. |

**Examples**

The following output shows that two VRF instances named vrf_trans and vrf_users were configured on two serial interfaces.

```
Router# show ip vrf interfaces
Interface      IP-Address VRF  Protocol
Serial2      192.168.4.1   vrf_trans  up
Serial3      192.168.5.1   vrf_user   up
```

**Manually Configuring a BGP Router ID per VRF**

Perform this task to manually configure a BGP router ID for each VRF. In this task, several address family configurations are shown and the router ID is configured in the IPv4 address family mode for one VRF instance. Step 22 shows you how to repeat certain steps to permit the configuration of more than one VRF on the same router.

**Before you begin**

This task assumes that you have previously created the VRF instances and associated them with interfaces. For more details, see the Configuring VRF Instances, on page 670 and the Associating VRF Instances with Interfaces, on page 672.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `no bgp default ipv4-unicast`
5. `bgp log-neighbor-changes`
6. `neighbor {ip-address|peer-group-name} remote-as autonomous-system-number`
7. `neighbor {ip-address|peer-group-name} update-source interface-type interface-number`
8. `address-family {ipv4 [mdt | multicast | unicast [vrf vrf-name] | vrf vrf-name] | vpnv4 [unicast]}`
9. `neighbor {ip-address|peer-group-name} activate`
10. `neighbor {ip-address|peer-group-name} send-community {both | standard | extended}`
11. `exit-address-family`
12. `address-family {ipv4 [mdt | multicast | unicast [vrf vrf-name] | vrf vrf-name] | vpnv4 [unicast]}`
13. `redistribute connected`
14. `neighbor {ip-address|peer-group-name} remote-as autonomous-system-number`
15. `neighbor ip-address local-as autonomous-system-number [no-prepend [replace-as [dual-as]]]`
16. `neighbor {ip-address|peer-group-name} ebgp-multihop[ttl]`
17. `neighbor {ip-address|peer-group-name} activate`
18. `neighbor ip-address allowas-in [number]`
19. `no auto-summary`
20. `no synchronization`
21. `bgp router-id {ip-address|auto-assign}`
22. Repeat Step 11 to Step 21 to configure another VRF instance.
23. `end`
24. `show ip bgp vpnv4 {all | rd route-distinguisher | vrf vrf-name}`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td><code>Router&gt; enable</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td><code>Router# configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td><code>Router(config)# router bgp 45000</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> no bgp default ipv4-unicast</td>
<td>Disables the IPv4 unicast address family for the BGP routing process.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Router(config-router)# no bgp default ipv4-unicast</td>
<td>Routing information for the IPv4 unicast address family is advertised by default for each BGP routing session configured with the <code>neighbor remote-as</code> router configuration command unless you configure the <code>no bgp default ipv4-unicast</code> router configuration command before configuring the <code>neighbor remote-as</code> command. Existing neighbor configurations are not affected.</td>
</tr>
</tbody>
</table>

**Step 5**

**bgp log-neighbor-changes**

**Example:**

Router(config-router)# bgp log-neighbor-changes

Enables logging of BGP neighbor resets.

**Step 6**

**neighbor {ip-address|peer-group-name} remote-as autonomous-system-number**

**Example:**

Router(config-router)# neighbor 192.168.1.1 remote-as 45000

Adds the IP address or peer group name of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local router.

- If the `autonomous-system-number` argument matches the autonomous system number specified in the `router bgp` command, the neighbor is an internal neighbor.
- If the `autonomous-system-number` argument does not match the autonomous system number specified in the `router bgp` command, the neighbor is an external neighbor.
- In this example, the neighbor is an internal neighbor.

**Step 7**

**neighbor {ip-address|peer-group-name} update-source interface-type interface-number**

**Example:**

Router(config-router)# neighbor 192.168.1.1 update-source loopback0

Allows BGP sessions to use any operational interface for TCP connections.

- In this example, BGP TCP connections for the specified neighbor are sourced with the IP address of the loopback interface rather than the best local address.

**Step 8**

**address-family {ipv4 [mdt | multicast | unicast [vrf vrf-name] | vrf vrf-name] | vpnv4 [unicast]}**

**Example:**

Router(config-router)# address-family vpnv4

Enters address family configuration mode to configure BGP peers to accept address-family-specific configurations.

- The example creates a VPNv4 address family session.

**Step 9**

**neighbor {ip-address|peer-group-name} activate**

**Example:**

Router(config-router-af)# neighbor 172.16.1.1 activate

Activates the neighbor under the VPNv4 address family.

- In this example, the neighbor 172.16.1.1 is activated.
### Purpose

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 10</strong></td>
<td>neighbor {ip-address</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router(config-router-af)# neighbor 172.16.1.1 send-community extended</td>
</tr>
<tr>
<td><strong>Step 11</strong></td>
<td>exit-address-family</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router(config-router-af)# exit-address-family</td>
</tr>
<tr>
<td><strong>Step 12</strong></td>
<td>address-family {ipv4 [mdt</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router(config-router)# address-family ipv4 vrf vrf_trans</td>
</tr>
<tr>
<td><strong>Step 13</strong></td>
<td>redistribute connected</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router(config-router-af)# redistribute connected</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 14</strong></td>
<td>neighbor {ip-address</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router(config-router-af)# neighbor 192.168.1.1 remote-as 40000</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 15</strong></td>
<td>neighbor ip-address local-as autonomous-system-number [no-prepend [replace-as [dual-as]]]</td>
</tr>
</tbody>
</table>
### Command or Action

**Example:**

```bash
Router(config-router-af)# neighbor 192.168.1.1 local-as 50000 no-prepend
```

**Purpose**

- The autonomous system number from the local BGP routing process is prepended to all external routes by default.
- Use the `no-prepend` keyword to not prepend the local autonomous system number to any routes received from the eBGP neighbor.
- In this example, routes from the neighbor at 192.168.1.1 will not contain the local autonomous system number.

**Step 16**

- `neighbor {ip-address|peer-group-name} ebgp-multihop[ttl]`
- **Example:**

  ```bash
  Router(config-router-af)# neighbor 192.168.1.1 ebgp-multihop 2
  ```

  **Accepts and attempts BGP connections to external peers residing on networks that are not directly connected.**

  - In this example, BGP is configured to allow connections to or from neighbor 192.168.1.1, which resides on a network that is not directly connected.

**Step 17**

- `neighbor {ip-address|peer-group-name} activate`
- **Example:**

  ```bash
  Router(config-router-af)# neighbor 192.168.1.1 activate
  ```

  **Activates the neighbor under the IPV4 address family.**

  - In this example, the neighbor 192.168.1.1 is activated.

**Step 18**

- `neighbor ip-address allowas-in [number]`
- **Example:**

  ```bash
  Router(config-router-af)# neighbor 192.168.1.1 allowas-in 1
  ```

  **Configures provider edge (PE) routers to allow the readvertisement of all prefixes that contain duplicate autonomous system numbers.**

  - In the example, the PE router with autonomous system number 45000 is configured to allow prefixes from the VRF vrf-trans. The neighboring PE router with the IP address 192.168.1.1 is set to be readvertised once to other PE routers with the same autonomous system number.

**Step 19**

- `no auto-summary`
- **Example:**

  ```bash
  Router(config-router-af)# no auto-summary
  ```

  **Disables automatic summarization and sends subprefix routing information across classful network boundaries.**

**Step 20**

- `no synchronization`
- **Example:**

  ```bash
  Router(config-router-af)# no synchronization
  ```

  **Enables the Cisco IOS XE software to advertise a network route without waiting for synchronization with an Internal Gateway Protocol (IGP).**

**Step 21**

- `bgp router-id {ip-address|auto-assign}`
- **Example:**

  ```bash
  Router(config-router-af)# bgp router-id auto-assign
  ```

  **Configures a fixed router ID for the local BGP routing process.**
### Command or Action

<table>
<thead>
<tr>
<th>Step 22</th>
<th>Repeat Step 11 to Step 21 to configure another VRF instance.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 23</td>
<td><strong>end</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td></td>
<td>Router(config-router-af)# end</td>
</tr>
<tr>
<td>Step 24</td>
<td>**show ip bgp vpnv4 {all</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td></td>
<td>Router# show ip bgp vpnv4 all</td>
</tr>
</tbody>
</table>

### Purpose

- In this example, the specified BGP router ID is assigned for the VRF instance associated with this IPv4 address family configuration.
- Exits address family configuration mode and returns to privileged EXEC mode.
- In this example, the complete VPNv4 database is displayed.
- Only the syntax applicable to this task is used in this example. For more details, see the Cisco IOS Multiprotocol Label Switching Command Reference.

### Examples

The following sample output assumes that two VRF instances named vrf_trans and vrf_user were configured each with a separate router ID. The router ID is shown next to the VRF name.

```
Router# show ip bgp vpnv4 all
BGP table version is 5, local router ID is 172.17.1.99
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete
Network Next Hop Metric LocPrf Weight Path
Route Distinguisher: 1:1 (default for vrf vrf_trans) VRF Router ID 10.99.1.2
  *> 192.168.4.0 0.0.0.0 0 32768 ?
Route Distinguisher: 42:1 (default for vrf vrf_user) VRF Router ID 10.99.1.1
  *> 192.168.5.0 0.0.0.0 0 32768 ?
```

### Automatically Assigning a BGP Router ID per VRF

Perform this task to automatically assign a BGP router ID for each VRF. In this task, a loopback interface is associated with a VRF and the **bgp router-id** command is configured at the router configuration level to automatically assign a BGP router ID to all VRF instances. Step 9 shows you how to repeat certain steps to configure each VRF that is to be associated with an interface. Step 30 shows you how to configure more than one VRF on the same router.
Before you begin
This task assumes that you have previously created the VRF instances. For more details, see the Configuring VRF Instances, on page 670.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `interface type number`
4. `ip address ip-address mask [secondary]`
5. `exit`
6. `interface type number`
7. `ip vrf forwarding vrf-name [downstream vrf-name2]`
8. `ip address ip-address mask [secondary]`
9. Repeat Step 5 through Step 8 for each VRF to be associated with an interface.
10. `exit`
11. `router bgp autonomous-system-number`
12. `bgp router-id {ip-address|vrf auto-assign}`
13. `no bgp default ipv4-unicast`
14. `bgp log-neighbor-changes`
15. `neighbor {ip-address|peer-group-name} remote-as autonomous-system-number`
16. `neighbor {ip-address|peer-group-name} update-source interface-type interface-number`
17. `address-family {ipv4 [mdt | multicast | unicast [vrf vrf-name] | vrf vrf-name] | vpnv4 [unicast]}`
18. `neighbor {ip-address|peer-group-name} activate`
19. `neighbor {ip-address|peer-group-name} send-community {both|standard|extended}`
20. `exit-address-family`
21. `address-family {ipv4 [mdt | multicast | unicast [vrf vrf-name] | vrf vrf-name] | vpnv4 [unicast]}`
22. `redistribute connected`
23. `neighbor {ip-address|peer-group-name} remote-as autonomous-system-number`
24. `neighbor ip-address local-as autonomous-system-number [no-prepend {replace-as [dual-as]}]`
25. `neighbor {ip-address|peer-group-name} ebgp-multihop[ttl]`
26. `neighbor {ip-address|peer-group-name} activate`
27. `neighbor ip-address allowas-in [number]`
28. `no auto-summary`
29. `no synchronization`
30. Repeat Step 20 to Step 29 to configure another VRF instance.
31. `end`
32. `show ip bgp vpnv4 {all | rd route-distinguisher | vrf vrf-name}`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Router&gt; enable</td>
<td>Enters global configuration mode.</td>
</tr>
</tbody>
</table>

**Step 2**

configure terminal  
Example:  
Router# configure terminal

**Step 3**

interface type number  
Example:  
Router(config)# interface loopback0

**Step 4**

ip address ip-address mask [secondary]  
Example:  
Router(config-if)# ip address 172.16.1.1 255.255.255.255

**Step 5**

exit  
Example:  
Router(config-if)# exit

**Step 6**

interface type number  
Example:  
Router(config)# interface loopback1

**Step 7**

ip vrf forwarding vrf-name [downstream vrf-name2]  
Example:  
Router(config-if)# ip vrf forwarding vrf_trans  
**Note** Executing this command on an interface removes the IP address. The IP address should be reconfigured.

**Step 8**

ip address ip-address mask [secondary]  
Example:  
Router(config-if)# ip address 10.99.1.1 255.255.255.255

**Step 9**

Repeat Step 5 through Step 8 for each VRF to be associated with an interface.

**Step 10**

exit  
Example:  
Exits interface configuration mode and returns to global configuration mode.
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>router bgp 45000</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td>bgp router-id vrf auto-assign</td>
<td>Configures a fixed router ID for the local BGP routing process.</td>
</tr>
<tr>
<td>no bgp default ipv4-unicast</td>
<td>Disables the IPv4 unicast address family for the BGP routing process.</td>
</tr>
<tr>
<td>bgp log-neighbor-changes</td>
<td>Enables logging of BGP neighbor resets.</td>
</tr>
<tr>
<td>neighbor 192.168.1.1 remote-as 45000</td>
<td>Adds the IP address or peer group name of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local router.</td>
</tr>
<tr>
<td>neighbor update-source interface-type interface-number</td>
<td>Allows BGP sessions to use any operational interface for TCP connections.</td>
</tr>
</tbody>
</table>
### Command or Action

#### Example:

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td><code>Router(config-router)# neighbor 192.168.1.1 update-source loopback0</code></td>
<td>In this example, BGP TCP connections for the specified neighbor are sourced with the IP address of the loopback interface rather than the best local address.</td>
</tr>
</tbody>
</table>

#### Step 17

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>`address-family {ipv4 [mdt</td>
<td>multicast</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td><code>Router(config-router)# address-family vpnv4</code></td>
<td>The example creates a VPNv4 address family session.</td>
</tr>
</tbody>
</table>

#### Step 18

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>`neighbor {ip-address</td>
<td>peer-group-name} activate`</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td><code>Router(config-router-af)# neighbor 172.16.1.1 activate</code></td>
<td>In this example, the neighbor 172.16.1.1 is activated.</td>
</tr>
</tbody>
</table>

#### Step 19

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>`neighbor {ip-address</td>
<td>peer-group-name} send-community {both</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td><code>Router(config-router-af)# neighbor 172.16.1.1 send-community extended</code></td>
<td>In this example, an extended communities attribute is sent to the neighbor at 172.16.1.1.</td>
</tr>
</tbody>
</table>

#### Step 20

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>exit-address-family</code></td>
<td>Exits address family configuration mode and returns to router configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td><code>Router(config-router-af)# exit-address-family</code></td>
<td></td>
</tr>
</tbody>
</table>

#### Step 21

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>`address-family {ipv4 [mdt</td>
<td>multicast</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td><code>Router(config-router)# address-family ipv4 vrf vrf_trans</code></td>
<td>The example specifies that the VRF instance named vrf_trans is to be associated with subsequent IPv4 address family configuration mode commands.</td>
</tr>
</tbody>
</table>

#### Step 22

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>redistribute connected</code></td>
<td>Redistributes from one routing domain into another routing domain.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td><code>Router(config-router-af)# redistribute connected</code></td>
<td>In this example, the connected keyword is used to represent routes that are established automatically when IP is enabled on an interface.</td>
</tr>
<tr>
<td></td>
<td>Only the syntax applicable to this step is displayed. For more details, see the Cisco IOS IP Routing: BGP Command Reference.</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Step 23</strong></td>
<td><strong>neighbor</strong> <code>ip-address</code> <code>peer-group-name</code> <strong>remote-as</strong> <code>autonomous-system-number</code></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router(config-router-af)# neighbor 192.168.1.1 remote-as 40000</td>
<td>Adds the IP address or peer group name of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local router.</td>
</tr>
<tr>
<td></td>
<td>• If the <code>autonomous-system-number</code> argument matches the autonomous system number specified in the <code>router bgp</code> command, the neighbor is an internal neighbor.</td>
</tr>
<tr>
<td></td>
<td>• If the <code>autonomous-system-number</code> argument does not match the autonomous system number specified in the <code>router bgp</code> command, the neighbor is an external neighbor.</td>
</tr>
<tr>
<td></td>
<td>• In this example, the neighbor at 192.168.1.1 is an external neighbor.</td>
</tr>
<tr>
<td><strong>Step 24</strong></td>
<td><strong>neighbor</strong> <code>ip-address</code> <strong>local-as</strong> <code>autonomous-system-number</code> <code>no-prepend</code> <code>[replace-as [dual-as]]</code></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router(config-router-af)# neighbor 192.168.1.1 local-as 50000 no-prepend</td>
<td>Customizes the AS_PATH attribute for routes received from an eBGP neighbor.</td>
</tr>
<tr>
<td></td>
<td>• The autonomous system number from the local BGP routing process is prepended to all external routes by default.</td>
</tr>
<tr>
<td></td>
<td>• Use the <code>no-prepend</code> keyword to not prepend the local autonomous system number to any routes received from the eBGP neighbor.</td>
</tr>
<tr>
<td></td>
<td>• In this example, routes from the neighbor at 192.168.1.1 will not contain the local autonomous system number.</td>
</tr>
<tr>
<td><strong>Step 25</strong></td>
<td><strong>neighbor</strong> <code>ip-address</code> <code>peer-group-name</code> <strong>ebgp-multihop</strong> <code>[ttl]</code></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router(config-router-af)# neighbor 192.168.1.1 ebgp-multihop 2</td>
<td>Accepts and attempts BGP connections to external peers residing on networks that are not directly connected.</td>
</tr>
<tr>
<td></td>
<td>• In this example, BGP is configured to allow connections to or from neighbor 192.168.1.1, which resides on a network that is not directly connected.</td>
</tr>
<tr>
<td><strong>Step 26</strong></td>
<td><strong>neighbor</strong> <code>ip-address</code> <code>peer-group-name</code> <strong>activate</strong></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router(config-router-af)# neighbor 192.168.1.1 activate</td>
<td>Activates the neighbor under the IPV4 address family.</td>
</tr>
<tr>
<td></td>
<td>• In this example, the neighbor 192.168.1.1 is activated.</td>
</tr>
<tr>
<td><strong>Step 27</strong></td>
<td><strong>neighbor</strong> <code>ip-address</code> <strong>allowas-in</strong> <code>[number]</code></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router(config-router-af)# neighbor 192.168.1.1 allowas-in 1</td>
<td>Configures provider edge (PE) routers to allow the readvertisement of all prefixes that contain duplicate autonomous system numbers.</td>
</tr>
<tr>
<td></td>
<td>• In the example, the PE router with autonomous system number 45000 is configured to allow prefixes from the VRF vrf-trans. The neighboring PE router with</td>
</tr>
</tbody>
</table>
### Purpose

The IP address 192.168.1.1 is set to be readvertised once to other PE routers with the same autonomous system number.

**Step 28**

**no auto-summary**

**Example:**

Router(config-router-af)# no auto-summary

Disables automatic summarization and sends subprefix routing information across classful network boundaries.

**Step 29**

**no synchronization**

**Example:**

Router(config-router-af)# no synchronization

Enables the Cisco IOS XE software to advertise a network route without waiting for synchronization with an Internal Gateway Protocol (IGP).

**Step 30**

Repeat Step 20 to Step 29 to configure another VRF instance.

**Step 31**

**end**

**Example:**

Router(config-router-af)# end

Exits address family configuration mode and returns to privileged EXEC mode.

**Step 32**

**show ip bgp vpnv4 {all | rd route-distinguisher | vrf vrf-name}**

**Example:**

Router# show ip bgp vpnv4 all

(Optional) Displays VPN address information from the BGP table.

- In this example, the complete VPNv4 database is displayed.

**Note**

Only the syntax applicable to this task is used in this example. For more details, see the *Cisco IOS Multiprotocol Label Switching Command Reference*.

#### Examples

The following sample output assumes that two VRF instances named vrf_trans and vrf_user were configured, each with a separate router ID. The router ID is shown next to the VRF name.

```
Router# show ip bgp vpnv4 all
BGP table version is 43, local router ID is 172.16.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

Network       Next Hop        Metric LocPrf Weight Path
Route Distinguisher: 1:1 (default for vrf vrf_trans) VRF Router ID 10.99.1.2
*> 172.22.0.0       0.0.0.0         0            32768 ?
r> 172.23.0.0    172.23.1.1       0            0 3 1 ?
*>110.21.1.1/32 192.168.3.1       0          100 0 2 1
*>10.52.1.0/24 172.23.1.1       0          0 3 1 ?
*>10.52.2.1/32 172.23.1.1       0          0 3 1 3 1
```
Configuration Examples for Per-VRF Assignment of BGP Router ID

Manually Configuring a BGP Router ID per VRF Examples

The following example shows how to configure two VRFs—vrf_trans and vrf_user—with sessions between each other on the same router. The BGP router ID for each VRF is configured manually under separate IPv4 address families. The `show ip bgp vpnv4` command can be used to verify that the router IDs have been configured for each VRF. The configuration starts in global configuration mode.

```
ip vrf vrf_trans
   rd 45000:1
   route-target export 50000:50
   route-target import 40000:1
!
ip vrf vrf_user
   rd 65500:1
   route-target export 65500:1
   route-target import 65500:1
!
interface Loopback0
   ip address 10.1.1.1 255.255.255.255
!
routing bgp 45000
   no bgp default ipv4-unicast
   bgp log-neighbor-changes
   neighbor 192.168.3.1 remote-as 45000
   neighbor 192.168.3.1 update-source Loopback0
!
address-family vpnv4
   neighbor 192.168.3.1 activate
   neighbor 192.168.3.1 send-community extended
   exit-address-family
!
address-family ipv4 vrf vrf_user
   redistribute connected
   neighbor 172.22.1.1 remote-as 40000
   neighbor 172.22.1.1 local-as 50000 no-prepend
   neighbor 172.22.1.1 ebgp-multihop 2
   neighbor 172.22.1.1 activate
   neighbor 172.22.1.1 allowas-in 1
```
After the configuration, the output of the `show ip bgp vpnv4 all` command shows the router ID displayed next to the VRF name:

```
Router# show ip bgp vpnv4 all
BGP table version is 43, local router ID is 10.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

Network       Next Hop         Metric LocPrf Weight Path
Route Distinguisher: 45000:1 (default for vrf vrf_trans) VRF Router ID 10.99.1.2
*> 172.22.0.0          0.0.0.0         0              32768 ?
r> 172.23.0.0          172.23.1.1       0              0 3 1 ?
*>110.21.1.1/32        192.168.3.1       0              100 0 2 i
*> 10.52.1.0/24        172.23.1.1       0              0 3 1 ?
*> 10.52.2.1/32        172.23.1.1       0              0 3 1 3 i
*> 10.52.3.1/32        172.23.1.1       0              0 3 1 3 i
*> 10.99.1.1/32        172.23.1.1       0              0 3 1 ?
*> 10.99.2.2/32        0.0.0.0          0              32768 ?
Route Distinguisher: 50000:1
*>110.21.1.1/32        192.168.3.1       0              100 0 2 i
Route Distinguisher: 65500:1 (default for vrf vrf_user) VRF Router ID 10.99.1.1
r> 172.22.0.0          172.22.1.1       0              0 2 i ?
*> 172.23.0.0          0.0.0.0          0              32768 ?
*>10.21.1.1/32         172.22.1.1       0              0 2 1 2 i
*>110.52.1.0/24        192.168.3.1       0              100 0 ?
*>110.52.2.1/32        192.168.3.1       0              100 0 3 i
*>110.52.3.1/32        192.168.3.1       0              100 0 3 i
*> 10.99.1.1/32        0.0.0.0          0              32768 ?
*> 10.99.2.2/32        172.22.1.1       0              0 2 i ?
```

The output of the `show ip bgp vpnv4 vrf vrf_user` command for a specified VRF displays the router ID in the output header:

```
Router# show ip bgp vpnv4 vrf vrf_user
BGP table version is 43, local router ID is 10.99.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

Network       Next Hop         Metric LocPrf Weight Path
Route Distinguisher: 65500:1 (default for vrf vrf_user) VRF Router ID 10.99.1.1
r> 172.22.0.0          172.22.1.1       0              0 2 i ?
*> 172.23.0.0          0.0.0.0          0              32768 ?
*> 10.21.1.1/32         172.22.1.1       0              0 2 1 2 i
*>110.52.1.0/24        192.168.3.1       0              100 0 ?
*>110.52.2.1/32        192.168.3.1       0              100 0 3 i
*>110.52.3.1/32        192.168.3.1       0              100 0 3 i
```
The output of the `show ip bgp vpnv4 vrf summary` command for a specified VRF displays the router ID in the first line of the output:

```
Router# show ip bgp vpnv4 vrf vrf_user summary
BGP router identifier 10.99.1.1, local AS number 45000
BGP table version is 43, main routing table version 43
8 network entries using 1128 bytes of memory
8 path entries using 544 bytes of memory
16/10 BGP path/bestpath attribute entries using 1856 bytes of memory
6 BGP AS-PATH entries using 144 bytes of memory
3 BGP extended community entries using 72 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 3744 total bytes of memory
BGP activity 17/0 prefixes, 17/0 paths, scan interval 15 secs
Neighbor   V  AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd
172.22.1.1 4  2  20  21   43  0  0 00:12:33 3
```

When the path is sourced in the VRF, the correct router ID is displayed in the output of the `show ip bgp vpnv4 vrf` command for a specified VRF and network address:

```
Router# show ip bgp vpnv4 vrf vrf_user 172.23.0.0
BGP routing table entry for 65500:1:172.23.0.0/8, version 22
Paths: (1 available, best #1, table vrf_user)
Advertised to update-groups:
    2
    3
Local
    0.0.0.0 from 0.0.0.0 (10.99.1.1)
    Origin incomplete, metric 0, localpref 100, weight 32768, valid, sourced, best
    Extended Community: RT:65500:1
```

### Automatically Assigning a BGP Router ID per VRF Examples

The following three configuration examples show different methods of configuring BGP to automatically assign a separate router ID to each VRF instance:

#### Globally Automatically Assigned Router ID Using Loopback Interface IP Addresses Example

The following example shows how to configure two VRFs--vrf_trans and vrf_user--with sessions between each other on the same router. Under router configuration mode, BGP is globally configured to automatically assign each VRF a BGP router ID. Loopback interfaces are associated with individual VRFs to source an IP address for the router ID. The `show ip bgp vpnv4` command can be used to verify that the router IDs have been configured for each VRF.

```bash
ip vrf vrf_trans
d 45000:1
route-target export 50000:50
route-target import 40000:1
!
ip vrf vrf_user
d 65500:1
route-target export 65500:1
route-target import 65500:1
!
interface Loopback0
```
Router# show ip bgp vpnv4 all
BGP table version is 43, local router ID is 10.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
 r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete
Network Next Hop Metric LocPrf Weight Path
Route Distinguisher: 45000:1 (default for vrf vrf_trans) VRF Router ID 10.99.2.2
* 172.22.0.0 0.0.0.0 0 32768 ?
r 172.23.0.0 172.23.1.1 0 0 3 1 ?
* 10.21.1.1/32 192.168.3.1 0 100 0 2 1
* 10.52.1.0/24 172.23.1.1 0 3 1 ?
* 10.52.2.1/32 172.23.1.1 0 3 1 3 1
* 10.52.3.1/32 172.23.1.1 0 3 1 3 1
* 10.99.1.1/32 172.23.1.1 0 3 1 ?

After the configuration, the output of the show ip bgp vpnv4 all command shows the router ID displayed next to the VRF name. Note that the router IDs used in this example are sourced from the IP addresses configured for loopback interface 1 and loopback interface 2. The router IDs are the same as in the Manually Configuring a BGP Router ID per VRF Examples, on page 686.
Globally Automatically Assigned Router ID with No Default Router ID Example

The following example shows how to configure a router and associate a VRF that is automatically assigned a BGP router ID when no default router ID is allocated.

```
ip vrf vpn1
  rd 45000:1
  route-target export 45000:1
  route-target import 45000:1
!
interface Loopback0
  ip vrf forwarding vpn1
  ip address 10.1.1.1 255.255.255.255
!
routerr bgp 45000
  bgp router-id vrf auto-assign
  no bgp default ipv4-unicast
  bgp log-neighbor-changes
!
address-family ipv4 vrf vpn1
  neighbor 172.22.1.2 remote-as 40000
  neighbor 172.22.1.2 activate
  no auto-summary
  no synchronization
  exit-address-family
```

Assuming that a second router is configured to establish a session between the two routers, the output of the `show ip interface brief` command shows only the VRF interfaces that are configured.

```
Router# show ip interface brief
Interface     IP-Address OK? Method Status              Protocol
Serial2/0/0   unassigned YES NVRAM administratively down down
Serial3/0/0   unassigned YES NVRAM administratively down down
Loopback0     10.1.1.1   YES NVRAM up
```

The `show ip vrf` command can be used to verify that a router ID is assigned for the VRF:

```
Router# show ip vrf
Name         Default RD Interfaces
vpn1         45000:1 Loopback0
```

Per-VRF Automatically Assigned Router ID Example

The following example shows how to configure two VRFs--vrf_trans and vrf_user--with sessions between each other on the same router. Under the IPv4 address family associated with an individual VRF, BGP is configured to automatically assign a BGP router ID. Loopback interfaces are associated with individual VRFs.
to source an IP address for the router ID. The output of the `show ip bgp vpnv4` command can be used to verify that the router IDs have been configured for each VRF.

```
ip vrf vrf_trans
  rd 45000:1
  route-target export 50000:50
  route-target import 40000:1
!
ip vrf vrf_user
  rd 65500:1
  route-target export 65500:1
  route-target import 65500:1
!
interface Loopback0
  ip address 10.1.1.1 255.255.255.255
!
interface Loopback1
  ip vrf forwarding vrf_user
  ip address 10.99.1.1 255.255.255.255
!
interface Loopback2
  ip vrf forwarding vrf_trans
  ip address 10.99.2.2 255.255.255.255
!
router bgp 45000
  no bgp default ipv4-unicast
  bgp log-neighbor-changes
  neighbor 192.168.3.1 remote-as 45000
  neighbor 192.168.3.1 update-source Loopback0
!
address-family vpnv4
  neighbor 192.168.3.1 activate
  neighbor 192.168.3.1 send-community extended
  exit-address-family
!
address-family ipv4 vrf vrf_user
  redistribute connected
  neighbor 172.22.1.1 remote-as 40000
  neighbor 172.22.1.1 local-as 50000 no-prepend
  neighbor 172.22.1.1 ebgp-multihop 2
  neighbor 172.22.1.1 activate
  neighbor 172.22.1.1 allowas-in 1
  no auto-summary
  no synchronization
  bgp router-id auto-assign
  exit-address-family
!
address-family ipv4 vrf vrf_trans
  redistribute connected
  neighbor 172.23.1.1 remote-as 50000
  neighbor 172.23.1.1 local-as 40000 no-prepend
  neighbor 172.23.1.1 ebgp-multihop 2
  neighbor 172.23.1.1 activate
  neighbor 172.23.1.1 allowas-in 1
  no auto-summary
  no synchronization
  bgp router-id auto-assign
  exit-address-family
```

After the configuration, the output of the `show ip bgp vpnv4 all` command shows the router ID displayed next to the VRF name. Note that the router IDs used in this example are sourced from the IP addresses configured for loopback interface 1 and loopback interface 2.
Router# show ip bgp vpnv4 all
BGP table version is 43, local router ID is 10.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal, r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

<table>
<thead>
<tr>
<th>Network</th>
<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>* 172.22.0.0 0.0.0.0</td>
<td>0</td>
<td>32768 ?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>r 172.23.0.0 172.23.1.1</td>
<td>0</td>
<td>0 3 1 ?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* 10.21.1.1/32 192.168.3.1</td>
<td>0</td>
<td>0 2 1 ?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* 10.52.1.0/24 172.23.1.1</td>
<td>0</td>
<td>0 3 1 ?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>r 10.52.2.1/32 172.23.1.1</td>
<td>0</td>
<td>0 3 1 3 i</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* 10.52.3.1/32 172.23.1.1</td>
<td>0</td>
<td>0 3 1 3 i</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* 10.99.1.1/32 172.23.1.1</td>
<td>0</td>
<td>0 3 1 ?</td>
<td></td>
<td></td>
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<tr>
<td>* 10.99.1.2/32 172.23.1.1</td>
<td>0</td>
<td>32768 ?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Route Distinguisher: 45000:1 (default for vrf vrf_trans) VRF Router ID 10.99.2.2

<table>
<thead>
<tr>
<th>Network</th>
<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>* 172.22.0.0 0.0.0.0</td>
<td>0</td>
<td>32768 ?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>r 172.23.0.0 172.23.1.1</td>
<td>0</td>
<td>0 3 1 ?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* 10.21.1.1/32 192.168.3.1</td>
<td>0</td>
<td>0 2 1 ?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* 10.52.1.0/24 172.23.1.1</td>
<td>0</td>
<td>0 3 1 ?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>r 10.52.2.1/32 172.23.1.1</td>
<td>0</td>
<td>0 3 1 3 i</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* 10.52.3.1/32 172.23.1.1</td>
<td>0</td>
<td>0 3 1 3 i</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* 10.99.1.1/32 172.23.1.1</td>
<td>0</td>
<td>0 3 1 ?</td>
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</tr>
<tr>
<td>* 10.99.1.2/32 172.23.1.1</td>
<td>0</td>
<td>32768 ?</td>
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Route Distinguisher: 50000:1

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<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
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</thead>
<tbody>
<tr>
<td>* 10.21.1.1/32 192.168.3.1</td>
<td>0</td>
<td>0 2 1 ?</td>
<td></td>
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</table>

Route Distinguisher: 65500:1 (default for vrf vrf_user) VRF Router ID 10.99.1.1

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<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
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<tr>
<td>* 172.22.0.0 172.22.1.1</td>
<td>0</td>
<td>0 2 1 ?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* 172.23.0.0 0.0.0.0</td>
<td>0</td>
<td>32768 ?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* 10.21.1.1/32 172.22.1.1</td>
<td>0</td>
<td>0 2 1 2 i</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*10.52.1.0/24 192.168.3.1</td>
<td>0</td>
<td>0 2 1 ?</td>
<td></td>
<td></td>
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<tr>
<td>*10.52.2.1/32 192.168.3.1</td>
<td>0</td>
<td>0 3 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*10.52.3.1/32 192.168.3.1</td>
<td>0</td>
<td>0 3 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* 10.99.1.1/32 0.0.0.0</td>
<td>0</td>
<td>32768 ?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* 10.99.1.2/32 172.22.1.1</td>
<td>0</td>
<td>0 2 1 ?</td>
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**Additional References**

**Related Documents**

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<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
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<tr>
<td>BGP commands: complete command syntax, defaults, command mode, command history, usage guidelines, and examples</td>
<td><em>Cisco IOS IP Routing: BGP Command Reference</em></td>
</tr>
<tr>
<td>MPLS commands: complete command syntax, defaults, command mode, command history, usage guidelines, and examples</td>
<td><em>Cisco IOS Multiprotocol Label Switching Command Reference</em></td>
</tr>
<tr>
<td>Cisco IOS master command list, all releases</td>
<td><em>Cisco IOS Master Command List, All Releases</em></td>
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**Standards**

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MIBs

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<th>MIBs Link</th>
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<td>No new or modified MIBs are supported by this feature, and support for existing MIBs has not been modified by this feature.</td>
<td>To locate and download MIBs for selected platforms, Cisco IOS XE software releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
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RFCs

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Technical Assistance

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<tr>
<td>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/techsupport">http://www.cisco.com/techsupport</a></td>
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</table>

Feature Information for Per-VRF Assignment of BGP Router ID

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.
The Per-VRF Assignment of BGP Router ID feature introduces the ability to have VRF-to-VRF peering in Border Gateway Protocol (BGP) on the same router. BGP is designed to refuse a session with itself because of the router ID check. The per-VRF assignment feature allows a separate router ID per VRF using a new keyword in the existing `bgp router-id` command. The router ID can be manually configured for each VRF or can be assigned automatically either globally under address family configuration mode or for each VRF.

This feature was introduced on the Cisco ASR 1000 Series Aggregation Services Routers.

The following commands were introduced or modified by this feature: `bgp router-id`, `show ip bgp vpnv4`. 

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
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<tbody>
<tr>
<td>Per-VRF Assignment of BGP Router ID</td>
<td>Cisco IOS XE Release 2.1</td>
<td>The Per-VRF Assignment of BGP Router ID feature introduces the ability to have VRF-to-VRF peering in Border Gateway Protocol (BGP) on the same router. BGP is designed to refuse a session with itself because of the router ID check. The per-VRF assignment feature allows a separate router ID per VRF using a new keyword in the existing <code>bgp router-id</code> command. The router ID can be manually configured for each VRF or can be assigned automatically either globally under address family configuration mode or for each VRF. This feature was introduced on the Cisco ASR 1000 Series Aggregation Services Routers. The following commands were introduced or modified by this feature: <code>bgp router-id</code>, <code>show ip bgp vpnv4</code>.</td>
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</tbody>
</table>
BGP Next Hop Unchanged

In an external BGP (eBGP) session, by default, the router changes the next hop attribute of a BGP route (to its own address) when the router sends out a route. The BGP Next Hop Unchanged feature allows BGP to send an update to an eBGP multihop peer with the next hop attribute unchanged.

- Finding Feature Information, on page 695
- Information About Next Hop Unchanged, on page 695
- How to Configure BGP Next Hop Unchanged, on page 696
- Configuration Example for BGP Next Hop Unchanged, on page 699
- Additional References, on page 699
- Feature Information for BGP Next Hop Unchanged, on page 700

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About Next Hop Unchanged

BGP Next Hop Unchanged

In an external BGP (eBGP) session, by default, the router changes the next hop attribute of a BGP route (to its own address) when the router sends out a route. If the BGP Next Hop Unchanged feature is configured, BGP will send routes to an eBGP multihop peer without modifying the next hop attribute. The next hop attribute is unchanged.
There is an exception to the default behavior of the router changing the next hop attribute of a BGP route when the router sends out a route. When the next hop is in the same subnet as the peering address of the eBGP peer, the next hop is not modified. This is referred to as third party next-hop.

The BGP Next Hop Unchanged feature provides flexibility when designing and migrating networks. It can be used only between eBGP peers configured as multihop. It can be used in a variety of scenarios between two autonomous systems. One scenario is when multiple autonomous systems are connected that share the same IGP, or at least the routers have another way to reach each other’s next hops (which is why the next hop can remain unchanged).

A common use of this feature is to configure Multiprotocol Label Switching (MPLS) inter-AS with multihop MP-eBGP for VPNv4 between RRAs.

Another common use of this feature is a VPNv4 inter-AS Option C configuration, as defined in RFC4364, Section 10. In this configuration, VPNv4 routes are passed among autonomous systems between RR of different autonomous systems. The RRs are several hops apart, and have `neighbor next-hop unchanged` configured. PEs of different autonomous systems establish an LSP between them (via a common IGP or by advertising the next-hops--via ASBRs--routes from different autonomous systems separated by one hop). PEs are able to reach the next hops of the PEs in another AS via the LSPs, and can therefore install the VPNv4 routes in the VRF RIB.

Restriction

The BGP Next Hop Unchanged feature can be configured only between multihop eBGP peers. The following error message will be displayed if you try to configure this feature for a directly connected neighbor:

```
%BGP: Can propagate the next-hop only to multi-hop EBGP neighbor
```

How to Configure BGP Next Hop Unchanged

Configuring the BGP Next Hop Unchanged for an eBGP Peer

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp as-number`
4. `address-family {ipv4 | ipv6 | l2vpn | nsap | rtfilter | vpnv4 | vpnv6}`
5. `neighbor ip-address remote-as as-number`
6. `neighbor ip-address activate`
7. `neighbor ip-address ebgp-multihop ttl`
8. `neighbor ip-address next-hop-unchanged`
9. `end`
10. `show ip bgp`
### Detailed Steps

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router&gt; enable</td>
<td></td>
</tr>
<tr>
<td>Step 2</td>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td>router bgp as-number</td>
<td>Enters router configuration mode, and creates a BGP routing process.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config)# router bgp 65535</td>
<td></td>
</tr>
<tr>
<td>Step 4</td>
<td>address-family {ipv4</td>
<td>ipv6</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config-router-af)# address-family vpnv4</td>
<td></td>
</tr>
<tr>
<td>Step 5</td>
<td>neighbor ip-address remote-as as-number</td>
<td>Adds an entry to the BGP neighbor table.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config-router-af)# neighbor 10.0.0.100 remote-as 65600</td>
<td></td>
</tr>
<tr>
<td>Step 6</td>
<td>neighbor ip-address activate</td>
<td>Enables the exchange of information with the peer.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config-router-af)# neighbor 10.0.0.100 activate</td>
<td></td>
</tr>
<tr>
<td>Step 7</td>
<td>neighbor ip-address ebgp-multihop ttl</td>
<td>Configures the local router to accept and initiate connections to external peers that reside on networks that are not directly connected.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config-router-af)# neighbor 10.0.0.100 ebgp-multihop 255</td>
<td></td>
</tr>
<tr>
<td>Step 8</td>
<td>neighbor ip-address next-hop-unchanged</td>
<td>Configures the router to send BGP updates to the specified eBGP peer without modifying the next hop attribute.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config-router-af)# neighbor 10.0.0.100 next-hop-unchanged</td>
<td></td>
</tr>
</tbody>
</table>
### Configuring BGP Next Hop Unchanged using Route-Maps

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 9</strong></td>
<td>Exits address family configuration mode, and enters privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Router(config-router-af)# end</td>
</tr>
</tbody>
</table>

| **Step 10** | (Optional) Displays entries in the BGP routing table. |
| **Example:** | Router# show ip bgp |

**Configure next-hop unchanged for both iBGP and eBGP path prefixes while sending to eBGP neighbor**

To configure next-hop unchanged for both iBGP and eBGP path prefixes while sending to eBGP neighbor, use `next-hop-unchanged allpaths` command.

---

**Note**

From Cisco IOS XE Denali 16.3 release, the `next-hop-unchanged allpaths` command supports IPv4 and IPv6 address families along with VPNv4 and VPNv6 address families.

In the following configuration the next-hop is not changed for both iBGP and eBGP path prefixes while sending to eBGP neighbor 15.1.1.2:
enable
cfg-term
rtr bgp 2
  bgp log-neighbor-changes
  neighbor 15.1.1.2 remote-as 3
  neighbor 15.1.1.2 ebgp-multihop 10
  !
  address-family ipv4
  neighbor 15.1.1.2 activate
  neighbor 15.1.1.2 next-hop-unchanged allpaths
  exit address-family
  !
end

Configuration Example for BGP Next Hop Unchanged

Example: BGP Next Hop Unchanged for an eBGP Peer

The following example configures a multihop eBGP peer at 10.0.0.100 in a remote AS. When the local router sends updates to that peer, it will send them without modifying the next hop attribute.

router bgp 65535
  address-family ipv4
  neighbor 10.0.0.100 remote-as 65600
  neighbor 10.0.0.100 activate
  neighbor 10.0.0.100 ebgp-multihop 255
  neighbor 10.0.0.100 next-hop-unchanged
end

Note
All address families, such as IPv4, IPv6, VPNv4, VPNv6, L2VPN, and so on support the next-hop unchanged command. However, for the address family L2VPN BGP VPLS signaling, you must use the next-hop self command for its proper functioning.

Additional References

Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
<tr>
<td>BGP Outbound Route Map on Route Reflector to Set IP Next Hop for iBGP Peer</td>
<td>“Configuring Internal BGP Features” in the IP Routing: BGP Configuration Guide</td>
</tr>
</tbody>
</table>
Feature Information for BGP Next Hop Unchanged

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to [www.cisco.com/go/cfn](http://www.cisco.com/go/cfn). An account on Cisco.com is not required.

**Table 59: Feature Information for BGP Next Hop Unchanged**

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP Next Hop Unchanged</td>
<td>Cisco IOS XE Release 2.1</td>
<td>The BGP Next Hop Unchanged feature allows BGP to send an update to an eBGP multihop peer with the next hop attribute unchanged. The following command was added by this feature: <code>neighbor next-hop-unchanged</code>.</td>
</tr>
<tr>
<td>set ip next-hop unchanged/next-hop-unchanged allpaths IPv4/IPv6</td>
<td>Cisco IOS XE Denali 16.3.1</td>
<td>In Cisco IOS XE Denali 16.3 release, the set ip next-hop unchanged/next-hop-unchanged allpaths IPv4/IPv6 feature extends the support for BGP Next Hop Unchanged to IPv4 and IPv6 allpaths. The set ip next-hop unchanged/next-hop-unchanged allpaths IPv4/IPv6 feature adds two new knobs to support BGP Next Hop Unchanged. The 'set ip next-hop unchanged' knob was added under the route-map and 'next-hop-unchanged allpaths' was added under the neighbor. The following command was modified by this feature: <code>set ip next-hop unchanged</code>.</td>
</tr>
</tbody>
</table>
CHAPTER 44

BGP Support for the L2VPN Address Family

BGP support for the Layer 2 Virtual Private Network (L2VPN) address family introduces a BGP-based autodiscovery mechanism to distribute L2VPN endpoint provisioning information. BGP uses a separate L2VPN Routing Information Base (RIB) to store endpoint provisioning information, which is updated each time any Layer 2 virtual forwarding instance (VFI) is configured. When BGP distributes the endpoint provisioning information in an update message to all its BGP neighbors, the endpoint information is used to set up a pseudowire mesh to support L2VPN-based services.

- Finding Feature Information, on page 701
- Prerequisites for BGP Support for the L2VPN Address Family, on page 701
- Restrictions for BGP Support for the L2VPN Address Family, on page 702
- Information About BGP Support for the L2VPN Address Family, on page 702
- How to Configure BGP Support for the L2VPN Address Family, on page 703
- Configuration Examples for BGP Support for the L2VPN Address Family, on page 709
- Where to Go Next, on page 712
- Additional References, on page 712
- Feature Information for BGP Support for the L2VPN Address Family, on page 713

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for BGP Support for the L2VPN Address Family

The BGP Support for L2VPN Address Family feature assumes prior knowledge of Virtual Private Network (VPN), Virtual Private LAN Service (VPLS), and Multiprotocol Layer Switching (MPLS) technologies.
Restrictions for BGP Support for the L2VPN Address Family

• For route maps used within BGP, all commands related to prefix processing, tag processing, and automated tag processing are ignored when used under L2VPN address family configuration. All other route map commands are supported.

• BGP multipaths and confederations are not supported under the L2VPN address family.

Information About BGP Support for the L2VPN Address Family

L2VPN Address Family

In Cisco IOS XE Release 2.6 and later releases, support for the L2VPN address family is introduced. L2VPN is defined as a secure network that operates inside an unsecured network by using an encryption technology such as IP security (IPsec) or Generic Routing Encapsulation (GRE). The L2VPN address family is configured under BGP routing configuration mode, and within the L2VPN address family the VPLS subsequent address family identifier (SAFI) is supported.

BGP support for the L2VPN address family introduces a BGP-based autodiscovery mechanism to distribute L2VPN endpoint provisioning information. BGP uses a separate L2VPN Routing Information Base (RIB) to store endpoint provisioning information, which is updated each time any Layer 2 VFI is configured. Prefix and path information is stored in the L2VPN database, allowing BGP to make best-path decisions. When BGP distributes the endpoint provisioning information in an update message to all its BGP neighbors, the endpoint information is used to set up a pseudowire mesh to support L2VPN-based services.

The BGP autodiscovery mechanism facilitates the setting up of L2VPN services, which are an integral part of the Cisco IOS Virtual Private LAN Service (VPLS) feature. VPLS enables flexibility in deploying services by connecting geographically dispersed sites as a large LAN over high-speed Ethernet in a robust and scalable IP MPLS network. For more details about VPLS, see the VPLS Autodiscovery: BGP Based feature.

In L2VPN address family, the following BGP commands are supported:

• bgp nexthop
• bgp scan-time
• neighbor activate
• neighbor advertisement-interval
• neighbor allowas-in
• neighbor capability
• neighbor inherit
• neighbor maximum-prefix
• neighbor next-hop-self
• neighbor next-hop-unchanged
• neighbor peer-group
For route reflectors using L2VPNs, the **neighbor next-hop-self** and **neighbor next-hop-unchanged** commands are not supported.

For route maps used within BGP, all commands related to prefix processing, tag processing, and automated tag processing are ignored when used under L2VPN address family configuration. All other route map commands are supported.

BGP multipaths and confederations are not supported under the L2VPN address family.

### VPLS ID

A VPLS ID is a BGP extended community value that identifies the VPLS domain. Manual configuration of this ID is optional because a default VPLS ID is generated using the BGP autonomous system number and the configured VPN ID. A VPLS ID can be composed in one of two ways: with an autonomous system number and an arbitrary number or with an IP address and an arbitrary number.

You can enter a VPLS ID in either of these formats:

- Enter a 16-bit autonomous system number, a colon, and a 32-bit number. For example:
  
  45000:3

- Enter a 32-bit IP address, a colon, and a 16-bit number. For example:

  192.168.10.15:1

### How to Configure BGP Support for the L2VPN Address Family

#### Configuring VPLS Autodiscovery Using BGP and the L2VPN Address Family

Perform this task to implement VPLS autodiscovery of each provider edge (PE) router that is a member of a specific VPLS. In Cisco IOS XE Release 2.6, the BGP L2VPN address family was introduced with a separate L2VPN RIB that contains endpoint provisioning information. BGP learns the endpoint provisioning information from the L2VPN database, which is updated each time any Layer 2 (L2) virtual forwarding instance (VFI) is configured. When BGP distributes the endpoint provisioning information in an update message to all its BGP neighbors, the endpoint information is used to set up a pseudowire mesh to support L2VPN-based services.
BGP-based VPLS autodiscovery eliminates the need to manually provision a VPLS neighbor. After a PE router configures itself to be a member of a particular VPLS, information needed to set up connections to remote routers in the same VPLS is distributed by a discovery process. When the discovery process is complete, each member of the VPLS will have the information needed to set up VPLS pseudowires to form the full mesh of pseudowires needed for the VPLS.

This task is configured at router N-PE3 in the figure below and must be repeated at routers N-PE1 and N-PE2 with the appropriate changes such as different IP addresses. For a full configuration of these routers, see the figure below.

**Figure 63: Network Diagram for BGP Autodiscovery Using the L2VPN Address Family**

In this task, the PE router N-PE3 in the figure above is configured with a Layer 2 router ID, a VPN ID, a VPLS ID, and is enabled to automatically discover other PE routers that are part of the same VPLS domain. A BGP session is created to activate BGP neighbors under the L2VPN address family. Finally, two optional `show` commands are entered to verify the steps in the task.

**Before you begin**

This task assumes that MPLS is configured with VPLS options. For more details, see the "VPLS Autodiscovery: BGP Based" feature.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `l2 router-id ip-address`
4. `l2 vfi vfi-name autodiscovery`
5. `vpn id vpn-id`
6. `vpls-id vpls-id`
7. `exit`
8. Repeat Step 4 through Step 6 to configure other L2 VFIs and associated VPN and VPLS IDs.
9. `router bgp autonomous-system-number`
10. `no bgp default ipv4-unicast`
11. `bgp log-neighbor-changes`
12. `bgp update-delay seconds`
13. `neighbor {ip-address|peer-group-name} remote-as autonomous-system-number`
14. `neighbor {ip-address|peer-group-name} update-source interface-type interface-number`
15. Repeat Step 13 and Step 14 to configure other BGP neighbors.
16. `address-family l2vpn [vpls]`
17. `neighbor ip-address activate`
18. `neighbor {ip-address|peer-group-name} send-community [both | standard | extended]`
19. Repeat Step 17 and Step 18 to activate other BGP neighbors under L2VPN address family.
20. `end`
21. `show vfi`
22. `show ip bgp l2vpn vpls {all | rd vpn-rd}`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| 1    | enable            | Enables privileged EXEC mode.  
|      | Example:          | • Enter your password if prompted. |
|      | Router> enable    |         |
| 2    | configure terminal| Enters global configuration mode. |
|      | Example:          |         |
|      | Router# configure terminal |         |
| 3    | l2 router-id ip-address | Specifies a router ID (in IP address format) for the PE router to use with VPLS autodiscovery pseudowires.  
|      | Example:          | • In this example, the L2 router ID is defined as 10.1.1.3. |
|      | Router(config)# l2 router-id 10.1.1.3 |         |
| 4    | l2 vfi vfi-name autodiscovery | Creates an L2 VFI, enables the VPLS PE router to automatically discover other PE routers that are part of the same VPLS domain, and enters L2 VFI autodiscovery configuration mode.  
|      | Example:          | • In this example, the L2 VFI named customerA is created. |
|      | Router(config)# l2 vfi customerA autodiscovery |         |
| 5    | vpn id vpn-id   | Specifies a VPN ID.  
|      | Example:          | • Use the same VPN ID for the PE routers that belong to the same VPN. Make sure that the VPN ID is unique for each VPN in the service provider network.  
|      | Router(config-vfi)# vpn id 100 | • Use the `vpn-id` argument to specify a number in the range from 1 to 4294967295.  
|      |                  | • In this example, a VPN ID of 100 is specified. |
| 6    | vpls-id vpls-id  | (Optional) Specifies a VPLS ID. |
### Purpose

**Command or Action**

**Example:**

Router(config-vfi)# vpls-id 65000:100

### Purpose

- The VPLS ID is an identifier that is used to identify the VPLS domain. This command is optional because a default VPLS ID is automatically generated using the BGP autonomous system number and the VPN ID configured for the VFI. Only one VPLS ID can be configured per VFI, and the same VPLS ID cannot be configured in multiple VFIIs on the same router.

- In this example, a VPLS ID of 65000:100 is specified.

**Step 7**

**exit**

**Example:**

Router(config-vfi)# exit

- Exits L2 VFI autodiscovery configuration mode and returns to global configuration mode.

**Step 8**

Repeat Step 4 through Step 6 to configure other L2 VFIs and associated VPN and VPLS IDs.

**Step 9**

**router bgp**  
**autonomous-system-number**

**Example:**

Router(config)# router bgp 65000

- Enters router configuration mode for the specified routing process.

**Step 10**

**no bgp default ipv4-unicast**

**Example:**

Router(config-router)# no bgp default ipv4-unicast

- Disables the IPv4 unicast address family for the BGP routing process.

**Note**

Routing information for the IPv4 unicast address family is advertised by default for each BGP routing session configured with the `neighbor remote-as` router configuration command unless you configure the `no bgp default ipv4-unicast` router configuration command before configuring the `neighbor remote-as` command. Existing neighbor configurations are not affected.

**Step 11**

**bgp log-neighbor-changes**

**Example:**

Router(config-router)# bgp log-neighbor-changes

- Enables logging of BGP neighbor resets.

**Step 12**

**bgp update-delay**  
**seconds**

**Example:**

Router(config-router)# bgp update-delay 1

- Sets the maximum initial delay period before a BGP-speaking networking device sends its first updates.

  - Use the `seconds` argument to set the delay period.

**Step 13**

**neighbor**  
**\{ip-address|peer-group-name\}**  
**remote-as**  
**autonomous-system-number**

**Example:**

- Adds the IP address or peer group name of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local router.
### Command or Action

| Step 14 | **neighbor {ip-address|peer-group-name} update-source interface-type interface-number** |
|---------|--------------------------------------------------------------------------------|
| **Example:** | Router(config-router)# neighbor 10.10.10.1 update-source loopback 1 |

#### Purpose
- **(Optional) Configures a router to select a specific source or interface to receive routing table updates.**
- **This example uses a loopback interface. The advantage to this configuration is that the loopback interface is not as susceptible to the effects of a flapping interface.**

#### Step 15

**Repeat Step 13 and Step 14 to configure other BGP neighbors.**

#### Step 16

**address-family l2vpn [vpls]**

**Example:**

Router(config-router)# address-family l2vpn vpls

#### Step 17

**neighbor ip-address activate**

**Example:**

Router(config-router-af)# neighbor 10.10.10.1 activate

#### Step 18

**neighbor {ip-address|peer-group-name} send-community [both|standard|extended]**

**Example:**

Router(config-router-af)# neighbor 10.10.10.1 send-community extended

### BGP Support for the L2VPN Address Family

#### Configuring VPLS Autodiscovery Using BGP and the L2VPN Address Family

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| Router(config-router)# neighbor 10.10.10.1 remote-as 65000 | • If the **autonomous-system-number** argument matches the autonomous system number specified in the **router bgp** command, the neighbor is an internal neighbor.  
• If the **autonomous-system-number** argument does not match the autonomous system number specified in the **router bgp** command, the neighbor is an external neighbor.  
• In this example, the neighbor at 10.10.10.1 is an internal BGP neighbor. |

| Step 14 | **neighbor {ip-address|peer-group-name} update-source interface-type interface-number** |
|---------|--------------------------------------------------------------------------------|
| **Example:** | Router(config-router)# neighbor 10.10.10.1 update-source loopback 1 |

### Step 15

**Repeat Step 13 and Step 14 to configure other BGP neighbors.**

### Step 16

**address-family l2vpn [vpls]**

**Example:**

Router(config-router)# address-family l2vpn vpls

### Step 17

**neighbor ip-address activate**

**Example:**

Router(config-router-af)# neighbor 10.10.10.1 activate

### Step 18

**neighbor {ip-address|peer-group-name} send-community [both|standard|extended]**

**Example:**

Router(config-router-af)# neighbor 10.10.10.1 send-community extended

### Note
- If you have configured a BGP peer group as a neighbor, you do not use this step. BGP peer groups are activated when a BGP parameter is configured. For example, the **neighbor send-community** command in the next step will automatically activate a peer group.

### Specifies that a communities attribute should be sent to a BGP neighbor.
- **In this example, an extended communities attribute is sent to the neighbor at 10.10.1.**
<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>Repeat Step 17 and Step 18 to activate other BGP neighbors under L2VPN address family.</td>
<td>--</td>
</tr>
<tr>
<td>20</td>
<td>end</td>
<td>Exits address family configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config-router-af)# end</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>show vfi</td>
<td>(Optional) Displays information about the configured VFI instances.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router# show vfi</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>show ip bgp l2vpn vpls {all</td>
<td>rd vpn-rd}</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router# show ip bgp l2vpn vpls all</td>
<td></td>
</tr>
</tbody>
</table>

**Examples**

The following is sample output from the `show vfi` command that shows two VFIs, CustomerA and CustomerB, with their associated VPN and VPLS IDs:

```
Router# show vfi
Legend: RT=Route-target, S=Split-horizon, Y=Yes, N=No
VFI name: customerA, state: down, type: multipoint
  VPN ID: 100, VPLS-ID: 65000:100
  RD: 65000:100, RT: 65000:100
  Local attachment circuits:
    Neighbors connected via pseudowires:
      Peer Address   VC ID   Discovered Router ID S
      10.10.10.1     100     10.10.10.99   Y

VFI name: customerB, state: down, type: multipoint
  VPN ID: 200, VPLS-ID: 65000:200
  RD: 65000:200, RT: 65000:200
  Local attachment circuits:
    Neighbors connected via pseudowires:
      Peer Address   VC ID   Discovered Router ID S
      10.10.10.3     200     10.10.10.98   Y
```

The following is sample output from the `show ip bgp l2vpn vpls all` command that shows two VFIs identified by their VPN route distinguisher:

```
Router# show ip bgp l2vpn vpls all
BGP table version is 5, local router ID is 10.10.10.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal, r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete
Network   Next Hop   Metric LocPrf Weight Path
Route Distinguisher: 65000:100
  *> 65000:100:10.10.10.1/96
  0.0.0.0   32768 ?
  *>65000:100:192.168.1.1/96
```

What to Do Next

To configure more VPLS features, see the main VPLS documentation in the “VPLS Autodiscovery: BGP Based” module in the *MPLS Layer 2 VPNs Configuration Guide*.

Configuration Examples for BGP Support for the L2VPN Address Family

Example: Configuring VPLS Autodiscovery Using BGP and the L2VPN Address Family

In this configuration example, all the routers in autonomous system 65000 in the figure below are configured to provide BGP support for the L2VPN address family. VPLS autodiscovery is enabled and L2 VFI and VPN IDs are configured. BGP neighbors are configured and activated under L2VPN address family to ensure that the VPLS endpoint provisioning information is saved to a separate L2VPN RIB and then distributed to the other BGP peers in BGP update messages. When the endpoint information is received by the BGP peers, a pseudowire mesh is set up to support L2VPN-based services.

*Figure 64: Network Diagram for VPLS Autodiscovery Using BGP and the L2VPN Address Family*

```plaintext
Router N-PE1

ip subnet-zero
ip cef
no ip dhcp use vrf connected
```
Example: Configuring VPLS Autodiscovery Using BGP and the L2VPN Address Family

! no mpls traffic-eng auto-bw timers frequency 0
mpls label range 1000 2000
mpls label protocol ldp
l2 router-id 10.1.1.1
l2 vfi auto autodiscovery
vpn id 100
!
pseudowire-class mpls
capsulation mpls
!
interface Loopback1
 ip address 10.1.1.1 255.255.255.255
!
interface GigabitEthernet0/0/1
description Backbone interface
 ip address 10.0.0.1 255.255.255.0
 mpls ip
!
router ospf 1
 log-adjacency-changes
 network 10.10.1.0 0.0.0.255 area 0
 network 192.168.0.0 0.0.0.255 area 0
!
router bgp 65000
 no bgp default ipv4-unicast
 bgp log-neighbor-changes
 bgp update-delay 1
 neighbor 10.10.10.2 remote-as 65000
 neighbor 10.10.10.2 update-source Loopback 1
 neighbor 10.10.10.3 remote-as 65000
 neighbor 10.10.10.3 update-source Loopback 1
!
address-family l2vpn vpls
 neighbor 10.10.10.2 activate
 neighbor 10.10.10.2 send-community extended
 neighbor 10.10.10.3 activate
 neighbor 10.10.10.3 send-community extended
 exit-address-family
!
ip classless

Router N-PE2

ip subnet-zero
ip cef
no ip dhcp use vrf connected
!
no mpls traffic-eng auto-bw timers frequency 0
mpls label range 2000 3000
mpls label protocol ldp
l2 router-id 10.1.1.2
l2 vfi auto autodiscovery
vpn id 100
!
pseudowire-class mpls
encapsulation mpls
!
interface Loopback1
 ip address 10.1.1.2 255.255.255.255
!
interface GigabitEthernet0/0/1
description Backbone interface
ip address 10.0.0.2 255.255.255.0
mpls ip
!
router ospf 1
  log-adjacency-changes
  network 10.10.1.0 0.0.0.255 area 0
  network 192.168.0.0 0.0.0.255 area 0
!
router bgp 65000
  no bgp default ipv4-unicast
  bgp log-neighbor-changes
  bgp update-delay 1
  neighbor 10.10.10.1 remote-as 65000
  neighbor 10.10.10.1 update-source Loopback1
  neighbor 10.10.10.3 remote-as 65000
  neighbor 10.10.10.3 update-source Loopback1
!
address-family l2vpn vpls
  neighbor 10.10.10.1 activate
  neighbor 10.10.10.1 send-community extended
  neighbor 10.10.10.3 activate
  neighbor 10.10.10.3 send-community extended
  exit-address-family
!
ip classless

Router N-PE3

ip subnet-zero
ip cef
no ip dhcp use vrf connected
!
nompls traffic-eng auto-bw timers frequency 0
mpls label range 2000 3000
mpls label protocol ldp
l2 router-id 10.1.1.3
l2 vfi auto autodiscovery
  vpn id 100
!
pseudowire-class mpls
  encapsulation mpls
!
interface Loopback1
  ip address 10.1.1.3 255.255.255.255
!
interface GigabitEthernet0/0/1
  description Backbone interface
  ip address 10.0.0.3 255.255.255.0
mpls ip
!
router ospf 1
  log-adjacency-changes
  network 10.10.1.0 0.0.0.255 area 0
  network 192.168.0.0 0.0.0.255 area 0
!
router bgp 65000
  no bgp default ipv4-unicast
  bgp log-neighbor-changes
  bgp update-delay 1
  neighbor 10.10.10.1 remote-as 65000
  neighbor 10.10.10.1 update-source Loopback1
  neighbor 10.10.10.2 remote-as 65000
  neighbor 10.10.10.2 update-source Loopback1
Where to Go Next

For more details about configuring VPLS autodiscovery, see the “VPLS Autodiscovery: BGP Based” module in the *MPLS Layer 2 VPNs Configuration Guide*.

Additional References

### Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
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<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
</tbody>
</table>

### MIBs

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<thead>
<tr>
<th>MIB</th>
<th>MIBs Link</th>
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<tbody>
<tr>
<td></td>
<td>To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
</tr>
</tbody>
</table>

### Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
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<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>
Feature Information for BGP Support for the L2VPN Address Family

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 60: Feature Information for BGP Support for the L2VPN Address Family

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP Support for the L2VPN Address Family</td>
<td>Cisco IOS XE Release 2.6</td>
<td>BGP support for the L2VPN address family introduces a BGP-based autodiscovery mechanism to distribute L2VPN endpoint provisioning information. BGP uses a separate L2VPN Routing Information Base (RIB) to store endpoint provisioning information, which is updated each time any Layer 2 VFI is configured. When BGP distributes the endpoint provisioning information in an update message to all its BGP neighbors, the endpoint information is used to set up a pseudowire mesh to support L2VPN-based services.</td>
</tr>
<tr>
<td></td>
<td>Cisco IOS XE Release 3.3SG</td>
<td></td>
</tr>
</tbody>
</table>

The following commands were introduced or modified by this feature: `address-family l2vpn`, `clear ip bgp l2vpn`, and `show ip bgp l2vpn`. 
CHAPTER 45

BGP Event-Based VPN Import

The BGP Event-Based VPN Import feature introduces a modification to the existing Border Gateway Protocol (BGP) path import process. The enhanced BGP path import is driven by events; when a BGP path changes, all of its imported copies are updated as soon as processing is available. Convergence times are significantly reduced because there is no longer any delay in the propagation of routes due to the software waiting for a periodic scanner time interval before processing the updates. To implement the new processing, new command-line interface (CLI) commands are introduced.

• Finding Feature Information, on page 715
• Prerequisites for BGP Event-Based VPN Import, on page 715
• Information About BGP Event-Based VPN Import, on page 716
• How to Configure BGP Event-Based VPN Import, on page 717
• Configuration Examples for BGP Event-Based VPN Import, on page 723
• Additional References, on page 723
• Feature Information for BGP Event-Based VPN Import, on page 724

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for BGP Event-Based VPN Import

Cisco Express Forwarding or distributed Cisco Express Forwarding must be enabled on all participating routers.
Information About BGP Event-Based VPN Import

BGP Event-Based VPN Import

The BGP Event-Based VPN Import feature introduces a modification to the existing BGP path import process. BGP Virtual Private Network (VPN) import provides importing functionality for BGP paths where BGP paths are imported from the BGP VPN table into a BGP virtual routing and forwarding (VRF) topology. In the existing path import process, when path updates occur, the import updates are processed during the next scan time which is a configurable interval of 5 to 15 seconds. The scan time adds a delay in the propagation of routes. The enhanced BGP path import is driven by events; when a BGP path changes, all of its imported copies are updated as soon as processing is available.

Using the BGP Event-Based VPN Import feature, convergence times are significantly reduced because provider edge (PE) routers can propagate VPN paths to customer edge (CE) routers without the scan time delay. Configuration changes such as adding imported route-targets to a VRF are not processed immediately, and are still handled during the 60-second periodic scanner pass.

Import Path Selection Policy

Event-based VPN import introduces three path selection policies:

- **All**—Import all available paths from the exporting net that match any route target (RT) associated with the importing VRF instance.
- **Best path**—Import the best available path that matches the RT of the VRF instance. If the best path in the exporting net does not match the RT of the VRF instance, a best available path that matches the RT of the VRF instance is imported.
- **Multipath**—Import the best path and all paths marked as multipaths that match the RT of the VRF instance. If there are no best path or multipath matches, then the best available path is selected.

Multipath and best path options can be restricted using an optional keyword to ensure that the selection is made only on the configured option. If the **strict** keyword is configured in the `import path selection` command, the software disables the fall back safety option of choosing the best available path. If no paths appropriate to the configured option (best path or multipath) in the exporting net match the RT of the VRF instance, then no paths are imported. This behavior matches the behavior of the software before the BGP Event-Based VPN Import feature was introduced.

When the restriction is not set, paths that are imported as the best available path are tagged. In `show` command output these paths are identified with the wording, “imported safety path.”

The paths existing in an exporting net that are considered for import into a VRF instance may have been received from another peer router and were not subject to the VPN importing rules. These paths may contain the same route-distinguisher (RD) information because the RD information is local to a router, but some of these paths do not match the RT of the importing VRF instance and are marked as “not-in-vrf” in the `show` command output. Any path that is marked as “not-in-vrf” is not considered as a best path because paths not in the VRF appear less attractive than paths in the VRF.

Import Path Limit

To control the memory utilization, a maximum limit of the number of paths imported from an exporting net can be specified per importing net. When a selection is made of paths to be imported from one or more
exporting net, the first selection priority is a best path, the next selection priority is for multipaths, and the lowest selection priority is for nonmultipaths.

### How to Configure BGP Event-Based VPN Import

#### Configuring a Multiprotocol VRF

Perform this task to configure a multiprotocol VRF that allows you to share route-target policies (import and export) between IPv4 and IPv6 or to configure separate route-target policies for IPv4 and IPv6 VPNs. In this task, only the IPv4 address family is configured, but we recommend using the multiprotocol VRF configuration for all new VRF configurations.

**Note**

This task is not specific to the BGP Event-Based VPN Import feature.

### SUMMARY STEPS

1. enable
2. configure terminal
3. vrf definition vrf-name
4. rd route-distinguisher
5. route-target {import | export | both} route-target-ext-community
6. address-family ipv4 [unicast]
7. exit-address-family
8. exit
9. interface type number
10. vrf forwarding vrf-name
11. ip address ip-address mask
12. no shutdown
13. exit
14. Repeat Step 3 through Step 13 to bind other VRF instances with an interface.
15. end

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
</tr>
<tr>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
</tbody>
</table>
| ```
| Router> enable    | • Enter your password if prompted.|
| ``` |
| **Step 2**        |         |
| configure terminal| Enters global configuration mode. |
| **Example:**      |         |
| ```
<p>| ``` | |</p>
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Router# configure terminal</td>
<td>Configures a VRF routing table and enters VRF configuration mode.</td>
</tr>
</tbody>
</table>

**Step 3**

- **vrf definition vrf-name**

  **Example:***
  
  Router(config)# vrf definition vrf-A

  Configures a VRF routing table and enters VRF configuration mode.  
  - Use the `vrf-name` argument to specify a name to be assigned to the VRF.

**Step 4**

- **rd route-distinguisher**

  **Example:***
  
  Router(config-vrf)# rd 45000:1

  Creates routing and forwarding tables and specifies the default route distinguisher for a VPN.  
  - Use the `route-distinguisher` argument to add an 8-byte value to an IPv4 prefix to create a unique VPN IPv4 prefix.

**Step 5**

- **route-target {import | export | both} route-target-ext-community**

  **Example:***
  
  Router(config-vrf)# route-target both 45000:100

  Creates a route target extended community for a VRF.  
  - Use the `import` keyword to import routing information from the target VPN extended community.  
  - Use the `export` keyword to export routing information to the target VPN extended community.  
  - Use the `both` keyword to both import routing information from, and export routing information to, the target VPN extended community.  
  - Use the `route-target-ext-community` argument to add the route target extended community attributes to the VRF’s list of import, export, or both (import and export) route target extended communities.

**Step 6**

- **address-family ipv4 [unicast]**

  **Example:***
  
  Router(config-vrf)# address-family ipv4 unicast

  Specifies the IPv4 address family and enters VRF address family configuration mode.  
  - This step is required here to specify an address family for the VRF defined in the previous steps.

**Step 7**

- **exit-address-family**

  **Example:***
  
  Router(config-vrf-af)# exit-address-family

  Exits VRF address family configuration mode and returns to VRF configuration mode.

**Step 8**

- **exit**

  **Example:***
  
  Router(config-vrf)# exit

  Exits VRF configuration mode and enters global configuration mode.
<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>interface type number</td>
<td>Enters interface configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config)# interface FastEthernet 1/1</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>vrf forwarding vrf-name</td>
<td>Associates a VRF instance with the interface configured in Step 9.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config-if)# vrf forwarding vrf-A</td>
<td>- When the interface is bound to a VRF, previously configured IP addresses are removed, and the interface is disabled.</td>
</tr>
<tr>
<td>11</td>
<td>ip address ip-address mask</td>
<td>Configures an IP address for the interface.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config-if)# ip address 10.4.8.149 255.255.255.0</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>no shutdown</td>
<td>Restarts a disabled interface.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config-if)# no shutdown</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>exit</td>
<td>Exits interface configuration mode and enters global configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config-if)# exit</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Repeat Step 3 through Step 13 to bind other VRF instances with an interface.</td>
<td>--</td>
</tr>
<tr>
<td>15</td>
<td>end</td>
<td>Exits global configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config)# end</td>
<td></td>
</tr>
</tbody>
</table>

### Configuring Event-Based VPN Import Processing for BGP Paths

Perform this task to reduce convergence times when BGP paths change by configuring event-based processing for importing BGP paths into a VRF table. Two new CLI commands allow the configuration of a maximum number of import paths per importing net and the configuration of a path selection policy.

**Before you begin**

This task assumes that you have previously configured the VRF to be used with the VRF address family syntax. To configure a VRF, see the “Configuring a Multiprotocol VRF” section earlier in this module.

Complete BGP neighbor configuration is also assumed. For an example configuration, see the “Example: Configuring Event-Based VPN Import Processing for BGP Paths” section in this module.
### SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router bgp** `autonomous-system-number`
4. **address-family ipv4** `vrf` `vrf-name`
5. **import path selection** `{all | bestpath [strict] | multipath [strict]}
6. **import path limit** `number-of-import-paths`
7. **end**

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router&gt; enable</td>
<td><strong>Enables privileged EXEC mode.</strong></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router# configure terminal</td>
<td><strong>Enters global configuration mode.</strong></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td><strong>autonomous-system-number</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router(config)# router bgp 45000</td>
<td><strong>Enters router configuration mode for the specified routing process.</strong></td>
</tr>
<tr>
<td><strong>Step 4</strong> address-family ipv4</td>
<td>Specifies the IPv4 address family and enters address family configuration mode.</td>
</tr>
<tr>
<td><strong>vrf</strong> <code>vrf-name</code></td>
<td><strong>Specifies the IPv4 address family and enters address family configuration mode.</strong></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router(config-router)# address-family</td>
<td><strong>Specifies the IPv4 address family and enters address family configuration mode.</strong></td>
</tr>
<tr>
<td>ipv4 vrf vrf-A</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> import path selection</td>
<td>Specifies the BGP path selection policy for importing routes into a VRF table.</td>
</tr>
<tr>
<td>`{all</td>
<td>bestpath [strict]</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router(config-router-af)# import path</td>
<td><strong>Specifies the BGP path selection policy for importing routes into a VRF table.</strong></td>
</tr>
<tr>
<td>selection all</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> import path limit</td>
<td>Specifies, per importing net, a maximum number of BGP paths that can be imported from an exporting net.</td>
</tr>
<tr>
<td><code>number-of-import-paths</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router(config-router-af)# import path</td>
<td><strong>Specifies, per importing net, a maximum number of BGP paths that can be imported from an exporting net.</strong></td>
</tr>
<tr>
<td>limit 3</td>
<td></td>
</tr>
</tbody>
</table>
Purpose

Exits address family configuration mode and returns to privileged EXEC mode.

Example:
Step 7
Router(config-router-af)# end

Monitoring and Troubleshooting BGP Event-Based VPN Import Processing

Perform the steps in this task as required to monitor and troubleshoot the BGP event-based VPN import processing.

Only partial command syntax for the show commands used in this task is displayed. For more details, see the Cisco IOS IP Routing: BGP Command Reference.

SUMMARY STEPS

1. enable

2. show ip bgp vpnv4 {all | rd route-distinguisher | vrf vrf-name} [network-address [mask]]

3. show ip route [vrf vrf-name] [ip-address [mask]]

4. debug ip bgp vpnv4 unicast import {events | updates [access-list]}

DETAILED STEPS

Step 1

enable

Enables privileged EXEC mode. Enter your password if prompted.

Example:
Router> enable

Step 2

show ip bgp vpnv4 {all | rd route-distinguisher | vrf vrf-name} [network-address [mask]]

In this example output, a safe import path selection policy is in effect because the strict keyword is not configured using the import path selection command. When a path is imported as the best available path (when the bestpath or multipaths are not eligible for import), the path is marked with "imported safety path," as shown in the output.

Example:
Router# show ip bgp vpnv4 all 172.17.0.0

BGP routing table entry for 45000:1:172.17.0.0/16, version 10
Paths: (1 available, best #1, table vrf-A)
Flag: 0x820
 Not advertised to any peer
 2, imported safety path from 50000:2:172.17.0.0/16
 10.0.101.1 from 10.0.101.1 (10.0.101.1)
 Origin IGP, metric 200, localpref 100, valid, internal, best
 Extended Community: RT:45000:100

The paths existing in an exporting net that are considered for import into a VRF instance may have been received from another peer router and were not subject to the VPN importing rules. These paths may contain the same route-distinguisher

---

### Table: Command or Action and Purpose

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 7</td>
<td>end</td>
<td>Exits address family configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td>Step 7</td>
<td>Example: Router(config-router-af)# end</td>
<td></td>
</tr>
</tbody>
</table>
(RD) information because the RD information is local to a router, but some of these paths do not match the RT of the importing VRF instance and are marked as "not-in-vrf" in the `show` command output.

In the following example output, a path was received from another peer router and was not subject to the VPN importing rules. This path, 10.0.101.2, was added to the VPNv4 table and associated with the vrf-A net because it contains a match of the RD information although the RD information was from the original router. This path is not, however, an RT match for vrf-A and is marked as "not-in-vrf." Note that on the net for vrf-A, this path is not the best path because any paths that are not in the VRF appear less attractive than paths in the VRF.

**Example:**

Router# show ip bgp vpnv4 all 172.17.0.0

```
BBGP routing table entry for 45000:1:172.17.0.0/16, version 11
Paths: (2 available, best #2, table vrf-A)
Flag: 0x820
  Not advertised to any peer
  10.0.101.2 from 10.0.101.2 (10.0.101.2)
    Origin IGP, metric 100, localpref 100, valid, internal, not-in-vrf
    Extended Community: RT:45000:200
    mpls labels in/out nolabel/16
  2
  10.0.101.1 from 10.0.101.1 (10.0.101.1)
    Origin IGP, metric 50, localpref 100, valid, internal, best
    Extended Community: RT:45000:100
    mpls labels in/out nolabel/16
```

**Step 3**

```
show ip route [vrf vrf-name] [ip-address [mask]]
```

In this example output, information about the routing table for VRF vrf-A is displayed:

**Example:**

Router# show ip route vrf vrf-A 172.17.0.0

```
Routing Table: vrf-A
Routing entry for 172.17.0.0/16
  Known via "bgp 1", distance 200, metric 50
  Tag 2, type internal
  Last update from 10.0.101.33 00:00:32 ago
  Routing Descriptor Blocks:
    * 10.0.101.33 (default), from 10.0.101.33, 00:00:32 ago
      Route metric is 50, traffic share count is 1
      AS Hops 1
      Route tag 2
      MPLS label: 16
      MPLS Flags: MPLS Required
```

**Step 4**

```
debug ip bgp vpnv4 unicast import {events | updates [access-list]}
```

Use this command to display debugging information related to the importing of BGP paths into a VRF instance table. The actual output depends on the commands that are subsequently entered.

**Note** If no access list to filter prefixes is specified when using the updates keyword, all updates for all prefixes are displayed and this may slow down your network.

**Example:**

Router# debug ip bgp vpnv4 unicast import events
Example: Configuring Event-Based VPN Import Processing for BGP Paths

In this example, a VRF (vrf-A) is configured and VRF forwarding is applied to Fast Ethernet interface 1/1. In address family mode, the import path selection is set to all and the number of import paths is set to 3. Two BGP neighbors are configured under the IPv4 address family and activated under the VPNv4 address family.

vrf definition vrf-A
   rd 45000:1
   route-target import 45000:100
   address-family ipv4
   exit-address-family
!
interface FastEthernet1/1
   no ip address
   vrf forwarding vrf-A
   ip address 10.4.8.149 255.255.255.0
   no shut
   exit
!
router bgp 45000
   network 172.17.1.0 mask 255.255.255.0
   neighbor 192.168.1.2 remote-as 40000
   neighbor 192.168.3.2 remote-as 50000
   address-family ipv4 vrf vrf-A
   import path selection all
   import path limit 3
   exit-address-family
   address-family vpnv4
   neighbor 192.168.1.2 activate
   neighbor 192.168.3.2 activate
end

Additional References

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<td>Cisco IOS IP Routing: BGP Command Reference</td>
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</tbody>
</table>
Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.</td>
<td>—</td>
</tr>
</tbody>
</table>

MIBs

<table>
<thead>
<tr>
<th>MIB</th>
<th>MIBs Link</th>
</tr>
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<tbody>
<tr>
<td>No new or modified MIBs are supported by this feature, and support for existing MIBs has not been modified by this feature.</td>
<td>To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
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</tbody>
</table>

RFCs

<table>
<thead>
<tr>
<th>RFC</th>
<th>Title</th>
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<tr>
<td>No new or modified RFCs are supported by this feature, and support for existing RFCs has not been modified by this feature.</td>
<td>—</td>
</tr>
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</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

Feature Information for BGP Event-Based VPN Import

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.
The BGP Event-Based VPN Import feature introduces a modification to the existing Border Gateway Protocol (BGP) path import process. The enhanced BGP path import is driven by events; when a BGP path changes, all of its imported copies are updated as soon as processing is available. Convergence times are significantly reduced because there is no longer any delay in the propagation of routes due to the software waiting for a periodic scanner time interval before processing the updates. To implement the new processing, new command-line interface (CLI) commands are introduced.

The following commands were introduced or modified:

- `bgp scan-time`
- `import path limit`
- `import path selection`
- `maximum-path ebgp`
- `maximum-path ibgp`
- `show ip bgp vpnv4`
- `show ip bgp vpnv6`

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP Event-Based VPN Import</td>
<td>Cisco IOS XE Release 2.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cisco IOS XE Release 3.3SG</td>
<td></td>
</tr>
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</table>

Table 61: Feature Information for BGP Event-Based VPN Import
BGP Best External

The BGP Best External feature provides the network with a backup external route to avoid loss of connectivity of the primary external route. The BGP Best External feature advertises the most preferred route among those received from external neighbors as a backup route. This feature is beneficial in active-backup topologies, where service providers use routing policies that cause a border router to choose a path received over an Interior Border Gateway Protocol (iBGP) session (of another border router) as the best path for a prefix even if it has an Exterior Border Gateway Protocol (eBGP) learned path. This active-backup topology defines one exit or egress point for the prefix in the autonomous system and uses the other points as backups if the primary link or eBGP peering is unavailable. The policy causes the border router to hide the paths learned over its eBGP sessions from the autonomous system because it does not advertise any path for such prefixes. To cope with this situation, some devices advertise one externally learned path called the best external path.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for BGP Best External

- The Bidirectional Forwarding Detection (BFD) protocol must be enabled to quickly detect link failures.
• Ensure that the BGP and the Multiprotocol Label Switching (MPLS) network is up and running with the customer site connected to the provider site by more than one path (multihomed).

• The backup path must have a unique next hop that is not the same as the next hop of the best path.

• BGP must support lossless switchover between operational paths.

Restrictions for BGP Best External

• The BGP Best External feature will not install a backup path if BGP Multipath is installed and a multipath exists in the BGP table. One of the multipaths automatically acts as a backup for the other paths.

• The BGP Best External feature is not supported with the following features:
  • MPLS VPN Carrier Supporting Carrier
  • MPLS VPN Inter-Autonomous Systems, option B
  • MPLS VPN Per Virtual Routing and Forwarding (VRF) Label

• The BGP Best External feature cannot be configured with Multicast or L2VPN VRF address families.

• The BGP Best External feature cannot be configured on a route reflector, unless it is running Cisco IOS XE Release 3.4S or later.

• The BGP Best External feature does not support NSF/SSO. However, ISSU is supported if both Route Processors have the BGP Best External feature configured.

• The BGP Best External feature can only be configured on VPNv4, VPNv6, IPv4 VRF, and IPv6 VRF address families.

• When you configure the BGP Best External feature using the `bgp advertise-best-external` command, you need not enable the BGP PIC feature with the `bgp additional-paths install` command. The BGP PIC feature is automatically enabled by the BGP Best External feature.

• When you configure the BGP Best External feature, it will override the functionality of the "MPLS VPN--BGP Local Convergence" feature. However, you do not have to remove the `protection local-prefixes` command from the configuration.

Information About BGP Best External

BGP Best External Overview

Service providers use routing policies that cause a border router to choose a path received over an iBGP session (of another border router) as the best path for a prefix even if it has an eBGP learned path. This practice is popularly known as active-backup topology and is done to define one exit or egress point for the prefix in the autonomous system and to use the other points as backups if the primary link or eBGP peering is unavailable.

The policy, though beneficial, causes the border router to hide the paths learned over its eBGP sessions from the autonomous system because the border router does not advertise any path for such prefixes. To cope with this situation, some routers advertise one externally learned path called the best external path. The best external behavior causes the BGP selection process to select two paths to every destination:
The best path is selected from the complete set of routes known to that destination.

The best external path is selected from the set of routes received from its external peers.

BGP advertises the best path to external peers. Instead of withdrawing the best path from its internal peers when it selects an iBGP path as the best path, BGP advertises the best external path to the internal peers.

The BGP Best External feature is an essential component of the Prefix-Independent Convergence (PIC) edge for both Internet access and MPLS VPN scenarios and makes alternate paths available in the network in the active-backup topology.

What the Best External Route Means

The BGP Best External feature uses a “best external route” as a backup path, which, according to draft-marques-idr-best-external, is the most preferred route among those received from external neighbors. The most preferred route from external neighbors can be the following:

- Two routers in different clusters that have an Interior Border Gateway Protocol (iBGP) session between them.
- Two routers in different autonomous systems of a confederation that have an External Border Gateway Protocol (eBGP) session between them.

The best external route might be different from the best route installed in the Routing Information Base (RIB). The best route could be an internal route. By allowing the best external route to be advertised and stored, in addition to the best route, networks gain faster restoration of connectivity by providing additional paths that may be used if the primary path fails.

How the BGP Best External Feature Works

The BGP Best External feature is based on Internet Engineering Task Force (IETF) draft-marques-idr-best-external.txt. The BGP Best External feature advertises a best external route to its internal peers as a backup route. The backup route is stored in the RIB and Cisco Express Forwarding. If the primary path fails, the BGP PIC functionality enables the best external path to take over, enabling faster restoration of connectivity.

Figure 65: MPLS VPN: Best External at the Edge of MPLS VPN
The figure above shows an MPLS VPN using the BGP Best External feature. The network includes the following components:

- E-BGP sessions exist between the provider edge (PE) and customer edge (CE) routers.
- PE1 is the primary router and has a higher local preference setting.
- Traffic from CE2 uses PE1 to reach router CE1.
- PE1 has two paths to reach CE1.
- CE1 is dual-homed with PE1 and PE2.
- PE1 is the primary path and PE2 is the backup path.

In the figure above, traffic in the MPLS cloud flows through PE1 to reach CE1. Therefore, PE2 uses PE1 as the best path and PE2 as the backup path.

PE1 and PE2 are configured with the BGP Best External feature. BGP computes both the best path (the PE1-CE1 link) and a backup path (PE2) and installs both paths into the RIB and Cisco Express Forwarding. The best external path (PE2) is advertised to the peer routers, in addition to the best path.

When Cisco Express Forwarding detects a link failure on the PE1-CE1 link, Cisco Express Forwarding immediately switches to the backup path PE2. Traffic is quickly rerouted due to local Fast Convergence in Cisco Express Forwarding using the backup path. Thus, traffic loss is minimized and fast convergence is achieved.

**Configuration Modes for Enabling BGP Best External**

You can enable the BGP Best External feature in different modes, each of which protects Virtual Routing and Forwarding (VRF) in its own way:

- If you issue the `bgp advertise-best-external` command in VPNv4 address family configuration mode, it applies to all IPv4 VRFs. If you issue the command in this mode, you need not issue it for specific VRFs.
- If you issue the `bgp advertise-best-external` command in IPv4 address family configuration mode, it applies only to that VRF.

**BGP Best External Path on RR for Intercluster**

Beginning with Cisco IOS XE Release 3.4S, BGP Best External is extended to BGP Best External for Intercluster RRs. This feature provides path diversity between RR clusters, providing best external functionality toward non-client iBGP peers. The feature is also known as the “intercluster best external path.”

Best external path at an RR means the best path within the RR’s cluster. This path might also be referred to as the best internal path.

When an RR (RR1) chooses a non-client iBGP path (that is, a path learned from another RR, let’s say RR2) as its overall best, with the BGP Best External for Intercluster RRs feature, RR1 will be able to advertise its best internal path to the non-client iBGP peers. This will help RR2 to learn an additional path, providing a diverse path.
Best external functionality at RRs is only for non-client iBGP peers. An RR cannot advertise best external paths to its clients because it has to advertise its overall best path (which can be either a client path or non-client or eBGP path).

The best external path calculated by the RR is the best internal path for the cluster. It will be advertised to the non-client iBGP peers only when the overall best path at this RR is a non-client iBGP path.

When there are multiple RRs, each in its own cluster, each RR must have the `neighbor advertise best-external` command configured for each of its neighbor RRs.

If the RR is in the forwarding plane, the `bgp additional paths install` command is necessary.

### CLI Differences for Best External Path on an RR for Intercluster

Prior to Cisco IOS XE Release 3.4S, the BGP Best External feature was allowed on a PE only, and it was configured by the `bgp advertise-best-external` command. The calculation of the backup path, installation, and advertisement were tied together in one command.

Beginning with Cisco IOS XE Release 3.4S, the BGP Best External feature is allowed on PEs and RRs. The functionality of the `bgp advertise-best-external` command is divided among the following three commands that calculate, install, and advertise the best external path:

- `bgp additional-path select best-external`
- `bgp additional-path install`
- `neighbor advertise diverse-path best-external`

If the `bgp additional-path select best-external` command is not configured, the system will calculate and install the best external path, but not advertise it.

The `neighbor advertise diverse-path best-external` command enables the advertisement of the best external path to the specified neighbor.

### Rules Used to Calculate the BGP Best External Path for Intercluster RRs

The best internal path implementation on an RR toward non-clients (different cluster RRs) is calculated based on the following rules:

1. Calculate the overall primary bestpath on the RR per the normal bestpath selection rules.
2. If a backup path configuration is enabled, calculate the second bestpath (which is a different path from the primary bestpath selected in Rule 1 and has a different nexthop from this bestpath), which is marked as the backup path. Backup path selection is enabled using the `bgp additional-paths install` or `bgp additional-paths select [best-external] [backup]` command.
3. If the overall best path on the RR is a non-client iBGP path and not an eBGP path, calculate the best external/internal path from the remaining paths after excluding results from Rule 1 and Rule 2 and by ignoring all the other paths from the other clusters and run normal bestpath rules by including all the remaining eBGP and iBGP paths. Select the newly obtained bestpath and mark it as the best internal path.
4. Advertise this best internal path, which is either eBGP (received from CE peers for RR/ASBR) or iBGP (received from RR clients) toward the non-client RRs when `neighbor advertise best-external` is configured towards the non-client RRs.
5. If the overall best path is a path received from either an RR client or eBGP peer (in case of RR/ASBR) either an iBGP or an eBGP path will be chosen as best path per the normal bestpath algorithm. Because the overall best path is an internal client path, the normal advertisement rules will automatically advertise this path to non-client iBGP peers/RRs. This behavior is the same as the existing behavior (when best external is not enabled on RR) when an RR client’s path is chosen as the overall bestpath.

6. We do not allow a best external path to be configured on an RR towards RR-clients. The `neighbor advertise best-external` command can be configured on RR/ASBR only for non-clients or peering with RR in the other clusters.

7. When multipath is enabled on the RR and only when the overall bestpath is from a non-client and if some of the intracluster client paths are also marked as multipaths, when best external is enabled on the RR (`neighbor advertise best-external` towards the RR non-client), the algorithm selects the older multipath among the intra-cluster client multipaths (paths obtained from RR clients and eBGP peers within the cluster) and marks it as best internal path and announces it to the non-clients as best external path, so that the non-clients get path diversity from this cluster. If there are no intra-cluster multipaths found, we choose the best external path per Rules 3 through 5.

How to Configure BGP Best External

Configuring the BGP Best External Feature

Perform the following task to configure the BGP Best External feature. This task shows how to configure the BGP Best External feature in either an IPv4 or VPNv4 address family. In VPNv4 address family configuration mode, the BGP Best External feature applies to all IPv4 Virtual Routing Forwarding (VRF); you need not configure it for specific VRFs. If you issue the `bgp advertise-best-external` command in IPv4 VRF address family configuration mode, the BGP Best External feature applies only to that VRF.

Before you begin

- Configure the MPLS VPN and verify that it is working properly before configuring the BGP Best External feature. See the "Configuring MPLS Layer 3 VPNs" section for more information.
- Configure multiprotocol VRFs to allow you to share route-target policies (import and export) between IPv4 and IPv6 or configure separate route-target policies for IPv4 and IPv6 VPNs. For information about configuring multiprotocol VRFs, see the "MPLS VPN--VRF CLI for IPv4 and IPv6 VPNs section".
- Ensure that the customer edge (CE) router is connected to the network by at least two paths.

SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. Do one of the following:
   • `address-family ipv4 [unicast | vrf vrf-name]`
   • or
   • `address-family vpnv4 [unicast]`
### Configuring the BGP Best External Feature

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example: <code>Router&gt; enable</code></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>2</td>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example: <code>Router# configure terminal</code></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>router bgp 40000</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td></td>
<td>Example: <code>Router(config)# router bgp 40000</code></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Do one of the following:</td>
<td>Specifies the IPv4 or VPNv4 address family and enters address family configuration mode.</td>
</tr>
<tr>
<td></td>
<td>• address-family ipv4 [unicast</td>
<td>vrf vrf-name]</td>
</tr>
<tr>
<td></td>
<td>• or</td>
<td>• The <strong>vrf</strong> keyword and <strong>vrf-name</strong> argument specify the name of the VRF instance to associate with subsequent IPv4 address family configuration mode commands.</td>
</tr>
<tr>
<td></td>
<td>• address-family vpnv4 [unicast]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• or</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Example: <code>Router(config-router)# address-family ipv4 unicast</code></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Example: <code>Router(config-router)# address-family vpnv4</code></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>bgp advertise-best-external</td>
<td>Calculates and uses an external backup path and installs it into the RIB and Cisco Express Forwarding.</td>
</tr>
<tr>
<td></td>
<td>Example: <code>Router(config-router-af)# bgp advertise-best-external</code></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>neighbor ip-address remote-as autonomous-system-number</td>
<td>Adds the IP address of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local router.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
</tbody>
</table>
### Command or Action

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Router(config-router-af)# neighbor 192.168.1.1 remote-as 45000</td>
<td>By default, neighbors that are defined using the <code>neighbor remote-as</code> command in router configuration mode exchange only IPv4 unicast address prefixes. To exchange other address prefix types, neighbors must also be activated using the <code>neighbor activate</code> command in address family configuration mode for the other prefix types.</td>
</tr>
<tr>
<td><strong>Step 7</strong> neighbor ip-address activate</td>
<td>Enables the neighbor to exchange prefixes for the IPv4 unicast address family with the local router.</td>
</tr>
<tr>
<td>Example: Router(config-router-af)# neighbor 192.168.1.1 activate</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong> neighbor ip-address fall-over [bfd</td>
<td>route-map map-name]</td>
</tr>
<tr>
<td>Example: Router(config-router-af)# neighbor 192.168.1.1 fall-over bfd</td>
<td></td>
</tr>
<tr>
<td><strong>Step 9</strong> end</td>
<td>(Optional) Exits address family configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Router(config-router-af)# end</td>
<td></td>
</tr>
</tbody>
</table>

### Verifying the BGP Best External Feature

Perform the following task to verify that the BGP Best External feature is configured correctly.

#### SUMMARY STEPS

1. `enable`
2. `show vrf detail`
3. `show ip bgp ipv4 mdt all | rd vrf | multicast | tunnel unicast or show ip bgp vpn4 all rd route-distinguisher | vrf vrf-name rib-failure ip-prefix/length longer-prefixes | network-address mask longer-prefixes | cidr-only community community-list dampened-paths filter-list | flap-statistics inconsistent-as neighbors paths line | peer-group quote-regexp regexp | summary labels`
4. `show bgp vpn4 unicast vrf vrf-name ip-address`
5. `show ip route vrf vrf-name repair-paths ip-address`
6. `show ip cef vrf vrf-name ip-address detail`

#### DETAILED STEPS

**Step 1** `enable`
Use this command to enable privileged EXEC mode. Enter your password, if prompted. For example:

**Example:**

Router> enable
Router#

**Step 2** 
**show vrf detail**

Use this command to verify that the BGP Best External feature is enabled. The following `show vrf detail` command output shows that the BGP Best External feature is enabled.

**Example:**

```
Router# show vrf detail
VRF test1 (VRF Id = 1); default RD 400:1; default VPNID <not set>
  Interfaces:
    Se4/0
Address family ipv4 (Table ID = 1 (0x1)):
  Export VPN route-target communities
    RT:100:1
    RT:200:1
    RT:400:1
  Import VPN route-target communities
    RT:100:1
    RT:200:1
    RT:300:1
    RT:400:1
  No import route-map
  No export route-map
  VRF label distribution protocol: not configured
  VRF label allocation mode: per-prefix
  Prefix protection with additional path enabled
Address family ipv6 not active.
```

**Step 3** 
**show ip bgp ipv4 mdt all | rd vrf | multicast | tunnel unicast or show ip bgp vpn4 all rd route-distinguisher | vrf vrf-name rib-failure ip-prefix/length longer-prefixes] | network-address mask longer-prefixes] | cidr-only community community-list dampened-paths filter-list | [flap-statistics inconsistent-as neighbors paths line] | peer-group quote-regexp regexp] [summary labels**

Use this command to verify that the best external route is advertised. In the command output, the code b indicates a backup path and the code x designates the best external path.

**Example:**

```
Router# show ip bgp vpnv4 all
BGP table version is 1104964, local router ID is 10.2.2.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
r RIB-failure, S Stale, multipath,
b backup-path, x best-external
Origin codes: i - IGP, e - EGP, ? - incomplete
Network Next Hop Metric LocPrf Weight Path
Route Distinguisher: 11:12 (default for vrf blue)
*>11.0.0.1/32 10.10.3.3 0 200 0 1 ?
* 1 10.10.3.3 0 200 0 1 ?
* 10.0.0.1 0 0 1 ?
*bx 10.0.0.1 0 0 1 ?
* 10.0.0.1 0 0 1 ?
```

**Step 4**  
**show bgp vpnv4 unicast vrf vrf-name ip-address**

Use this command to verify that the best external route is advertised.

**Example:**
Router# show bgp vpnv4 unicast vrf vpn1 10.10.10.10
BGP routing table entry for 10:10:10.10.10.10/32, version 10
Paths: (2 available, best #1, table vpn1)
  Advertise-best-external
  Advertised to update-groups:
    1 2
  200
    10.6.6.6 (metric 21) from 10.6.6.6 (10.6.6.6)
    Origin incomplete, metric 0, localpref 200, valid, internal, best
    Extended Community: RT:1:1
    mpls labels in/out 23/23
  200
    10.1.2.1 from 10.1.2.1 (10.1.1.1)
    Origin incomplete, metric 0, localpref 100, valid,
    external, backup/repair, advertise-best-external
    Extended Community: RT:1:1, recursive-via-connected
    mpls labels in/out 23/nolabel

Step 5  show ip route vrf  vrf-name  repair-paths  ip-address
Use this command to display the repair route.

Example:

Router# show ip route vrf vpn1 repair-paths

Routing Table: vpn1
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2
i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
ia - IS-IS inter area, * - candidate default, U - per-user static route
o - ODR, P - periodic downloaded static route, H - NHRP
+ - replicated route, % - next hop override
Gateway of last resort is not set
  B 10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
  10.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
  B 10.1.1.0/24 (200/0) via 10.6.6.6, 00:38:33
      [RPR](200/0) via 10.1.2.1, 00:38:33
      [RPR](200/0) via 10.1.2.1, 00:38:33
  B 10.1.6.0/24 (200/0) via 10.6.6.6, 00:38:33
      [RPR](200/0) via 10.1.2.1, 00:38:33

Step 6  show ip cef vrf  vrf-name  ip-address  detail
Use this command to display the best external route.

Example:

Router# show ip cef vrf test 10.71.8.164 detail
10.71.8.164/30, epoch 0, flags rib defined all labels
  recursive via 10.249.0.102 label 35
  nexthop 10.249.246.101 Ethernet0/0 label 25
  recursive via 10.249.0.104 label 28
Configuring Best External Path on an RR for an Intercluster

Perform the following task to configure a best external path on an RR for an intercluster. The steps in this particular task configure RR1 in the figure below, in the IPv4 address family. The step that configures address family lists the other address families supported.

*Figure 66: Scenario for Configuring a BGP Best External Path on a RR for an Intercluster*

**SUMMARY STEPS**

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. neighbor ip-address remote-as autonomous-system-number
5. neighbor ip-address remote-as autonomous-system-number
6. address-family ipv4 unicast
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| 1    | enable            | Enables privileged EXEC mode.  
  *Example:*  
  ```bash  
  Router> enable  
  ``` |
| 2    | configure terminal | Enters global configuration mode.  
  *Example:*  
  ```bash  
  Router# configure terminal  
  ``` |
| 3    | router bgp autonomous-system-number | Enters router configuration mode for the specified routing process.  
  *Example:*  
  ```bash  
  Router(config)# router bgp 1  
  ``` |
| 4    | neighbor ip-address remote-as autonomous-system-number | Adds an entry to the BGP or multiprotocol BGP neighbor table.  
  *Example:*  
  ```bash  
  Router(config-router)# neighbor 10.5.1.1 remote-as 1  
  ``` |
| 5    | neighbor ip-address remote-as autonomous-system-number | Adds an entry to the BGP or multiprotocol BGP neighbor table.  
  *Example:*  
  ```bash  
  Router(config-router)# neighbor 10.5.1.2 remote-as 1  
  ``` |
| 6    | address-family ipv4 unicast | Specifies the address family and enters address family configuration mode.  
  *Example:*  
  ```bash  
  Router(config-router)# address-family ipv4 unicast  
  ``` |
| 7    | neighbor ip-address activate | Enables the exchange of information with a BGP neighbor.  
  *Example:*  
  ```bash  
  Router(config-router-af)# neighbor 10.5.1.1 activate  
  ``` |
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 8</strong> neighbor ip-address activate</td>
<td>Enables the exchange of information with a BGP neighbor. • This step is for RR6.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router(config-router-af)# neighbor 10.5.1.2 activate</td>
<td></td>
</tr>
<tr>
<td><strong>Step 9</strong> bgp additional-paths select best-external</td>
<td>Configures the system to calculate a best external path (external to RR cluster).</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router(config-router-af)# bgp additional-paths select best-external</td>
<td></td>
</tr>
<tr>
<td><strong>Step 10</strong> bgp additional-paths install</td>
<td>Enables BGP to calculate a backup path for a given address family and to install it into the RIB and CEF. • This step is necessary if the RR is enabled for forwarding (the RR is in the forwarding plane). Otherwise, this step is unnecessary.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router(config-router-af)# bgp additional-paths install</td>
<td></td>
</tr>
<tr>
<td><strong>Step 11</strong> neighbor ip-address advertise best-external</td>
<td>(Optional) Configures a neighbor to receive the best external path in an advertisement. • This step is for RR3.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router(config-router-af)# neighbor 10.5.1.1 advertise best-external</td>
<td></td>
</tr>
<tr>
<td><strong>Step 12</strong> neighbor ip-address advertise best-external</td>
<td>(Optional) Configures a neighbor to receive the best external path in an advertisement. • This step is for RR6.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router(config-router-af)# neighbor 10.5.1.2 advertise best-external</td>
<td></td>
</tr>
<tr>
<td><strong>Step 13</strong> end</td>
<td>(Optional) Exits address family configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router(config-router-af)# end</td>
<td></td>
</tr>
</tbody>
</table>

In the scenario shown above, the following paths are selected as best path, backup bath, and best internal path on the three RRs located in the three different clusters:

**On RR1:**

**On RR3:**

**On RR6:**

<table>
<thead>
<tr>
<th>To Reach Prefix 10/8</th>
<th>Next Hop:</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE5 (best path, local preference = 200)</td>
<td></td>
</tr>
<tr>
<td>PE3 (backup path, local preference = 150)</td>
<td></td>
</tr>
<tr>
<td>PE3 (best internal path, local preference = 150)</td>
<td></td>
</tr>
</tbody>
</table>
Configuration Examples for BGP Best External

Example: Configuring the BGP Best External Feature

The following example shows how to configure the BGP Best External feature in VPNv4 mode:

```plaintext
vrf definition test1
rd 400:1
route-target export 100:1
route-target export 200:1
route-target export 300:1
route-target export 400:1
route-target import 100:1
route-target import 200:1
route-target import 300:1
route-target import 400:1
address-family ipv4
exit-address-family
exit
!
interface Ethernet1/0
  vrf forwarding test1
  ip address 10.0.0.1 255.0.0.0
  exit
!
routing bgp 64500
  no synchronization
  bgp log-neighbor-changes
  neighbor 10.5.5.5 remote-as 64500
  neighbor 10.5.5.5 update-source Loopback0
  neighbor 10.6.6.6 remote-as 64500
  neighbor 10.6.6.6 update-source Loopback0
  no auto-summary
  !
  address-family vpnv4
  bgp advertise-best-external
  neighbor 10.5.5.5 activate
  neighbor 10.5.5.5 send-community extended
```
neighbor 10.6.6.6 activate
neighbor 10.6.6.6 send-community extended
exit-address-family
!
address-family ipv4 vrf test1
no synchronization
bgp recursion host
neighbor 192.168.13.2 remote-as 64511
neighbor 192.168.13.2 fall-over bfd
neighbor 192.168.13.2 activate
neighbor 192.168.13.2 as-override
exit-address-family

Example: Configuring a Best External Path on an RR for an Intercluster

The following example configures RR1 in the figure shown in the “Configuring a Best External Path on an RR for an Intercluster” section. RR1 is configured to calculate, install, and advertise the best external path to its intercluster RR neighbors.

RR1

router bgp 1
  neighbor 10.5.1.1 remote-as 1
  neighbor 10.5.1.2 remote-as 1
  address-family ipv4 unicast
  neighbor 10.5.1.1 activate
  neighbor 10.5.1.2 activate
  bgp additional-paths select best-external
  bgp additional-paths install
  neighbor 10.5.1.1 advertise best-external
  neighbor 10.5.1.2 advertise best-external
end

Additional References

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
<tr>
<td>Basic MPLS VPNs</td>
<td>“Configuring MPLS Layer 3 VPNs” module in the <em>MPLS: Layer 3 VPNs Configuration Guide</em></td>
</tr>
<tr>
<td>Multiprotocol VRFs</td>
<td>“MPLS VPN VRF CLI for IPv4 and IPv6 VPNs” module in the <em>MPLS: Layer 3 VPNs Configuration Guide</em></td>
</tr>
<tr>
<td>A failover feature that creates a new path after a link or node failure</td>
<td>MPLS VPN--BGP Local Convergence</td>
</tr>
</tbody>
</table>
### Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>draft-marques-idr-best-external</td>
<td>BGP Best External, Advertisement of the best external route to iBGP</td>
</tr>
</tbody>
</table>

### MIBs

<table>
<thead>
<tr>
<th>MIB</th>
<th>MIBs Link</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
</tr>
</tbody>
</table>

### RFCs

<table>
<thead>
<tr>
<th>RFC</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFC 1771</td>
<td>A Border Gateway Protocol 4 (BGP-4)</td>
</tr>
<tr>
<td>RFC 2547</td>
<td>BGP/MPLS VPNs</td>
</tr>
</tbody>
</table>

### Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

---

### Feature Information for BGP Best External

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to [www.cisco.com/go/cfn](http://www.cisco.com/go/cfn). An account on Cisco.com is not required.
Table 62: Feature Information for BGP Best External

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP Best External</td>
<td>Cisco IOS XE Release 3.2S</td>
<td>The BGP Best External feature provides the network with a backup external route to avoid loss of connectivity of the primary external route. This feature advertises the most preferred route among those received from external neighbors as a backup route. In Cisco IOS XE Release 3.2S, this feature was introduced. The following commands were introduced or modified: <code>bgp advertise-best-external</code>, <code>bgp recursion host</code>, <code>show ip bgp</code>, <code>show ip bgp vpnv4</code>, <code>show ip cef</code>, <code>show ip cef vrf</code>, <code>show ip route</code>, <code>show ip route vrf</code></td>
</tr>
<tr>
<td>BGP Best External Path on an RR for Intercluster</td>
<td>Cisco IOS XE Release 3.4S</td>
<td>The BGP Best External Path on RR for Intercluster feature provides path diversity between RR clusters. The feature provides best external functionality toward non-client iBGP peers, and is also known as &quot;intercluster best external path.&quot; The following commands were introduced: <code>bgp additional-pathsselect</code>, <code>neighbor advertise best-external</code></td>
</tr>
</tbody>
</table>
 CHAPTER 47

BGP PIC Edge for IP and MPLS-VPN

The BGP PIC Edge for IP and MPLS-VPN feature improves BGP convergence after a network failure. This convergence is applicable to both core and edge failures and can be used in both IP and MPLS networks. The BGP PIC Edge for IP and MPLS-VPN feature creates and stores a backup/alternate path in the routing information base (RIB), forwarding information base (FIB), and Cisco Express Forwarding so that when a failure is detected, the backup/alternate path can immediately take over, thus enabling fast failover.

Note

In this document, the BGP PIC Edge for IP and MPLS-VPN feature is called BGP PIC.

- Finding Feature Information, on page 745
- Prerequisites for BGP PIC, on page 745
- Restrictions for BGP PIC, on page 746
- About BGP PIC, on page 746
- How to Configure BGP PIC, on page 755
- Configuration Examples for BGP PIC, on page 758
- Additional References, on page 761
- Feature Information for BGP PIC, on page 763

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for BGP PIC

- Ensure that the Border Gateway Protocol (BGP) and the IP or Multiprotocol Label Switching (MPLS) network is up and running with the customer site connected to the provider site by more than one path (multihomed).
• Ensure that the backup/alternate path has a unique next hop that is not the same as the next hop of the best path.
• Enable the Bidirectional Forwarding Detection (BFD) protocol to quickly detect link failures of directly connected neighbors.

Restrictions for BGP PIC

The following restrictions apply to the BGP PIC feature:

• With BGP Multipath, the BGP Prefix-Independent Convergence (PIC) feature is already supported.
• In MPLS VPNs, the BGP PIC feature is not supported with MPLS VPN Inter-Autonomous Systems Option B.
• The BGP PIC feature supports prefixes only for IPv4, IPv6, VPNv4, and VPNv6 address families.
• The BGP PIC feature cannot be configured with Multicast or L2VPN Virtual Routing and Forwarding (VRF) address families.
• If the route reflector is only in the control plane, then you do not need BGP PIC, because BGP PIC addresses data plane convergence.
• When two PE devices become each other’s backup/alternate path to a CE device, traffic might loop if the CE device fails. Neither device will reach the CE device, and traffic will continue to be forwarded between the PE devices until the time-to-live (TTL) timer expires.
• The BGP PIC feature does not support Nonstop Forwarding with Stateful Switchover (NSF/SSO). However, ISSU is supported if both Route Processors have the BGP PIC feature configured.
• The BGP PIC feature solves the traffic forwarding only for a single network failure at both the edge and the core.
• The BGP PIC feature does not work with the BGP Best External feature. If you try to configure the BGP PIC feature after configuring the BGP Best External feature, you receive an error.

About BGP PIC

In the following sections, we describe the BGP PIC feature in details, how to detect a failure, a scenario and how to configure it.

Benefits

• An extra path for failover allows faster restoration of connectivity when a primary path is invalid or withdrawn.
• Reduction of traffic loss.
• Constant convergence time so that the switching time is the same for all prefixes.
BGP Convergence

Under normal circumstances, BGP can take several seconds to a few minutes to converge after a change in the network. At a high level, BGP goes through the steps of the following process:

1. BGP learns of failures through either Interior Gateway Protocol (IGP) or BFD events or interface events.
2. BGP withdraws the routes from the routing information base (RIB), and the RIB withdraws the routes from the forwarding information base (FIB) and distributed FIB (dFIB). This process clears the data path for the affected prefixes.
3. BGP sends withdrawn messages to its neighbors.
4. BGP calculates the next best path to the affected prefixes.
5. BGP inserts the next best path for affected prefixes into the RIB, and the RIB installs them in the FIB and dFIB.

This process may take from few seconds to a few minutes to complete. It depends on, the latency of the network, the convergence time across the network, and the local load on the devices. The data plane converges only after the control plane converges.

Improve Convergence

The BGP PIC functionality is achieved by an extra functionality in the BGP, RIB, Cisco Express Forwarding, and MPLS.

• BGP Functionality

BGP PIC affects prefixes under IPv4 and VPNv4 address families. For those prefixes, BGP calculates an extra second best path, along with the primary best path. (The second best path is called the backup or alternate path.) BGP installs the best and backup or alternate paths for the affected prefixes into the BGP RIB. The backup or alternate path provides a fast reroute mechanism to counter a singular network failure. BGP also includes the alternate or backup path in its application programming interface (API) to the IP RIB.

• RIB Functionality

For BGP PIC, RIB installs an alternate path per route if one is available. If the RIB selects a BGP route containing a backup or alternate path, it installs the backup or alternate path with the best path. The RIB also includes the alternate path in its API with the FIB.

• Cisco Express Forwarding Functionality

With BGP PIC, Cisco Express Forwarding stores an alternate path per prefix. When the primary path goes down, Cisco Express Forwarding searches for the backup or alternate path in a prefix-independent manner. Cisco Express Forwarding also listens to BFD events to rapidly detect local failures.

• MPLS Functionality

MPLS Forwarding is similar to Cisco Express Forwarding in that it stores alternate paths and switches to an alternate path if the primary path goes down.

When the BGP PIC feature is enabled, BGP calculates a backup or alternate path per prefix and installs it into BGP RIB, IP RIB, and FIB. This improves convergence after a network failure. There are two types of network failures that the BGP PIC feature detects:
• Core node or link failure (internal Border Gateway Protocol [iBGP] node failure): If a PE node or link fails, then the failure is detected through IGP convergence. IGP conveys the failure through the RIB to the FIB.

• Local link or immediate neighbor node failure (external Border Gateway Protocol [eBGP] node or link failure): To detect a local link failure or eBGP single-hop peer node failure in less than a second, you must enable BFD. Cisco Express Forwarding looks for BFD events to detect a failure of an eBGP single-hop peer.

**Convergence in the Data Plane**

Upon detecting a failure, Cisco Express Forwarding detects the alternate next hop for all prefixes that are affected by the failure. The data plane convergence is achieved in subseconds depending on whether the BGP PIC implementation exists in the software or hardware.

**Convergence in the Control Plane**

Upon detecting a failure, BGP learns about the failure through IGP convergence or BFD events and sends withdrawn messages for the prefixes, recalculating the best and backup or alternate paths, and advertising the next best path across the network.

**BGP Fast Reroute**

BGP Fast Reroute (FRR) provides a best path and a backup or alternate path in BGP, RIB, and Cisco Express Forwarding. BGP FRR provides a fast reroute mechanism into the RIB and Cisco Express Forwarding (CEF) on the backup BGP next hop to reach a destination when the current best path is not available.

BGP FRR precomputes a second best path in BGP and gives it to the RIB and Cisco Express Forwarding as a backup or alternate path, and CEF programs it into line cards.

The BGP PIC feature provides the ability for CEF to quickly switch the traffic to the other egress ports if the current next hop or the link to this next hop goes down.
Detect a Failure

IGP detects a failure in the iBGP (remote) peer; it may take a few seconds to detect the failure. Convergence can occur in subseconds or seconds, depending on whether PIC is enabled on the line cards.

If the failure is among the directly connected neighbors (eBGP), and if you use BFD to detect when a neighbor has gone down. Depending on whether PIC is enabled on the line cards, the detection may happen within subseconds and the convergence can occur in subseconds or few seconds.

How BGP PIC Can Achieve Subsecond Convergence

The BGP PIC feature works at the Cisco Express Forwarding level, and Cisco Express Forwarding can be processed in both hardware line cards and in the software.

- For platforms that support Cisco Express Forwarding processing in the line cards, the BGP PIC feature can converge in subseconds.
- For platforms that do not use Cisco Express Forwarding in hardware line cards, Cisco Express Forwarding is achieved in the software. The BGP PIC feature works with the Cisco Express Forwarding through the software and achieves convergence within seconds.
How BGP PIC Improves Upon the Functionality of MPLS VPN BGP Local Convergence

The BGP PIC feature is an enhancement to the "MPLS VPN--BGP Local Convergence" feature, which provides a failover mechanism that recalculates the best path and installs the new path in forwarding after a link failure. The feature maintains the local label for 5 minutes to ensure that the traffic uses the backup/alternate path, thus minimizing traffic loss.

The BGP PIC feature improves the LoC time to under a second by calculating a backup/alternate path in advance. When a link failure occurs, the traffic is sent to the backup/alternate path.

When you configure the BGP PIC feature, it will override the functionality of the "MPLS VPN--BGP Local Convergence" feature. You do not have to remove the protection local-prefixes command from the configuration.

Enable BGP PIC

Because many service provider networks contain many VRFs, the BGP PIC allows you to configure, at a time, the BGP PIC feature for all VRFs.

- VPNv4 address family configuration mode protects all VRFs.
- VRF-IPv4 address family configuration mode protects only IPv4 VRFs.
- Router configuration mode protects prefixes in the global routing table.

BGP PIC Scenario

You can configure the BGP PIC functionality to achieve fast convergence.

IP PE-CE Link and Node Protection on the CE Side (Dual PEs)

The figure below shows a network that uses the BGP PIC feature. The network includes the following components:

- eBGP sessions exist between the PE and CE devices.
- Traffic from CE1 uses PE1 to reach network 192.168.9.0/24 through device CE3.
- CE1 has two paths:
  - PE1 as the primary path.
  - PE2 as the backup/alternate path.

CE1 is configured with the BGP PIC feature. BGP computes PE1 as the best path and PE2 as the backup/alternate path and installs both routes into the RIB and Cisco Express Forwarding plane. When the CE1-PE1 link goes down, Cisco Express Forwarding detects the link failure and points the forwarding object to the backup/alternate path. Traffic is quickly rerouted due to local fast convergence in Cisco Express Forwarding.
The figure below shows a network that uses the BGP PIC feature on CE1. The network includes the following components:

- eBGP sessions exist between the PE and CE devices.
- Traffic from CE1 uses PE1 to reach network 192.168.9.0/24 through device CE3.
- CE1 has two paths:
  - PE1 as the primary path.
  - PE2 as the backup/alternate path.
- An iBGP session exists between the CE1 and CE2 devices.

In this example, CE1 and CE2 are configured with the BGP PIC feature. BGP computes PE1 as the best path and PE2 as the backup/alternate path and installs both the routes into the RIB and Cisco Express Forwarding plane.

There should not be any policies set on CE1 and CE2 for the eBGP peers PE1 and PE2. Both CE devices must point to the eBGP route as next hop. On CE1, the next hop to reach CE3 is through PE1, so PE1 is the best path to reach CE3. On CE2, the best path to reach CE3 is PE2. CE2 advertises itself as the next hop to CE1, and CE1 does the same to CE2. As a result, CE1 has two paths for the specific prefix and it usually selects the directly connected eBGP path over the iBGP path according to the best path selection rules. Similarly, CE2 has two paths—an eBGP path through PE2 and an iBGP path through CE1-PE1.

When the CE1-PE1 link goes down, Cisco Express Forwarding detects the link failure and points the forwarding object to the backup/alternate node CE2. Traffic is quickly rerouted due to local fast convergence in Cisco Express Forwarding.

If the CE1-PE1 link or PE1 goes down and BGP PIC is enabled on CE1, BGP recomputes the best path, removing the next hop PE1 from RIB and reinstalling CE2 as the next hop into the RIB and Cisco Express Forwarding. CE1 automatically gets a backup/alternate repair path into Cisco Express Forwarding and the traffic loss during forwarding is now in subseconds, thereby achieving fast convergence.
IP MPLS PE-CE Link Protection for the Primary or Backup Alternate Path

The figure above shows a network that uses the BGP PIC feature on CE1 and CE2. The network includes the following components:

- eBGP sessions exist between the PE and CE devices.
- The PE devices are VPNv4 iBGP peers with reflect devices in the MPLS network.
- Traffic from CE1 uses PE1 to reach network 192.168.9.0/24 through device CE3.
- CE3 is dual-homed with PE3 and PE4.
- PE1 has two paths to reach CE3 from the reflect routers:
  - PE3 is the primary path with the next hop as a PE3 address.
  - PE4 is the backup/alternate path with the next hop as a PE4 address.

In this example, all the PE devices can be configured with the BGP PIC feature under IPv4 or VPNv4 address families.

For BGP PIC to work in BGP for PE-CE link protection, set the policies on PE3 and PE4 for prefixes received from CE3 so that one of the PE devices acts as the primary and the other as the backup/alternate. Usually, this is done using local preference and giving better local preference to PE3. In the MPLS cloud, traffic internally flows through PE3 to reach CE3. Thus, PE1 has PE3 as the best path and PE4 as the second path.

When the PE3-CE3 link goes down, Cisco Express Forwarding detects the link failure, and PE3 recomputes the best path, selects PE4 as the best path, and sends a withdraw message for the PE3 prefix to the reflect routers. Some of the traffic goes through PE3-PE4 until BGP installs PE4 as the best path route into the RIB and Cisco Express Forwarding. PE1 receives the withdraw, recomputes the best path, selects PE4 as the best path, and installs the routes into the RIB and Cisco Express Forwarding plane.

Thus, with BGP PIC enabled on PE3 and PE4, Cisco Express Forwarding detects the link failure and does in-place modification of the forwarding object to the backup/alternate node PE4 that already exists in Cisco Express Forwarding. PE4 knows that the backup/alternate path is locally generated and routes the traffic to the egress port connected to CE3. This way, traffic loss is minimized and fast convergence is achieved.
IP MPLS PE-CE Node Protection for Primary or Backup Alternate Path

The figure below shows a network that uses the BGP PIC feature on all the PE devices in an MPLS network.

**Figure 70: Enabling BGP PIC on all PEs devices in the MPLS Network**

The network includes the following components:

- eBGP sessions exist between the PE and CE devices.
- The PE devices are VPNv4 iBGP peers with reflect routers in the MPLS network.
- Traffic from CE1 uses PE1 to reach network 192.168.9.0/24 through device CE3.
- CE3 is dual-homed with PE3 and PE4.
- PE1 has two paths to reach CE3 from the reflect routers:
  - PE3 is the primary path with the next hop as a PE3 address.
  - PE4 is the backup/alternate path with the next hop as a PE4 address.

In this example, all the PE devices are configured with the BGP PIC feature under IPv4 and VPNv4 address families.

For BGP PIC to work in BGP for the PE-CE node protection, set the policies on PE3 and PE4 for the prefixes received from CE3 such that one of the PE devices acts as primary and the other as backup/alternate. Usually, this is done using local preference and giving better local preference to PE3. In the MPLS cloud, traffic internally flows through PE3 to reach CE3. So, PE1 has PE3 as the best path and PE4 as the second path.

When PE3 goes down, PE1 knows about the removal of the host prefix by IGP in subseconds, recomputes the best path, selects PE4 as the best path, and installs the routes into the RIB and Cisco Express Forwarding plane. Normal BGP convergence will happen while BGP PIC is redirecting the traffic through PE4, and packets are not lost.

Thus, with BGP PIC enabled on PE3, Cisco Express Forwarding detects the node failure on PE3 and points the forwarding object to the backup/alternate node PE4. PE4 knows that the backup/alternate path is locally generated and routes the traffic to the egress port using the backup/alternate path. This way, traffic loss is minimized.
No Local Policies Set on the PE Devices

PE1 and PE2 point to the eBGP CE paths as the next hop with no local policy. Each of the PE devices receives the other’s path, and BGP calculates the backup/alternate path and installs it into Cisco Express Forwarding, along with its own eBGP path towards CE as the best path. The limitation of the MPLS PE-CE link and node protection solutions is that you cannot change BGP policies. They should work without the need for a best-external path.

Local Policies Set on the PE Devices

Whenever there is a local policy on the PE devices to select one of the PE devices as the primary path to reach the egress CE, the `bgp advertise-best-external` command is needed on the backup/alternate node PE3 to propagate the external CE routes with a backup/alternate label into the route reflectors and the far-end PE devices.

Cisco Express Forwarding Recursion

Recursion is the ability to find the next longest matching path when the primary path goes down.

If BGP PIC is not installed, and if the next hop to a prefix fails, Cisco Express Forwarding finds the next path to reach the prefix by recursing through the FIB to find the next longest matching path to the prefix. This recursion mechanism is useful when the next hop is multiple hops away and there is more than one way of reaching the next hop.

However, with the BGP PIC feature, you may want to disable Cisco Express Forwarding recursion for the following reasons:

- Recursion slows down convergence when Cisco Express Forwarding searches all the FIB entries.
- BGP PIC Edge already precomputes an alternate path. It therefore eliminates the need for Cisco Express Forwarding recursion.

When the BGP PIC functionality is enabled, Cisco Express Forwarding recursion is disabled by default for two conditions:

- For next hops learned with a /32 network mask (host routes)
- For next hops that are directly connected.

For all other cases, Cisco Express Forwarding recursion is enabled.

You can issue the `bgp recursion host` command to disable or enable Cisco Express Forwarding recursion for BGP host routes. This provision is part of the BGP PIC functionality.

Note

When the BGP PIC feature is enabled, by default, `bgp recursion host` is configured for VPNv4 and VPNv6 address families and disabled for IPv4 and IPv6 address families.

To disable or enable Cisco Express Forwarding recursion for BGP directly connected next hops, run the `disable-connected-check` command.
How to Configure BGP PIC

Configuring BGP PIC

Because many service provider networks contain many VRFs, the BGP PIC feature allows you to configure the BGP PIC feature for all VRFs at once.

- VPNv4 address family configuration mode protects all the VRFs.
- VRF-IPv4 address family configuration mode protects only IPv4 VRFs.
- Router configuration mode protects prefixes in the global routing table.

For a full configuration example that includes configuring multiprotocol VRFs and shows output to verify that the feature is enabled, see the Example: Configuring BGP PIC, on page 758.

Before you begin

- If you are implementing the BGP PIC feature in an MPLS VPN, ensure that the network is working properly before configuring the BGP PIC feature. See “Configuring MPLS Layer 3 VPNs” for more information.

- If you are implementing the BGP PIC feature in an MPLS VPN, configure multiprotocol VRFs, which allow you to share route-target policies (import and export) between IPv4 and IPv6 or to configure separate route-target policies for IPv4 and IPv6 VPNs. For information about configuring multiprotocol VRFs, see “MPLS VPN—VRF CLI for IPv4 and IPv6 VPNs”.

- Ensure that the CE device is connected to the network by at least two paths.

SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. Do one of the following:
   - address-family ipv4 [unicast | vrf vrf-name]
   - address-family vpnv4 [unicast]
5. bgp additional-paths install
6. neighbor ip-address remote-as autonomous-system-number
7. neighbor ip-address activate
8. bgp recursion host
9. neighbor ip-address fall-over [bfd |route-map map-name]
10. end
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><code>enable</code></td>
<td>- Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><code>configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td><code>router bgp autonomous-system-number</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>Specifies the IPv4 or VPNv4 address family and enters address family configuration mode.</td>
</tr>
<tr>
<td>Do one of the following:</td>
<td>- The <code>unicast</code> keyword specifies the IPv4 or VPNv4 unicast address family.</td>
</tr>
<tr>
<td>• `address-family ipv4 [unicast</td>
<td>vrf vrf-name]`</td>
</tr>
<tr>
<td>• <code>address-family vpnv4 [unicast]</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>Calculates a backup/alternate path and installs it into the RIB and Cisco Express Forwarding.</td>
</tr>
<tr>
<td><code>bgp additional-paths install</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>Adds the IP address of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local router.</td>
</tr>
<tr>
<td><code>neighbor ip-address remote-as autonomous-system-number</code></td>
<td>- By default, neighbors that are defined using the <code>neighbor remote-as</code> command in router configuration mode exchange only IPv4 unicast address prefixes.</td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>Enables the neighbor to exchange prefixes for the IPv4 unicast address family with the local router.</td>
</tr>
<tr>
<td><code>neighbor ip-address activate</code></td>
<td>To exchange other address prefix types, neighbors must also be activated using the <code>neighbor activate</code> command in address family configuration mode for the other prefix types.</td>
</tr>
</tbody>
</table>
### Purpose

**Command or Action**

Device(config-router-af)# neighbor 192.168.1.1 activate

### Step 8

**bfg recursion host**

**Example:**

Device(config-router-af)# bgp recursion host

(Optional) Enables the recursive-via-host flag for IPv4, VPNv4, and VRF address families.

- When the BGP PIC feature is enabled, Cisco Express Forwarding recursion is disabled. Under most circumstances, you do not want to enable recursion when BGP PIC is enabled.

### Step 9

**neighbor ip-address fall-over [bfd | route-map map-name]**

**Example:**

Device(config-router-af)# neighbor 192.168.1.1 fall-over bfd

Enables BFD protocol support to detect when a neighbor has gone away, which can occur within a subsecond.

### Step 10

**end**

**Example:**

Device(config-router-af)# end

Exits address family configuration mode and returns to privileged EXEC mode.

---

**Disabling BGP PIC Core**

BGP PIC core feature is enabled by default. Use the following configuration to disable the BGP PIC core feature.

- Use the `cef table output-chain build favor convergence-speed` command in global configuration mode to re-enable the BGP PIC core feature.

#### SUMMARY STEPS

1. enable
2. configure terminal
3. cef table output-chain build favor memory-utilization
4. end

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
</tbody>
</table>
### Command or Action

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device&gt; enable</td>
<td></td>
</tr>
</tbody>
</table>

### Step 2

**configure terminal**

**Example:**

Device# configure terminal

### Step 3

**ceftable output-chain buildfavor memory-utilization**

**Example:**

Device(config)# cef table output-chain build favor memory-utilization

### Step 4

**end**

**Example:**

Device(config)# end

### Configuration Examples for BGP PIC

#### Example: Configuring BGP PIC

The following example shows how to configure the BGP PIC feature in VPNv4 address family configuration mode, which enables the feature on all VRFs. In the following example, there are two VRFs defined: blue and green. All the VRFs, including those in VRFs blue and green, are protected by backup/alternate paths.

```plaintext
vrf definition test1
  rd 400:1
  route-target export 100:1
  route-target export 200:1
  route-target export 300:1
  route-target export 400:1
  route-target import 100:1
  route-target import 200:1
  route-target import 300:1
  route-target import 400:1
  address-family ipv4
  exit-address-family
  exit

vrf forwarding test1
  ip address 10.0.0.1 255.0.0.0
  exit
  router bgp 3
  no synchronization
  bgp log-neighbor-changes
  redistribute static
  redistribute connected
  neighbor 10.6.6.6 remote-as 3
```
neighbor 10.6.6.6 update-source Loopback0
neighbor 10.7.7.7 remote-as 3
neighbor 10.7.7.7 update-source Loopback0
no auto-summary

! address-family vpnv4
  bgp additional-paths install
  neighbor 10.6.6.6 activate
  neighbor 10.6.6.6 send-community both
  neighbor 10.7.7.7 activate
  neighbor 10.7.7.7 send-community both
  exit-address-family

! address-family ipv4 vrf blue
  import path selection all
  import path limit 10
  no synchronization
  neighbor 10.11.11.11 remote-as 1
  neighbor 10.11.11.11 activate
  exit-address-family

! address-family ipv4 vrf green
  import path selection all
  import path limit 10
  no synchronization
  neighbor 10.13.13.13 remote-as 1
  neighbor 10.13.13.13 activate
  exit-address-family

The following `show vrf detail` command output shows that the BGP PIC feature is enabled:

Router# show vrf detail
VRF test1 (VRF Id = 1); default RD 400:1; default VPNID <not set>
  Interfaces:
  Se4/0
Address family ipv4 (Table ID = 1 (0x1)):
  Export VPN route-target communities
    RT:100:1   RT:200:1   RT:300:1
    RT:400:1
  Import VPN route-target communities
    RT:100:1   RT:200:1   RT:300:1
    RT:400:1
  No import route-map
  No export route-map
  VRF label distribution protocol: not configured
  VRF label allocation mode: per-prefix
  Prefix protection with additional path enabled
Address family ipv6 not active.

Example: Displaying Backup Alternate Paths for BGP PIC

The command output in the following example shows that the VRFs in VRF blue have backup/alternate paths:

Device# show ip bgp vpnv4 vrf blue 10.0.0.0

BGP routing table entry for 10:12:12.0.0.0/24, version 88
Paths: (4 available, best #1, table blue)
  Additional-path
  Advertised to update-groups:
    6
  1, imported path from 12:23:12.0.0.0/24
Example: Displaying Backup Alternate Paths for BGP PIC

10.3.3.3 (metric 21) from 10.6.6.6 (10.6.6.6)
Origin incomplete, metric 0, localpref 200, valid, internal, best
Extended Community: RT:12:23
Originator: 10.3.3.3, Cluster list: 10.0.0.1 , recursive-via-host
mpls labels in/out nolabel/37
1, imported path from 12:23:12.0.0.0/24
10.13.13.13 (via green) from 10.13.13.13 (10.0.0.2)
Origin incomplete, metric 0, localpref 100, valid, external
Extended Community: RT:12:23 , recursive-via-connected
1, imported path from 12:23:12.0.0.0/24
10.3.3.3 (metric 21) from 10.7.7.7 (10.7.7.7)
Origin incomplete, metric 0, localpref 200, valid, internal
Extended Community: RT:12:23
Originator: 10.3.3.3, Cluster list: 10.0.0.1 , recursive-via-host
mpls labels in/out nolabel/37
1
10.11.11.11 from 10.11.11.11 (1.0.0.1)
Origin incomplete, metric 0, localpref 100, valid, external, backup/repair
Extended Community: RT:11:12 , recursive-via-connected

The command output in the following example shows that the VRFs in VRF green have backup/alternate paths:

Device# show ip bgp vpnv4 vrf green 12.0.0.0

BGP routing table entry for 12:23:12.0.0.0/24, version 87
Paths: (4 available, best #4, table green)
    Additional-path
      Advertised to update-groups:
        5
        1, imported path from 11:12:12.0.0.0/24
        10.11.11.11 (via blue) from 10.11.11.11 (1.0.0.1)
          Origin incomplete, metric 0, localpref 100, valid, external
          Extended Community: RT:11:12 , recursive-via-connected
        1
        10.3.3.3 (metric 21) from 10.7.7.7 (10.7.7.7)
          Origin incomplete, metric 0, localpref 200, valid, internal
          Extended Community: RT:12:23
          Originator: 10.3.3.3, Cluster list: 10.0.0.1 , recursive-via-host
          mpls labels in/out nolabel/37
        1
          10.13.13.13 from 10.13.13.13 (10.0.0.2)
          Origin incomplete, metric 0, localpref 100, valid, external, backup/repair
          Extended Community: RT:12:23 , recursive-via-connected
        1
        10.3.3.3 (metric 21) from 10.6.6.6 (10.6.6.6)
          Origin incomplete, metric 0, localpref 200, valid, internal, best
          Extended Community: RT:12:23
          Originator: 10.3.3.3, Cluster list: 10.0.0.1 , recursive-via-host
          mpls labels in/out nolabel/37

The command output in the following example shows the BGP routing table entries for the backup and alternate paths:

Device# show ip bgp 10.0.0.0 255.255.0.0

BGP routing table entry for 10.0.0.0/16, version 123
Paths: (4 available, best #3, table default)
    Additional-path
      Advertised to update-groups:
        2
        3
      Local
        10.0.101.4 from 10.0.101.4 (10.3.3.3)
Origin IGP, localpref 100, weight 500, valid, internal
Local
10.0.101.3 from 10.0.101.3 (10.4.4.4)
Origin IGP, localpref 100, weight 200, valid, internal
Local
10.0.101.2 from 10.0.101.2 (10.1.1.1)
Origin IGP, localpref 100, weight 900, valid, internal, best
Local
10.0.101.1 from 10.0.101.1 (10.5.5.5)
Origin IGP, localpref 100, weight 700, valid, internal, backup/repair

The command output in the following example shows the routing information base entries for the backup and alternate paths:

Device# show ip route repair-paths 10.0.0.0 255.255.0.0
Routing entry for 10.0.0.0/16
Known via "bgp 10", distance 200, metric 0, type internal
Last update from 10.0.101.2 00:00:56 ago
Routing Descriptor Blocks:
* 10.0.101.2, from 10.0.101.2, 00:00:56 ago
  Route metric is 0, traffic share count is 1
  AS Hops 0
  MPLS label: none
[RPR]10.0.101.1, from 10.0.101.1, 00:00:56 ago
  Route metric is 0, traffic share count is 1
  AS Hops 0
  MPLS label: none

The command output in the following example shows the Cisco Express Forwarding/forwarding information base entries for the backup and alternate paths:

Device# show ip cef 10.0.0.0 255.255.0.0 detail
10.0.0.0/16, epoch 0, flags rib only nolabel, rib defined all labels
  recursive via 10.0.101.2
  attached to
  recursive via 10.0.101.1, repair
  attached to

**Example: Disabling BGP PIC Core**

The following example shows how to disable the BGP PIC core in global configuration mode.

Device> enable
Device# configure terminal
Device(config)# cef table output-chain build favor memory-utilization
Device(config)# end

**Additional References**

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
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<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>Related Topic</td>
<td>Document Title</td>
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<td>--------------------------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
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<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
<tr>
<td>Basic MPLS VPNs</td>
<td>“Configuring MPLS Layer 3 VPNs” module in the MPLS: Layer 3 VPNs Configuration Guide</td>
</tr>
<tr>
<td>A failover feature that creates a new path after a link or node failure</td>
<td>“MPLS VPN—BGP Local Convergence” module in the MPLS: Layer 3 VPNs Configuration Guide</td>
</tr>
<tr>
<td>Configuring multiprotocol VRFs</td>
<td>“MPLS VPN—VRF CLI for IPv4 and IPv6 VPNs” module in the MPLS: Layer 3 VPNs Configuration Guide</td>
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### Related Documents

#### Standards

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<tbody>
<tr>
<td>draft-walton-bgp-add-paths-04.txt</td>
<td>Advertisement of Multiple Paths in BGP</td>
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</table>

#### MIBs

<table>
<thead>
<tr>
<th>MIB</th>
<th>MIBs Link</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
</tr>
</tbody>
</table>

#### RFCs

<table>
<thead>
<tr>
<th>RFC</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFC 1771</td>
<td>A Border Gateway Protocol 4 (BGP-4)</td>
</tr>
<tr>
<td>RFC 2547</td>
<td>BGP/MPLS VPNs</td>
</tr>
</tbody>
</table>

### Technical Assistance

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<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>
Feature Information for BGP PIC

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 63: Feature Information for BGP PIC

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP PIC Edge for IP and MPLS-VPN</td>
<td>Cisco IOS XE Release 3.2S</td>
<td>The BGP PIC Edge for IP and MPLS-VPN feature improves BGP convergence after a network failure. This convergence is applicable to both core and edge failures and can be used in both IP and MPLS networks. The BGP PIC Edge for IP and MPLS-VPN feature creates and stores a backup/alternate path in the routing information base (RIB), forwarding information base (FIB), and Cisco Express Forwarding so that when a failure is detected, the backup/alternate path can immediately take over, thus enabling fast failover.</td>
</tr>
<tr>
<td></td>
<td>Cisco IOS XE Release 3.7S</td>
<td>In Cisco IOS XE Release 3.2S, this feature was introduced. The following commands were introduced or modified: <code>bgp additional-paths install</code>, <code>bgp recursion host</code>, <code>show ip bgp</code>, <code>show ip cef</code>, <code>show ip route</code>, <code>show vrf</code>.</td>
</tr>
</tbody>
</table>
CHAPTER 48

Detecting and Mitigating a BGP Slow Peer

The BGP Slow Peer feature allows a network administrator to detect a BGP slow peer and also to configure a peer as a slow peer statically or to dynamically mark it.

• BGP slow peer detection identifies a BGP peer that is not transmitting update messages within a configured amount of time. It is helpful to know if there is a slow peer, which indicates there is a network issue, such as network congestion or a receiver not processing updates in time, that the network administrator can address.

• BGP slow peer configuration moves or splits the peer from its normal update group to a slow update group, thus allowing the normal update group to function without being slowed down and to converge quickly.

• Finding Feature Information, on page 765
• Information About Detecting and Mitigating a BGP Slow Peer, on page 766
• How to Detect and Mitigate a BGP Slow Peer, on page 768
• Configuration Examples for Detecting and Mitigating a BGP Slow Peer, on page 782
• Additional References, on page 784
• Feature Information for BGP—Support for iBGP Local-AS, on page 785

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.
Information About Detecting and Mitigating a BGP Slow Peer

BGP Slow Peer Problem

BGP update generation uses the concept of update groups to optimize performance. An update group is a collection of peers with the identical outbound policy. When generating updates, the group policy is used to format messages that are then transmitted to the members of the group.

In order to maintain fairness in resource utilization, each update group is allocated a quota of formatted messages that it keeps in its cache. Messages are added to the cache when they are formatted by the group, and they are removed when they are transmitted to all the members of the group.

A slow peer is a peer that cannot keep up with the rate at which the Cisco IOS software is generating update messages, and is not keeping up over a prolonged period (in the order of a few minutes). There are several causes of a peer being slow:

- There is packet loss or high traffic on the link to the peer, and the throughput of the BGP TCP connection is very low.
- The peer has a heavy CPU load and cannot service the TCP connection at the required frequency.

When a slow peer is present in an update group, the number of formatted updates pending transmission builds up. When the cache limit is reached, the group does not have any more quotas to format new messages. In order for a new message to be formatted, some of the existing messages must be transmitted by the slow peer and then removed from the cache. The rest of the members of the group that are faster than the slow peer and have completed transmission of the formatted messages will not have anything new to send, even though there may be newly modified BGP networks waiting to be advertised or withdrawn. This effect of blocking formatting of all the peers in a group when one of the peers is slow in consuming updates is the "slow peer" problem.

Temporary Slowness Does Not Constitute a Slow Peer

Events that cause large churn in the BGP table (such as connection resets) can cause a brief spike in the rate of update generation. A peer that temporarily falls behind during such events, but quickly recovers after the event, is not considered a slow peer. In order for a peer to be marked as slow, it must be incapable of keeping up with the average rate of generated updates over a longer period (in the order of a few minutes).

BGP Slow Peer Feature

The BGP Slow Peer feature provides you, the network administrator, with three options:

- You can configure BGP slow peer detection only, which will simply detect a slow peer and provide you with information about it. Such detection is a key feature, especially in a large network of BGP peers, because you can then address the network problem that is causing the slow peer.

- You can configure a dynamic BGP slow peer. When such slow peer protection is configured, slow peer detection is enabled by default. The slow peer is moved or "split" from its normal update group to a slow update group, thus allowing the normal update group to function without being slowed down, and to converge more quickly than it would with the slow peer. You have the choice of whether to keep the slow peer in that slow update group until you clear the slow peer (by specifying the permanent keyword), or allow the slow peer to dynamically move back to its regular update group as conditions improve. We
recommend that you use the **permanent** keyword and resolve the network issue before you clear the slow peer status.

- You can configure a static BGP slow peer if you already know which peer is slow, perhaps due to a link issue or slow CPU process power. No detection is necessary, and it is more likely that the slow peer will remain there, hence the static configuration.

**BGP Slow Peer Detection**

You can choose to detect a BGP slow peer, whether or not you also configure the slow peer to be moved to a slow peer update group. Simply detecting a BGP slow peer provides you with useful information about the slow peer without splitting the update group. You should then address the network problem causing the slow peer.

**Timestamp on an Update Message**

BGP slow peer detection relies on the timestamp on the update messages in an update group. Update messages are timestamped when they are formatted. When BGP slow peer detection is configured, the timestamp of the oldest message in a peers queue is compared to the current time to determine if the peer is lagging more than the configured slow peer time threshold.

For example, if the oldest message in the peers queue was formatted more than 3 minutes ago, but the BGP slow peer detection threshold is configured at 3 minutes, then the peer that formatted that update message is determined to be a slow peer.

The Cisco IOS software generates a syslog event when a slow peer is detected or recovered (when its update group has converged and it has no messages formatted before the threshold time).

**Benefit of BGP Slow Peer Detection**

Slow peer detection provides you with information about the slow peer, and you can resolve the root cause without moving the peer to a different update group. Therefore, slow peer detection requires just one command that helps you identify something in your network that could be improved.

**Benefits of Configuring a Dynamic or Static BGP Slow Peer**

When a slow peer is present in an update group, the number of formatted updates pending transmission builds up. New messages cannot be formatted and transmitted until the backlog is reduced. That scenario delays BGP update packets and therefore delays BGP networks from being advertised. The problem can be resolved or prevented by configuring a dynamic slow peer or a static slow peer. Such configuration causes a slow peer to be put into a new, slow peer update group and thus prevents the slow peer from delaying the BGP peers that are not slow.

**Static Slow Peer**

If you believe that a peer is slow, you can statically configure the peer to be a slow peer. A static slow peer is recommended for a peer that is known to be slow, perhaps having a slow link or low processing power.

Static slow peer configuration causes the Cisco IOS software to create a separate update group for the peer. If you configure two peers belonging to the same update group as slow, these two peers will be moved into
A single slow peer update group because their policy will match. The slow update group will function at the pace of the slowest of the slow peers.

A static slow peer can be configured in either of two ways:

- At the BGP neighbor (address family) level
- Via a peer policy template

You probably want to determine the root cause of the peer being slow, such as network congestion or a receiver not processing updates in time. A static slow peer is not automatically restored to its original update group. You can restore a static slow peer to its original update group by using the `no neighbor slow-peer split-update-group static` command or the `no slow-peer split-update-group static` command.

**Dynamic Slow Peer**

An alternative to marking a static slow peer is to configure slow peers dynamically, based on the amount of time that the timestamp of the oldest message in a peers queue lags behind the current time. The default threshold is 300 seconds, and is configurable. We recommend that you specify the optional `permanent` keyword, which causes the peer to remain in the slow peer group while you resolve the root cause of the slow peer. You can then use the `clear bgp slow` command to move the peer back to its original group.

If you do not configure the `permanent` keyword, the peer moves back to its original group if and when it regains its non-slow functioning.

When a dynamic slow peer is configured, detection is enabled automatically.

You can configure dynamic slow peers in three ways:

- At the address family view level
- At the neighbor topology (that is, neighbor address-family) level
- Via a peer policy template

**How to Detect and Mitigate a BGP Slow Peer**

**Detecting a Slow Peer**

You might want to just detect a slow peer, but not move the slow peer out of its update group. Such detection notifies you by way of a syslog message that a BGP peer is not transmitting update messages within a configurable amount of time. The peer remains in its update group; the update group is not split. The syslog message level is notice level for both detection and recovery.

If you want to dynamically configure a BGP slow peer, see the Configuring Dynamic Slow Peer Protection, on page 774. You will notice that that task includes and requires the step of detecting a slow peer.

Detect a slow peer by performing one of the following tasks:

**Detecting Dynamic Slow Peers at the Address-Family Level**

Perform this task to detect all dynamic slow peers at the address-family level. (If you want to detect specific slow peers, detect slow peers at the neighbor level or by using a peer policy template).
The last step is optional; use it if you want to disable slow peer detection for a specific peer.

### SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. neighbor {ip-address | ipv6-address[| peer-group-name]} remote-as autonomous-system-number
5. address-family ipv4
6. bgp slow-peer detection [threshold seconds]
7. neighbor {neighbor-address | peer-group-name} slow-peer detection disable

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example: Router&gt; enable</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Step 2</td>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example: Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td>router bgp autonomous-system-number</td>
<td>Configures the BGP routing process.</td>
</tr>
<tr>
<td></td>
<td>Example: Router(config)# router bgp 5</td>
<td></td>
</tr>
<tr>
<td>Step 4</td>
<td>neighbor {ip-address</td>
<td>ipv6-address[</td>
</tr>
<tr>
<td></td>
<td>Example: Router(config-router)# neighbor 10.4.4.4 remote-as 5</td>
<td>• This step is required if you intend to disable dynamic slow peer protection for a specific peer as shown in Step 7 below.</td>
</tr>
<tr>
<td>Step 5</td>
<td>address-family ipv4</td>
<td>Enters address family configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example: Router(config-router)# address-family ipv4</td>
<td></td>
</tr>
<tr>
<td>Step 6</td>
<td>bgp slow-peer detection [threshold seconds]</td>
<td>Configures global slow peer detection and specifies the time in seconds that the timestamp of the oldest update message in a peers queue can be lagging behind the current time before the peer is determined to be a slow peer.</td>
</tr>
<tr>
<td></td>
<td>Example: Router(config-router-af)# bgp slow-peer detection threshold 600</td>
<td>• The range of the threshold is from 120 to 3600. As long as the command is configured, the default is 300.</td>
</tr>
</tbody>
</table>
### Detecting Dynamic Slow Peers at the Neighbor Level

Perform this task to detect dynamic slow peers at a specific neighbor address or belonging to a specific peer group.

#### SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. address-family ipv4
5. neighbor {neighbor-address | peer-group-name} slow-peer detection [threshold seconds]

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Configures the BGP routing process.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config)# router bgp 5</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> address-family ipv4</td>
<td>Enters address family configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config-router)# address-family ipv4</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> neighbor {neighbor-address</td>
<td>peer-group-name} slow-peer detection [threshold seconds]</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
</tbody>
</table>
Purpose

Command or Action

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Router(config-router-af)# neighbor 172.60.2.3 slow-peer detection threshold 1200</td>
<td>• The range of the threshold is 120 seconds to 3600 seconds. As long as the command is configured, the default is 300 seconds.</td>
</tr>
</tbody>
</table>

Detecting Dynamic Slow Peers Using a Peer Policy Template

Perform the following task to detect BGP slow peers using a peer policy template.

**SUMMARY STEPS**

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. template peer-policy policy-template-name
5. slow-peer detection [threshold seconds]
6. exit
7. address-family ipv4
8. neighbor ip-address inherit peer-policy policy-template-name

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>enable</td>
<td>Example:</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Router&gt; enable</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 2</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>configure terminal</td>
<td>Example:</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td>Router# configure terminal</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 3</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>router bgp autonomous-system-number</td>
<td>Example:</td>
<td>Configures the BGP routing process.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td>Router(config)# router bgp 5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 4</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>template peer-policy policy-template-name</td>
<td>Example:</td>
<td>Enters policy template configuration mode and creates a peer policy template.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td>Router(config-router)# template peer-policy global</td>
</tr>
</tbody>
</table>
### Marking a Peer as a Static Slow Peer

There are two ways to statically configure a slow peer. Perform one of the following tasks in this section to statically configure a slow peer:

#### Marking a Peer as a Static Slow Peer at the Neighbor Level

Perform this task to configure a static slow peer at a specific neighbor address or belonging to a specific peer group.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `address-family ipv4`
5. `neighbor {neighbor-address | peer-group-name} slow-peer split-update-group static`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
</tbody>
</table>

---

### Purpose

**Command or Action**

Step 5

**slow-peer detection** [threshold seconds]

**Example:**

Router(config-router-ptmp)# slow-peer detection threshold 600

**Purpose**

Specifies the time in seconds that the timestamp of the oldest message in a peers queue can be lagging behind the current time before the peer is determined to be a slow peer.

- The range of the threshold is from 120 to 3600. As long as the command is configured, the default is 300.

Step 6

**exit**

**Example:**

Router(config-router-ptmp)# exit

**Purpose**

Exits to higher configuration mode.

Step 7

**address-family ipv4**

**Example:**

Router(config-router)# address-family ipv4

**Purpose**

Enters address family configuration mode.

Step 8

**neighbor ip-address inherit peer-policy**

**policy-template-name**

**Example:**

Router(config-router-af)# neighbor 10.0.0.1 inherit peer-policy global

**Purpose**

Sends a peer policy template to a neighbor so that the neighbor can inherit the configuration.
Marking a Peer as a Static Slow Peer Using a Peer Policy Template

Perform this task to configure a static slow peer by using a peer policy template.

SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. template peer-policy policy-template-name
5. slow-peer split-update-group static
6. exit
7. address-family ipv4
8. neighbor ip-address inherit peer-policy policy-template-name

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------------------------------------------</td>
<td>----------------------------------------------</td>
</tr>
<tr>
<td>Router&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp <em>autonomous-system-number</em></td>
<td>Configures the BGP routing process.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config)# router bgp 5</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> template peer-policy <em>policy-template-name</em></td>
<td>Enters policy template configuration mode and creates a peer policy template.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config-router)# template peer-policy global</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> slow-peer split-update-group static</td>
<td>Configures the neighbor at the specified address as a slow peer.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Use the no slow-peer split-update-group static command if you want to restore the peer to its normal status.</td>
</tr>
<tr>
<td>Router(config-router-ptmp)# slow-peer split-update-group static</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> exit</td>
<td>Exits to higher configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config-router-ptmp)# exit</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong> address-family ipv4</td>
<td>Enters address family configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config-router)# address-family ipv4</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong> neighbor <em>ip-address</em> inherit peer-policy <em>policy-template-name</em></td>
<td>Sends a peer policy template to a neighbor so that the neighbor can inherit the configuration.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config-router-sf)# neighbor 10.0.0.1 inherit peer-policy global</td>
<td></td>
</tr>
</tbody>
</table>

**Configuring Dynamic Slow Peer Protection**

There are three ways to dynamically configure slow peers, also known as slow peer protection. Perform one or more of the tasks in this section to configure dynamic slow peers:
Configuring Dynamic Slow Peers at the Address-Family Level

Configuring dynamic slow peers at the address-family level applies to all peers in the address family specified. (If you want to configure specific slow peers, perform this task at the neighbor level or by using a peer policy template.)

The last step is optional; perform it only if you want to disable slow peer protection for a specific peer.

SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. neighbor {ip-address | ipv6-address[%] | peer-group-name} remote-as autonomous-system-number
5. address-family ipv4
6. bgp slow-peer detection [threshold seconds]
7. bgp slow-peer split-update-group dynamic [permanent]
8. neighbor {neighbor-address | peer-group-name} slow-peer split-update-group dynamic disable

DETAILLED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
</tr>
<tr>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Router&gt; enable</td>
<td></td>
</tr>
</tbody>
</table>

| **Step 2**        |         |
| configure terminal| Enters global configuration mode. |
| Example:          |         |
| Router# configure terminal |         |

| **Step 3**        |         |
| router bgp autonomous-system-number | Configures the BGP routing process. |
| Example:          |         |
| Router(config)# router bgp 5 |         |

| **Step 4**        |         |
| neighbor {ip-address | ipv6-address[%] | peer-group-name} remote-as autonomous-system-number | (Optional) Adds an entry to the BGP or multiprotocol BGP neighbor table. |
| Example:          | • This step is required if you intend to disable dynamic slow peer protection for a specific peer as shown in Step 8 below. |
| Router(config-router)# neighbor 10.4.4.4 remote-as 5 |         |

| **Step 5**        |         |
| address-family ipv4 | Enters address family configuration mode. |
| Example:          |         |
| Router(config-router)# address-family ipv4 |         |
### Purpose

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 6</strong> bgp slow-peer detection [threshold seconds]</td>
<td>(Optional) Specifies the time in seconds that the timestamp of the oldest update message in a peer's queue can be lagging behind the current time before the peer is determined to be a slow peer.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config-router-af)# bgp slow-peer detection</td>
<td></td>
</tr>
<tr>
<td>threshold 600</td>
<td></td>
</tr>
<tr>
<td>• When a dynamic slow peer is configured, as in the next step, this detection is enabled automatically.</td>
<td></td>
</tr>
<tr>
<td>• The range of the threshold is from 120 to 3600. The default is 300.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong> bgp slow-peer split-update-group dynamic [permanent]</td>
<td>Moves the dynamically detected slow peer to a slow update group.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config-router-af)# bgp slow-peer split-update</td>
<td></td>
</tr>
<tr>
<td>group dynamic permanent</td>
<td></td>
</tr>
<tr>
<td>• If a static slow peer update group exists (because of a static slow peer), the dynamic slow peer will be moved to the static slow peer update group.</td>
<td></td>
</tr>
<tr>
<td>• If no static slow peer update group exists, a new slow peer update group will be created and the peer will be moved to that.</td>
<td></td>
</tr>
<tr>
<td>• We recommend using the permanent keyword. If the permanent keyword is used, the peer will not be moved to its original update group automatically. After you determine the root cause of the slowness, such as network congestion, for example, you can use a clear bgp slow command to move the peer to its original update group. See the Restoring Dynamic Slow Peers as Normal Peers, on page 780 to move a dynamically slow peer back to its original update group.</td>
<td></td>
</tr>
<tr>
<td>• If the permanent keyword is not used, the slow peer will be moved back to its regular original update group after it becomes a normal peer (converges).</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong> neighbor {neighbor-address</td>
<td>peer-group-name} slow-peer split-update-group dynamic disable</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config-router-af)# neighbor 10.4.4.4</td>
<td></td>
</tr>
<tr>
<td>slow-peer split-update-group dynamic disable</td>
<td></td>
</tr>
</tbody>
</table>

### Configuring Dynamic Slow Peers at the Neighbor Level

Perform this task to configure a dynamic slow peer at a specific neighbor address or belonging to a specific peer group.

### SUMMARY STEPS

1. enable
2. `configure terminal`  
3. `router bgp autonomous-system-number`  
4. `address-family ipv4`  
5. `neighbor {neighbor-address | peer-group-name} slow-peer detection [threshold seconds]`  
6. `neighbor {neighbor-address | peer-group-name} slow-peer split-update-group dynamic [permanent]`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** enable | Enables privileged EXEC mode.  
Example:  
Router> enable |
| **Step 2** configure terminal | Enters global configuration mode.  
Example:  
Router# configure terminal |
| **Step 3** router bgp `autonomous-system-number` | Configures the BGP routing process.  
Example:  
Router(config)# router bgp 5 |
| **Step 4** address-family ipv4 | Enters address family configuration mode.  
Example:  
Router(config-router)# address-family ipv4 |
| **Step 5** neighbor `{neighbor-address | peer-group-name} slow-peer detection [threshold seconds]` | (Optional) Specifies the time in seconds that the timestamp of the oldest update message in a peer's queue can be lagging behind the current time before the peer is determined to be a slow peer.  
Example:  
Router(config-router-af)# neighbor 172.60.2.3 slow-peer detection threshold 1200  
• When a dynamic slow peer is configured, as in the next step, this detection is enabled automatically.  
• The range of the threshold is from 120 to 3600. The default is 300. |
| **Step 6** neighbor `{neighbor-address | peer-group-name} slow-peer split-update-group dynamic [permanent]` | Moves the dynamically detected slow peer to a slow update group.  
Example:  
Router(config-router-af)# neighbor 172.60.2.3 slow-peer split-update-group dynamic permanent  
• If a static slow peer update group exists (because of a static slow peer), the dynamic slow peer will be moved to the static slow peer update group.  
• If no static slow peer update group exists, a new slow peer update group will be created and the peer will be moved to that. |
### Configuring Dynamic Slow Peers Using a Peer Policy Template

Perform this task to configure a BGP slow peer using a peer policy template.

**SUMMARY STEPS**

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. template peer-policy policy-template-name
5. slow-peer detection [threshold seconds]
6. slow-peer split-update-group dynamic [permanent]
7. exit
8. address-family ipv4
9. neighbor ip-address inherit peer-policy policy-template-name

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Router&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example: Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Configures the BGP routing process.</td>
</tr>
<tr>
<td>Example: Router(config)# router bgp 5</td>
<td></td>
</tr>
</tbody>
</table>
## Detecting and Mitigating a BGP Slow Peer

### Configuring Dynamic Slow Peers Using a Peer Policy Template

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 4</strong></td>
<td><strong>template peer-policy</strong> <code>policy-template-name</code></td>
<td>Enters policy template configuration mode and creates a peer policy template.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>Router(config-router)# template peer-policy global</code></td>
<td></td>
</tr>
</tbody>
</table>
| **Step 5** | slow-peer detection `[threshold seconds]`  | (Optional) Specifies the time in seconds that the timestamp of the oldest message in a peers queue can be lagging behind the current time before the peer is determined to be a slow peer.  
- When a dynamic slow peer is configured, as in the next step, this detection is enabled automatically.  
- The range of the threshold is from 120 to 3600. The default is 300. |
|  | **Example:** |  |
|      | `Router(config-router-ptmp)# slow-peer detection threshold 600` |  |
| **Step 6** | slow-peer split-update-group dynamic `[permanent]`  | Moves the dynamically detected slow peer to a slow update group.  
- If a static slow peer update group exists (because of a static slow peer), the dynamic slow peer will be moved to the static slow peer update group.  
- If no static slow peer update group exists, a new slow peer update group will be created and the peer will be moved to that.  
- We recommend using the `permanent` keyword. If the `permanent` keyword is used, the peer will not be moved to its original update group automatically. After you determine the root cause of the slowness, such as network congestion, for example, you can use a command to move the peer to its original update group. See the Restoring Dynamic Slow Peers as Normal Peers, on page 780 to move a dynamically slow peer back to its original update group.  
- If the `permanent` keyword is not used, the slow peer will be moved back to its regular original update group after it becomes a normal peer (converges). |
|  | **Example:** |  |
|      | `Router(config-router-ptmp)# slow-peer split-update-group dynamic permanent` |  |
| **Step 7** | exit  | Exits to higher configuration mode. |
|  | **Example:** |  |
|      | `Router(config-router-ptmp)# exit` |  |
| **Step 8** | address-family ipv4  | Enters address family configuration mode. |
|  | **Example:** |  |
|      | `Router(config-router)# address-family ipv4` |  |
### Displaying Output About Dynamic Slow Peers

Use one or more of the `show` commands in this task to display output about dynamically configured BGP slow peers.

#### SUMMARY STEPS

1. `enable`
2. `show ip bgp [ipv4 {multicast | unicast} | vpnv4 all | vpnv6 unicast all | topology{*} routing-topology-instance-name{]} [update-group] summary slow`
3. `show ip bgp [ipv4 {multicast | unicast} | vpnv4 all | vpnv6 unicast all] neighbors slow`

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>enable</td>
<td><code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Example:</td>
<td><code>Router&gt; enable</code></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 2</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>`show ip bgp [ipv4 {multicast</td>
<td>unicast}</td>
<td>vpnv4 all</td>
</tr>
<tr>
<td>Example:</td>
<td><code>Router# show ip bgp summary slow</code></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 3</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>`show ip bgp [ipv4 {multicast</td>
<td>unicast}</td>
<td>vpnv4 all</td>
</tr>
<tr>
<td>Example:</td>
<td><code>Router# show ip bgp neighbors slow</code></td>
<td></td>
</tr>
</tbody>
</table>

### Restoring Dynamic Slow Peers as Normal Peers

Once you, the network administrator, resolve the root cause of a slow peer (network congestion, or a receiver not processing updates in time, and so forth), use the `clear` commands in the following task to move the peer back to its original group. Both commands perform the same function.
### SUMMARY STEPS

1. `enable`
2. `clear ip bgp { [af] * | neighbor-address | peer-group group-name } slow`
3. `clear bgp af { [* | neighbor-address | peer-group group-name ] slow }`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td><code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong> <code>Router&gt; enable</code></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Step 2</td>
<td>`clear ip bgp { [af] *</td>
<td>neighbor-address</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong> <code>Router# clear ip bgp * slow</code></td>
<td>• <code>af</code> is one of the following address families: <code>ipv4</code>, <code>vpnv4</code>, or <code>vpnv6</code>. Moves all peers in the IPv4, VVPNv4 or VVPNv6 address family back to their original update groups.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• <code>*</code> moves all peers back to their original update groups.</td>
</tr>
<tr>
<td>Step 3</td>
<td>`clear bgp af { [*</td>
<td>neighbor-address</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong> <code>Router# clear bgp ipv4 * slow</code></td>
<td>• <code>af</code> is one of the following address families: <code>ipv4</code>, <code>vpnv4</code>, or <code>vpnv6</code>. Moves peers in the IPv4, VVPNv4 or VVPNv6 address family back to their original update groups.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• <code>*</code> moves all peers in the address family back to their original update groups.</td>
</tr>
</tbody>
</table>
Configuration Examples for Detecting and Mitigating a BGP Slow Peer

Example: Static Slow Peer

The following example marks the neighbor at 192.168.12.10 as a static slow peer.

```
router bgp 5
  address-family ipv4
  neighbor 192.168.12.10 slow-peer split-update-group static
```

Example: Static Slow Peer Using Peer Policy Template

The following example configures a static slow peer using a peer policy template named ipv4_ucast_pp2. The neighbor at 10.0.101.4 inherits the policy.

```
router bgp 13
  template peer-policy ipv4_ucast_pp2
  slow-peer split-update-group static
  exit-peer-policy
  no bgp default route-target filter
  no bgp enforce-first-as
  bgp log-neighbor-changes
  neighbor 10.0.101.4 remote-as 13
  address-family ipv4
  neighbor 10.0.101.4 inherit peer-policy ipv4_ucast_pp2
```

RouterA# show ip bgp template peer-policy ipv4_ucast_pp2

```
Template:ipv4_ucast_pp2, index:2.
Local policies:0x180000000, Inherited polices:0x0
Local disable policies:0x0, Inherited disable policies:0x0
Locally configured policies:
  slow-peer split-update-group static
  Inherited policies:
```

Example: Dynamic Slow Peer at the Neighbor Level

The following example configures a slow peer at the neighbor level. The neighbor at 10.0.101.3 is configured with dynamic slow peer protection at a default threshold of 300 seconds.

```
router bgp 13
  no bgp default route-target filter
  no bgp enforce-first-as
  bgp log-neighbor-changes
  neighbor 10.0.101.3 remote-as 13
  address-family ipv4
  neighbor 10.0.101.3 slow-peer split-update-group dynamic
```
Example: Dynamic Slow Peers Using Peer Policy Template

In the following example, Router A uses a peer policy template named ipv4_ucast_pp1 and sets a detection threshold of 120 seconds. The `permanent` keyword causes slow peers to remain in the slow update group until the network administrator uses the `clear ip bgp slow` command to move the peer to its original update group. The neighbor at 10.0.101.2 inherits the peer policy, which means that if that neighbor is determined to be slow, it is moved to a slow update group.

```
router bgp 13
  template peer-policy ipv4_ucast_pp1
    slow-peer detection threshold 120
    slow-peer split-update-group dynamic permanent
  exit-peer-policy
! no bgp default route-target filter
no bgp enforce-first-as
bgp log-neighbor-changes
  neighbor 10.0.101.2 remote-as 13
! address-family ipv4
  neighbor 10.0.101.2 activate
  neighbor 10.0.101.2 inherit peer-policy ipv4_ucast_pp1
```

The following output displays the locally configured policies.

```
RouterA# show ip bgp template peer-policy ipv4_ucast_pp1
Template:ipv4_ucast_pp1, index:1.
Local policies:0x300000000, Inherited policies:0x0
Local disable policies:0x0, Inherited disable policies:0x0
Locally configured policies:
  slow-peer detection threshold is 120
  slow-peer split-update-group dynamic permanent
Inherited policies:
```

Example: Dynamic Slow Peers Using Peer Group

The following example configures two peer groups: ipv4_ucast_pg1 and ipv4_ucast_pg2. The neighbor at 10.0.101.1 belongs to ipv4_ucast_pg1, where slow peer detection is configured for 120 seconds. The neighbor at 10.0.101.5 belongs to ipv4_ucast_pg2, where slow peer detection is configured at 140 seconds.

```
router bgp 13
  no bgp default route-target filter
  no bgp enforce-first-as
  bgp log-neighbor-changes
    neighbor ipv4_ucast_pg1 peer-group
    neighbor ipv4_ucast_pg2 peer-group
    neighbor ipv4_ucast_pg1 remote-as 13
    neighbor ipv4_ucast_pg2 remote-as 13
    neighbor 10.0.101.1 peer-group ipv4_ucast_pg1
    neighbor 10.0.101.5 peer-group ipv4_ucast_pg2
  address-family ipv4
    neighbor ipv4_ucast_pg1 slow-peer detection threshold 120
    neighbor ipv4_ucast_pg1 slow-peer split-update-group dynamic
    neighbor ipv4_ucast_pg2 slow-peer detection threshold 140
    neighbor ipv4_ucast_pg2 slow-peer split-update-group dynamic
```

The following output displays information about the peer group ipv4_ucast_pg1.
RouterA# show ip bgp peer-group ipv4_ucast_pg1

BGP peer-group is ipv4_ucast_pg1, remote AS 13
BGP version 4
Neighbor sessions:
  0 active, is multisession capable
Default minimum time between advertisement runs is 0 seconds
For address family: IPv4 Unicast
BGP neighbor is ipv4_ucast_pg1, peer-group internal, members:
  10.0.101.1
  Index 0
Slow-peer detection is enabled, threshold value is 120
Slow-peer split-update-group dynamic is enabled
Update messages formatted 0, replicated 0
Number of NLRIs in the update sent: max 0, min 0

The following output displays information about the peer group ipv4_ucast_pg2.

RouterA# show ip bgp peer-group ipv4_ucast_pg2

BGP peer-group is ipv4_ucast_pg2, remote AS 13
BGP version 4
Neighbor sessions:
  0 active, is multisession capable
Default minimum time between advertisement runs is 0 seconds
For address family: IPv4 Unicast
BGP neighbor is ipv4_ucast_pg2, peer-group internal, members:
  10.0.101.5
  Index 0
Slow-peer detection is enabled, threshold value is 140
Slow-peer split-update-group dynamic is enabled
Update messages formatted 0, replicated 0
Number of NLRIs in the update sent: max 0, min 0

Additional References

Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
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</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
<tr>
<td>MPLS Layer 3 VPN configuration tasks</td>
<td>“Configuring MPLS Layer 3 VPNs” module in the MPLS: Layer 3 VPNs Configuration Guide</td>
</tr>
<tr>
<td>VRF selection using policy based routing</td>
<td>“MPLS VPN VRF Selection Using Policy-Based Routing” module in the MPLS: Layer 3 VPNs Configuration Guide</td>
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Standards

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<th>Title</th>
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<td>—</td>
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MIBs

<table>
<thead>
<tr>
<th>MIB</th>
<th>MIBs Link</th>
</tr>
</thead>
</table>
|     | To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL:  
http://www.cisco.com/go/mibs |

RFCs

<table>
<thead>
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<td>No new or modified RFCs are supported by this feature, and support for existing RFCs has not been modified by this feature.</td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
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<th>Description</th>
<th>Link</th>
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<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

Feature Information for BGP—Support for iBGP Local-AS

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.
### Table 64: Feature Information for BGP—Support for iBGP Local-AS

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
</table>
| BGP—Support for iBGP Local-AS | Cisco IOS XE Release 3.9S | Prior to the BGP—Support for Local-AS feature, the `neighbor local-as` command was used on a route reflector to customize AS_PATH attributes for routes received from an eBGP neighbor. The `neighbor local-as` command can now be used to enable the sending of the iBGP attributes (LOCAL_PREF, ORIGINATOR_ID, CLUSTER_ID, and CLUSTER_LIST) over an iBGP local-AS session. This functionality is useful when merging two autonomous systems, when it is advantageous to keep the iBGP attributes in routes. Prior to the BGP—Support for iBGP Local-AS feature, the RR should not have been configured to change iBGP attributes. With the introduction of this feature, the RR can be configured to change iBGP attributes, providing more flexibility. The following command was introduced:  
  • `neighbor allow-policy`  
  The following commands were modified:  
  • `neighbor local-as`  
  • `show ip bgp vpnv4`
CHAPTER 49

Configuring BGP: RT Constrained Route Distribution

BGP: RT Constrained Route Distribution is a feature that can be used by service providers in Multiprotocol Label Switching (MPLS) Layer 3 VPNs to reduce the number of unnecessary routing updates that route reflectors (RRs) send to Provider Edge (PE) routers. The reduction in routing updates saves resources by allowing RRs, Autonomous System Boundary Routers (ASBRs), and PEs to have fewer routes to carry. Route targets are used to constrain routing updates.

- Finding Feature Information, on page 787
- Prerequisites for BGP: RT Constrained Route Distribution, on page 787
- Restrictions for BGP: RT Constrained Route Distribution, on page 788
- Information About BGP: RT Constrained Route Distribution, on page 788
- How to Configure RT Constrained Route Distribution, on page 792
- Configuration Examples for BGP: RT Constrained Route Distribution, on page 801
- Additional References, on page 803
- Feature Information for BGP RT Constrained Route Distribution, on page 805

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for BGP: RT Constrained Route Distribution

Before you configure BGP: RT Constrained Route Distribution, you should understand how to configure the following:

- Multiprotocol Label Switching (MPLS) VPNs
- Route distinguishers (RDs)
• Route targets (RTs)
• Multiprotocol BGP (MBGP)

Restrictions for BGP: RT Constrained Route Distribution

BGP: RT Constrained Route Distribution constrains all VPN route advertisements.

Information About BGP: RT Constrained Route Distribution

Problem That BGP: RT Constrained Route Distribution Solves

Some service providers have a large number of routing updates being sent from RRs to PEs, which can require extensive use of resources. A PE does not need routing updates for VRFs that are not on the PE; therefore, the PE determines that many routing updates it receives are "unwanted." The PE filters out the unwanted updates.

The figure below illustrates a scenario in which unwanted routing updates arrive at two PEs.

"Figure 71: Unwanted Routing Updates at PE"

As shown in the figure above, a PE receives unwanted routes in the following manner:

1. PE-3 advertises VRF Blue and VRF Red routes to RR-1. PE-4 advertises VRF Red and VRF Green routes to RR-1.
2. RR-1 has all of the routes for all of the VRFs (Blue, Red, and Green).
3. During a route refresh or VRF provisioning, RR-1 advertises all of the VRF routes to both PE-3 and PE-4.
4. Routes for VRF Green are unwanted at PE-3. Routes for VRF Blue are unwanted at PE-4.

Now consider the scenario where there are two RR s with another set of PEs. There are unwanted routing updates from RR s to PEs and unwanted routing updates between RR s. The figure below illustrates a scenario in which unwanted routes arrive at an RR.
Figure 72: Unwanted Routing Updates at RR

As shown in the figure above, RR-1 and RR-2 receive unwanted routing updates in the following manner:

1. PE-3 and PE-4 advertise VRF Blue, VRF Red, and VRF Green VPN routes to RR-1.
2. RR-1 sends all of its VPN routes to RR-2.
3. VRF Red routes are unwanted on RR-2 because PE-1 and PE-2 do not have VRF Red.
4. Similarly, VRF Purple routes are unwanted on RR-1 because PE-3 and PE-4 do not have VRF Purple.

Hence, a large number of unwanted routes might be advertised among RR and PE. The BGP: RT Constrained Route Distribution feature addresses this problem by filtering unwanted routing updates.

Before the BGP: RT Constrained Route Distribution feature, the PE would filter the updates. With this feature, the burden is moved to the RR to filter the updates.

Benefits of BGP: RT Constrained Route Distribution

In MPLS L3VPNs, PE routers use BGP and route target (RT) extended communities to control the distribution of VPN routes to and from VRFs in order to separate the VPNs. PEs and Autonomous System Boundary Routers (ASBRs) commonly receive and then filter out the unwanted VPN routes.

However, receiving and filtering unwanted VPN routes is a waste of resources. The sender generates and transmits a VPN routing update and the receiver filters out the unwanted routes. Preventing the generation of VPN route updates would save resources.

Route Target Constraint (RTC) is a mechanism that prevents the propagation of VPN Network Layer Reachability Information (NLRI) from the RR to a PE that is not interested in the VPN. The feature provides considerable savings in CPU cycles and transient memory usage. RT constraint limits the number of VPN routes and describes VPN membership.

BGP RT-Constain SAFI

The BGP: RT Constrained Route Distribution feature introduces the BGP RT-Constain Subsequent Address Family Identifier (SAFI). The command to enter that address family is the `address-family rtfilter unicast` command.
BGP: RT Constrained Route Distribution Operation

In order to filter out the unwanted routes described in the "Problem that BGP RT Constrained Route Distribution Solves" section on page 2, the PEs and RRs must be configured with the BGP: RT Constrained Route Distribution feature.

The feature allows the PE to propagate RT membership and use the RT membership to limit the VPN routing information maintained at the PE and RR. The PE uses an MP-BGP UPDATE message to propagate the membership information. The RR restricts advertisement of VPN routes based on the RT membership information it received.

This feature causes two exchanges to happen:

- The PE sends RT Constraint (RTC) Network Layer Reachability Information (NLRI) to the RR.
- The RR installs an outbound route filter.

The figure below illustrates the exchange of the RTC NLRI and the outbound route filter.

*Figure 73: Exchange of RTC NLRI and Filter Between PE and RR*

As shown in the figure above, the following exchange occurs between the PE and the RR:

1. PE-3 sends RTC NLRI (RT 1, RT 2) to RR-1.
2. PE-4 sends RTC NLRI (RT 2, RT 3) to RR-1.
3. RR-1 translates the NLRI into an outbound route filter and installs this filter (Permit RT 1, RT 2) for PE-3.
4. RR-1 translates the NLRI into an outbound route filter and installs this filter (Permit RT 2, RT 3) for PE-4.

RT Constraint NLRI Prefix

The format of the RT Constraint NLRI is a prefix that is always 12 bytes long, consisting of the following:

- 4-byte origin autonomous system
- 8-byte RT extended community value

The following are examples of RT Constraint prefixes:

- 65000:2:100:1
  - Origin autonomous system number is 65000
- BGP Extended Community Type Code is 2
- Route target is 100:1

- 65001:256:192.0.0.1:100
  - Origin ASN is 65001
  - BGP Extended Community Type Code is 256
  - Route target is 192.0.0.1:100

- 1.10:512:1.10:2
  - Origin ASN is 4-byte, unique 1.10
  - BGP Extended Community Type Code is 512
  - Route target is 1.10:2

To determine what the BGP Extended Community Type Code means, refer to RFC 4360, *BGP Extended Communities Attribute*. In the first example shown, a 2 translates in hexadecimal to 0x002. In RFC 4360, 0x002 indicates that the value that follows the type code will be a two-octet AS specific route target.

**RT Constrained Route Distribution Process**

This section shows the RT Constrained Route Distribution process. In this example has two CE routers in AS 100 that are connected to PE1. PE1 communicates with PE2, which is also connected to CE routers. Between the two PEs is a route reflector (RR). PE1 and PE2 belong to AS 65000.

The general process for the feature is as follows:

1. The user configures PE1 to activate its BGP peers under the `address-family rtfilter unicast` command.
2. The user configures PE1 in AS 65000 with `route-target import 100:1`, for example.
3. PE1 translates that command into an RT prefix of 65000:2:100:1. The 65000 is the service provider’s AS number; the 2 is the BGP Extended Communities Type Code; and the 100:1 is the CE’s RT (AS number and another number).
4. PE1 advertises the RT Constrain (RTC) prefix of 65000:2:100:1 to its eBGP peer RR.
5. The RR installs RTC 65000:2:100:1 into the RTC RIB. Each VRF has its own RIB.
6. The RR also installs RTC 65000:2:100:1 into its outbound filter for the neighbor PE1.
7. A filter in the RR either permits or denies the RT. (The AS number is ignored because eBGP is operating in a single AS and does not need to track the AS number.)
8. The RR looks in its outbound filter and sees that it permits outbound VPN packets for RT 100:1 to PE1. So, the RR sends VPN update packet only with RT 100:1 to PE1 and denies VPN updates with any other RT.

**Default RT Filter**

The default RT filter has a value of zero and length of zero. The default RT filter is used:

- By a peer to indicate that the peer wants all of the VPN routes sent to it, regardless of the RT value.
- By the RR to request that the PE advertise all of its VPN routes to the RR.
The default RT filter is created by configuring the `neighbor default-originate` command under the `address-family rtfilter unicast` command. On the RR it comes as default along with the configuration of route-reflector-client under the address-family rtfilter.

# How to Configure RT Constrained Route Distribution

## Configuring Multiprotocol BGP on Provider Edge (PE) Routers and Route Reflectors

Perform this task to configure multiprotocol BGP (MP-BGP) connectivity on the PE routers and route reflectors.

### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `router bgp as-number`
4. `no bgp default ipv4-unicast`
5. `neighbor {ip-address | peer-group-name} remote-as as-number`
6. `address-family vpn4 [unicast]`
7. `neighbor {ip-address | peer-group-name} send-community extended`
8. `neighbor {ip-address | peer-group-name} activate`
9. `end`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example: Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp as-number</td>
<td>Configures a BGP routing process and enters router configuration mode.</td>
</tr>
<tr>
<td>Example: Device(config)# router bgp 100</td>
<td>• The <code>as-number</code> argument indicates the number of an autonomous system that identifies the router to other BGP routers and tags the routing information passed along. Valid numbers are from 0 to 65535. Private autonomous system numbers that can be used in internal networks range from 64512 to 65535.</td>
</tr>
<tr>
<td>Step 4</td>
<td>Command or Action</td>
</tr>
<tr>
<td>--------</td>
<td>------------------</td>
</tr>
<tr>
<td></td>
<td><code>no bgp default ipv4-unicast</code></td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td></td>
<td><code>Device(config-router)# no bgp default ipv4-unicast</code></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 5</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>`neighbor {ip-address</td>
<td>peer-group-name} remote-as as-number`</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>Device(config-router)# neighbor pp.0.0.1 remote-as 100</code></td>
<td>• The <code>ip-address</code> argument specifies the IP address of the neighbor.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The <code>peer-group-name</code> argument specifies the name of a BGP peer group.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The <code>as-number</code> argument specifies the autonomous system to which the neighbor belongs.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 6</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><code>address-family vpnv4 [unicast]</code></td>
<td>Enters address family configuration mode for configuring routing sessions, such as BGP, that use standard VPNv4 address prefixes.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>Device(config-router)# address-family vpnv4</code></td>
<td>• The optional <code>unicast</code> keyword specifies VPNv4 unicast address prefixes.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 7</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>`neighbor {ip-address</td>
<td>peer-group-name} send-community extended`</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>Device(config-router-af)# neighbor pp.0.0.1 send-community extended</code></td>
<td>• The <code>ip-address</code> argument specifies the IP address of the BGP-speaking neighbor.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The <code>peer-group-name</code> argument specifies the name of a BGP peer group.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 8</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>`neighbor {ip-address</td>
<td>peer-group-name} activate`</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>Device(config-router-af)# neighbor pp.0.0.1 activate</code></td>
<td>• The <code>ip-address</code> argument specifies the IP address of the neighbor.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The <code>peer-group-name</code> argument specifies the name of a BGP peer group.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 9</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><code>end</code></td>
<td>(Optional) Exits to privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>Device(config-router-af)# end</code></td>
<td></td>
</tr>
</tbody>
</table>
Troubleshooting Tips

You can enter a `show ip bgp neighbor` command to verify that the neighbors are up and running. If this command is not successful, enter a `debug ip bgp ip-address events` command, where `ip-address` is the IP address of the neighbor.

Connecting the MPLS VPN Customers

To connect the MPLS VPN customers to the VPN, perform the following tasks:

Defining VRFs on PE Routers to Enable Customer Connectivity

To define virtual routing and forwarding (VRF) instances, perform this task.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `ip vrf vrf-name`
4. `rd route-distinguisher`
5. `route-target {import | export | both} route-target-ext-community`
6. `import map route-map`
7. `exit`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td></td>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td><code>configure terminal</code></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td><code>ip vrf vrf-name</code></td>
<td>Defines the VPN routing instance by assigning a VRF name and enters VRF configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>• The <code>vrf-name</code> argument is the name assigned to a VRF.</td>
</tr>
<tr>
<td></td>
<td>Device(config)# ip vrf vpn1</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td><code>rd route-distinguisher</code></td>
<td>Creates routing and forwarding tables.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>• The <code>route-distinguisher</code> argument adds an 8-byte value to an IPv4 prefix to create a VPN IPv4 prefix. You can enter an RD in either of these formats:</td>
</tr>
<tr>
<td></td>
<td>Device(config-vrf)# rd 100:1</td>
<td>• 16-bit AS number: your 32-bit number, for example, 101:3</td>
</tr>
</tbody>
</table>
Purpose

Command or Action | Purpose
---|---
| | • 32-bit IP address: your 16-bit number, for example, 192.168.122.15:1

**Step 5**

route-target \{import | export | both\}
route-target-ext-community

Example:

Device(config-vrf)# route-target import 100:1

Creates a route-target extended community for a VRF.
- The `import` keyword imports routing information from the target VPN extended community.
- The `export` keyword exports routing information to the target VPN extended community.
- The `both` keyword imports routing information from and exports routing information to the target VPN extended community.
- The `route-target-ext-community` argument adds the RT extended community attributes to the VRF's list of import, export, or both (import and export) RT extended communities.

**Step 6**

import map route-map

Example:

Device(config-vrf)# import map vpn1-route-map

(Optional) Configures an import route map for a VRF.
- The `route-map` argument specifies the route map to be used as an import route map for the VRF.

**Step 7**

exit

Example:

Device(config-vrf)# exit

(Optional) Exits to global configuration mode.

---

**Configuring VRF Interfaces on PE Routers for Each VPN Customer**

To associate a VRF with an interface or subinterface on the PE routers, perform this task.

**SUMMARY STEPS**

1. enable
2. configure terminal
3. interface type number
4. ip vrf forwarding vrf-name
5. end

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Enter your password if prompted.</td>
</tr>
</tbody>
</table>
Configuring BGP as the Routing Protocol Between the PE and CE Routers

To configure PE-to-CE routing sessions using BGP, perform this task.

SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp as-number
4. address-family ipv4 [multicast | unicast | vrf vrf-name]
5. neighbor {ip-address | peer-group-name} remote-as as-number
6. neighbor {ip-address | peer-group-name} activate
7. exit-address-family
8. end

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>• Enter your password if prompted.</td>
</tr>
</tbody>
</table>
**Command or Action** | **Purpose**
---|---
Device> enable | Enters global configuration mode.

**Step 2**
**configure terminal**
**Example:**
Device# configure terminal

**Step 3**
**router bgp as-number**
**Example:**
Device(config)# router bgp 100

**Step 4**
**address-family ipv4 [multicast | unicast | vrf vrf-name]**
**Example:**
Device(config-router)# address-family ipv4 vrf vpn1

**Step 5**
**neighbor {ip-address | peer-group-name} remote-as as-number**
**Example:**
Device(config-router-af)# neighbor pp.0.0.1 remote-as 200

**Step 6**
**neighbor {ip-address | peer-group-name} activate**
**Example:**
Device(config-router-af)# neighbor pp.0.0.1 activate

- The *as-number* argument indicates the number of an autonomous system that identifies the router to other BGP routers and tags the routing information passed along. Valid numbers are from 0 to 65535. Private autonomous system numbers that can be used in internal networks range from 64512 to 65535.

- The *multicast* keyword specifies IPv4 multicast address prefixes.
- The *unicast* keyword specifies IPv4 unicast address prefixes.
- The *vrf vrf-name* keyword and argument specify the name of the VRF to associate with subsequent IPv4 address family configuration mode commands.

- The *ip-address* argument specifies the IP address of the neighbor.
- The *peer-group-name* argument specifies the name of a BGP peer group.
- The *as-number* argument specifies the autonomous system to which the neighbor belongs.

- The *ip-address* argument specifies the IP address of the neighbor.
- The *peer-group-name* argument specifies the name of a BGP peer group.
Configuring RT Constraint on the PE

Perform this task on the PE to configure BGP: RT Constrained Route Distribution with the specified neighbor, and optionally verify that route target (RT) filtering is occurring.

**SUMMARY STEPS**

1. `enable`  
2. `configure terminal`  
3. `router bgp as-number`  
4. `address-family rtfilter unicast`  
5. `neighbor {ip-address | peer-group-name} activate`  
6. `neighbor {ip-address | peer-group-name} send-community extended`  
7. `end`  
8. `show ip bgp rtfilter all`  
9. `show ip bgp rtfilter all summary`  
10. `show ip bgp vpnv4 all`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp as-number</td>
<td>Configures a BGP routing process and enters router configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# router bgp 1</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>Specifies the RT filter address family type and enters address family configuration mode.</td>
</tr>
<tr>
<td>address-family rtfilter unicast</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config-router)# address-family rtfilter unicast</td>
</tr>
</tbody>
</table>

| **Step 5** | Enables the exchange of automated RT filter information with the specified BGP neighbor.  |
| neighbor {ip-address | peer-group-name} activate |  |
| **Example:** | Device(config-router-af)# neighbor 10.0.0.1 activate  |

| **Step 6** | Specifies that a communities attribute should be sent to a BGP neighbor.  |
| neighbor {ip-address | peer-group-name} send-community extended |  |
| **Example:** | Device(config-router-af)# neighbor pp.0.0.1 send-community extended  |

| **Step 7** | Exits configuration mode and returns to privileged EXEC mode.  |
| end |  |
| **Example:** | Device(config-router-af)# end  |

| **Step 8** | (Optional) Displays all BGP RT filter information.  |
| show ip bgp rtfilter all |  |
| **Example:** | Device# show ip bgp rtfilter all  |

| **Step 9** | (Optional) Displays summary BGP RT filter information.  |
| show ip bgp rtfilter all summary |  |
| **Example:** | Device# show ip bgp rtfilter all summary  |

| **Step 10** | (Optional) Displays summary BGP VPNv4 information.  |
| show ip bgp vpnv4 all |  |
| **Example:** | Device# show ip bgp vpnv4 all  |

### Configuring RT Constraint on the RR

Perform this task on the RR to configure BGP: RT Constrained Route Distribution with the specified neighbor, and optionally verify that route target (RT) filtering is occurring.
SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp as-number
4. address-family rtfilter unicast
5. neighbor {ip-address | peer-group-name} activate
6. neighbor {ip-address | peer-group-name} route-reflector-client
7. neighbor {ip-address | peer-group-name} send-community extended
8. end
9. show ip bgp rtfilter all
10. show ip bgp rtfilter all summary
11. show ip bgp vpv4 all

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td>Step 2 configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example: Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td>Step 3 router bgp as-number</td>
<td>Configures a BGP routing process and enters router configuration mode.</td>
</tr>
<tr>
<td>Example: Device(config)# router bgp 1</td>
<td></td>
</tr>
<tr>
<td>Step 4 address-family rtfilter unicast</td>
<td>Specifies the RT filter address family type and enters address family configuration mode.</td>
</tr>
<tr>
<td>Example: Device(config-router)# address-family rtfilter unicast</td>
<td></td>
</tr>
<tr>
<td>Step 5 neighbor {ip-address</td>
<td>peer-group-name} activate</td>
</tr>
<tr>
<td>Example: Device(config-router-af)# neighbor 10.0.0.2 activate</td>
<td></td>
</tr>
<tr>
<td>Step 6 neighbor {ip-address</td>
<td>peer-group-name} route-reflector-client</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Note:</td>
<td></td>
</tr>
<tr>
<td>• Note that the route-reflector-client under RT Constraint address-family comes with a default</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td><code>Device(config-router-af)# neighbor 10.0.0.2 route-reflector-client</code></td>
<td>&quot;neighbor 10.0.0.2 default-originate&quot; functionality that automatically gets added to the BGP configuration. The reason to have this is to have the route-reflector get all the VPN prefixes from its peer.</td>
</tr>
<tr>
<td>Step 7</td>
<td>neighbor {ip-address</td>
</tr>
<tr>
<td>Example:</td>
<td>Specifies that a communities attribute should be sent to a BGP neighbor.</td>
</tr>
<tr>
<td>Device(config-router-af)# neighbor 10.0.0.2 send-community extended</td>
<td>• The <code>ip-address</code> argument specifies the IP address of the BGP-speaking neighbor.</td>
</tr>
<tr>
<td></td>
<td>• The <code>peer-group-name</code> argument specifies the name of a BGP peer group.</td>
</tr>
<tr>
<td>Step 8</td>
<td>end</td>
</tr>
<tr>
<td>Example:</td>
<td>Exits address family configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td>Device(config-router-af)# end</td>
<td></td>
</tr>
<tr>
<td>Step 9</td>
<td>show ip bgp rtfilter all</td>
</tr>
<tr>
<td>Example:</td>
<td>(Optional) Displays all BGP RT filter information.</td>
</tr>
<tr>
<td>Device# show ip bgp rtfilter all</td>
<td></td>
</tr>
<tr>
<td>Step 10</td>
<td>show ip bgp rtfilter all summary</td>
</tr>
<tr>
<td>Example:</td>
<td>(Optional) Displays summary BGP RT filter information.</td>
</tr>
<tr>
<td>Device# show ip bgp rtfilter all summary</td>
<td></td>
</tr>
<tr>
<td>Step 11</td>
<td>show ip bgp vpnv4 all</td>
</tr>
<tr>
<td>Example:</td>
<td>(Optional) Displays summary BGP VPNv4 information.</td>
</tr>
<tr>
<td>Device# show ip bgp vpnv4 all</td>
<td></td>
</tr>
</tbody>
</table>

### Configuration Examples for BGP: RT Constrained Route Distribution

#### Example: BGP RT Constrained Route Distribution Between a PE and RR

The following example provides the configurations of the routers in the figure below. PE1 and PE2 are each connected to the RR and belong to AS 65000.
Example: BGP RT Constrained Route Distribution Between a PE and RR

**Figure 74: BGP: RT Constrained Route Distribution Between a PE and RR**

```
PE1 Configuration

ip vrf BLUE
  rd 3:3
  route-target export 1:100
  route-target import 1:100
!
router bgp 65000
  bgp log-neighbor-changes
  neighbor 192.168.2.2 remote-as 65000
  neighbor 192.168.2.2 update-source Loopback0
  no auto-summary
!
  address-family vpnv4
    neighbor 192.168.2.2 activate
    neighbor 192.168.2.2 send-community extended
    exit-address-family
!
  address-family rtfilter unicast
    neighbor 192.168.2.2 activate
    neighbor 192.168.2.2 send-community extended
    exit-address-family
!
  address-family ipv4 vrf BLUE
    redistribute static
    exit-address-family
!
ip route vrf BLUE 51.51.51.51 255.255.255.255 Null0
!
RR Configuration

!
router bgp 65000
  bgp log-neighbor-changes
  neighbor 192.168.6.6 remote-as 65000
  neighbor 192.168.6.6 update-source Loopback0
  neighbor 192.168.7.7 remote-as 65000
  neighbor 192.168.7.7 update-source Loopback0
!
  address-family vpnv4
    neighbor 192.168.6.6 activate
    neighbor 192.168.6.6 send-community extended
    neighbor 192.168.6.6 route-reflector-client
    neighbor 192.168.7.7 activate
    neighbor 192.168.7.7 send-community extended
    neighbor 192.168.7.7 route-reflector-client
```
exit-address-family
!
address-family rtfilter unicast
  neighbor 192.168.6.6 activate
  neighbor 192.168.6.6 send-community extended
  neighbor 192.168.6.6 route-reflector-client
  neighbor 192.168.6.6 default-originate
  neighbor 192.168.7.7 activate
  neighbor 192.168.7.7 send-community extended
  neighbor 192.168.7.7 route-reflector-client
  neighbor 192.168.7.7 default-originate
exit-address-family
!

PE2 Configuration

!
ip vrf RED
  rd 17:17
  route-target export 150:15
  route-target import 150:1
  route-target import 1:100
!
routed bgp 65000
  bgp log-neighbor-changes
  neighbor 192.168.2.2 remote-as 65000
  neighbor 192.168.2.2 update-source Loopback0
  neighbor 192.168.2.2 weight 333
  no auto-summary
!
address-family vpnv4
  neighbor 192.168.2.2 activate
  neighbor 192.168.2.2 send-community extended
exit-address-family
!
address-family rtfilter unicast
  neighbor 192.168.2.2 activate
  neighbor 192.168.2.2 send-community extended
exit-address-family
!

Additional References

Related Documents

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<tr>
<th>Related Topic</th>
<th>Document Title</th>
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</thead>
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<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands: complete command syntax, command mode, defaults, command history, usage guidelines, and examples</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
<tr>
<td>BGP overview</td>
<td>“Cisco BGP Overview” module</td>
</tr>
<tr>
<td>Configuring basic BGP tasks</td>
<td>“Configuring a Basic BGP Network” module</td>
</tr>
<tr>
<td>MIB</td>
<td>MIBs Link</td>
</tr>
<tr>
<td>-----</td>
<td>----------</td>
</tr>
<tr>
<td>CISCO-BGP4-MIB</td>
<td>To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RFC</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFC 1772</td>
<td>Application of the Border Gateway Protocol in the Internet</td>
</tr>
<tr>
<td>RFC 1773</td>
<td>Experience with the BGP Protocol</td>
</tr>
<tr>
<td>RFC 1774</td>
<td>BGP-4 Protocol Analysis</td>
</tr>
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<td>Guidelines for Creation, Selection, and Registration of an Autonomous System (AS)</td>
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<tr>
<td>RFC 2519</td>
<td>A Framework for Inter-Domain Route Aggregation</td>
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<td>RFC 2858</td>
<td>Multiprotocol Extensions for BGP-4</td>
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<td>Route Refresh Capability for BGP-4</td>
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<td>Capabilities Advertisement with BGP-4</td>
</tr>
<tr>
<td>RFC 4271</td>
<td>A Border Gateway Protocol 4 (BGP-4)</td>
</tr>
<tr>
<td>RFC 4684</td>
<td>Constrained Route Distribution for Border Gateway Protocol/MultiProtocol Label Switching (BGP/MPLS) Internet Protocol (IP) Virtual Private Networks (VPNs)</td>
</tr>
<tr>
<td>RFC 4893</td>
<td>BGP Support for Four-Octet AS Number Space</td>
</tr>
<tr>
<td>RFC</td>
<td>Title</td>
</tr>
<tr>
<td>-------</td>
<td>------------------------------------------------------------</td>
</tr>
<tr>
<td>RFC 5291</td>
<td>Outbound Route Filtering Capability for BGP-4</td>
</tr>
<tr>
<td>RFC 5396</td>
<td>Textual Representation of Autonomous system (AS) Numbers</td>
</tr>
<tr>
<td>RFC 5398</td>
<td>Autonomous System (AS) Number Reservation for Documentation Use</td>
</tr>
</tbody>
</table>

### Technical Assistance

**Description**
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.

**Link**

### Feature Information for BGP RT Constrained Route Distribution

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

#### Table 65: Feature Information for BGP: RT Constrained Route Distribution

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP: RT Constrained Route Distribution</td>
<td>Cisco IOS XE</td>
<td>BGP: Route Target (RT) Constrained Route Distribution is a feature that service providers can use in MPLS L3VPNs to reduce the number of unnecessary routes that RRs send to PEs, and thereby save resources. The following commands were introduced:</td>
</tr>
<tr>
<td></td>
<td>Release 3.2S</td>
<td>• address-family rtfilter unicast</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• show ip bgp rtfilter</td>
</tr>
</tbody>
</table>
CHAPTER 50

Configuring a BGP Route Server

BGP route server is a feature designed for internet exchange (IX) operators that provides an alternative to full eBGP mesh peering among the service providers who have a presence at the IX. The route server provides eBGP route reflection with customized policy support for each service provider. That is, a route server context can override the normal BGP best path for a prefix with a different path based on a policy, or suppress all paths for a prefix and not advertise the prefix. The BGP route server provides reduced configuration complexity and reduced CPU and memory requirements on each border router. The route server also reduces overhead expense incurred by individualized peering agreements.

- Finding Feature Information, on page 807
- Information About BGP Route Server, on page 807
- How to Configure a BGP Route Server, on page 813
- Configuration Examples for BGP Route Server, on page 820
- Additional References, on page 823
- Feature Information for BGP Route Server, on page 824

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About BGP Route Server

The Problem That a BGP Route Server Solves

In order to understand the problem that a BGP route server solves, it is helpful to understand the following information about service provider (SP) peering and the eBGP mesh that results from public peering.
Private vs. Public Peering of Service Providers

Peering is the connecting of two service providers (SPs) for the purpose of exchanging network traffic between them. Peerings are either private or public.

- In a private peering, two SPs that want to connect decide on a physical site where their networks can be connected and negotiate a contract that covers the details of the connection arrangement. The two parties provide all of the physical space, network equipment, and services (such as electricity and cooling) required to operate the peering connections.

- A public internet exchange (IX), also called a network access point (NAP), is a physical location operated to facilitate the interconnection of multiple SP networks using a shared infrastructure. The IX provides the physical necessities such as rack space for networking devices, electricity, cooling, and a common switching infrastructure required for SPs to directly connect their networks. Unlike private peering, which is typically one-to-one, the IX allows an SP that has a presence at the exchange to connect to multiple peers at a single physical location. The IX provides an alternative to private peering for smaller SPs who do not have the resources required to maintain numerous private peering connections.

Public Peering of SPs within an IX Using BGP

Within the IX, each SP maintains a BGP border router connected to the common switching infrastructure or subnet, as shown in the figure below. In this example, eight different SPs with AS numbers 100 through 800 are connected to the 10.0.0.0/24 subnet through their BGP border routers addressed 10.0.0.1 through 10.0.0.8.

Figure 75: IX Shared Switching Infrastructure

Although each SP’s border router is attached to the shared subnet, BGP sessions between each of the SPs must still be configured and maintained individually, for every other SP with which a given SP wants to establish a peering relationship.

Assuming that each SP wants to connect to every other SP, the resulting full mesh of BGP sessions established is shown in the figure below.
Just as the required iBGP full mesh in an autonomous system presents a scaling and administrative challenge within an SP network, the eBGP full mesh required for peering at an IX presents a challenge for eBGP, for these reasons:

- The full mesh of direct peering sessions requires a BGP session to be configured and maintained for each connection.
- There is additional operational overhead from contracts that would need to be negotiated with each SP peer connecting to a given provider at the IX.

Because larger global SPs might have a presence at dozens or hundreds of internet exchanges worldwide, and dozens or hundreds of potential peers at each IX, it would be a huge operational expense to connect to all of the small providers. Consequently, the state of peering prior to the BGP Route Server feature is that a large global SP connects to only a subset of other large providers to limit the management and operational overhead. A more scalable alternative to direct peering would allow large global SPs to connect to more small providers.

**BGP Route Server Simplifies SP Interconnections**

A BGP route server simplifies interconnection of SPs at an IX, as shown in the figure below.
Instead of maintaining individual, direct eBGP peerings with every other provider, an SP maintains only a single connection to the route server operated by the IX. Peering with only the route server reduces the configuration complexity on each border router, reduces CPU and memory requirements on the border routers, and avoids most of the operational overhead incurred by individualized peering agreements.

The route server provides AS-path, MED, and nexthop transparency so that peering SPs at the IX still appear to be directly connected. In reality, the IX route server mediates this peering, but that relationship is invisible outside of the IX.

The figure below illustrates an example of transparent route propagation with a route server at an IX.
In the figure above, a routing update goes from AS 1 to AS 2 to AS 100. The update leaves the router in AS 100 advertising that the router can reach the prefix 10.9.9.0/24, use 10.0.0.1 as the next hop, and use the AS path of AS100, AS2, AS1.

The router in AS 900 is a route server and the router in AS 500 is a route server client. A route server client receives updates from a route server. As shown in the figure above, the router in AS 900 does not change the update; route server updates are transparent in terms of MED, next hop and AS-path. The update goes to the client with the same prefix, next hop and AS-path that came from the router at 10.0.0.1.

**Benefits of a BGP Route Server**

A BGP route server provides the following benefits:

- Reduced configuration complexity on each border router.
- Reduced CPU and memory requirements on each border router.
- Reduced operational overhead incurred by individualized peering agreements.
- The ability for a route server context to override the normal BGP best path with an alternative path based on some policy.
- The ability for a route server context to suppress all paths for a prefix and therefore not advertise the prefix.
Route Server Context Provides Flexible Routing Policy

A BGP route server can provide a flexible routing policy. Your network environment might or might not have routes that need a customized (flexible) policy handling.

Routes needing flexible policy handling are selected for import into a route server context by configuring an import map. The import map references a route map, where the actual policy is defined by at least one permit statement. Routes (paths) that match the route map are included in a second "best path" calculation. The resulting best path, if it is different from the global best path, is imported into the context. Router server clients associated with a router server context will override the global best path with the context’s best path when sending routing updates.

Multiple contexts can be created, and the appropriate context is referenced on the route server by the neighbors assigned to use that context (in the neighbor route-server-client command). Thus, multiple neighbors sharing the same policy can share the same route server context.

Three Stages of Filtering on a Route Server Client

With the introduction of route server context, there are now three stages of route filtering that can be applied to a route server client, as shown in the figure below. The three stages of filtering are described below the figure. You can apply all, none, or any combination of the three filtering methods to a route server client. In the figure, the decreasing arrow sizes symbolize that potentially fewer routes might pass each filter than entered the filter.

1. As shown in the figure above beginning at the left, when incoming eBGP updates arrive from a route server client, the system will apply inbound route filters for a route server client the same way it does for a non-route-server client (configured with the neighbor route-map in command). All routes permitted by the client’s inbound filtering are installed in the global BGP table for the appropriate address family, as usual, and anything else is dropped.

2. If any route server contexts have been configured with flexible policy using the import-map command, the best path from among the subset of matching routes is imported into the virtual table for the contexts. Route server clients associated with a context will then override any routes from the global BGP table with customized routes from the context’s virtual table when generating updates.

3. A route server client’s outbound filtering policies (configured with the neighbor route-map out command) will be applied to the global updates that do not have customized policy, and the outbound filtering policies are also applied to any updates generated from the route server context’s virtual table.
# How to Configure a BGP Route Server

## Configure a Route Server with Basic Functionality

Perform this task to configure a BGP router as route server for IPv4 or IPv6. This task will enable the basic route server functionality for next-hop, AS-path, and MED transparency.

**Note**

This task does not enable flexible policy handling. To enable flexible policy handling, see the [Configure a Route Server with Flexible Policy Handling](#), on page 816.

### SUMMARY STEPS

1. `enable`  
2. `configure terminal`  
3. `router bgp autonomous-system-number`  
4. `neighbor {ipv4-address|ipv6-address} remote-as remote-as-number`  
5. `address-family {ipv4 | ipv6} {unicast | multicast}`  
6. `neighbor {ipv4-address|ipv6-address} activate`  
7. `neighbor {ipv4-address|ipv6-address} route-server-client`  
8. `end`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** `enable`  
Example:  
`Router> enable` | Enables privileged EXEC mode.  
- Enter your password if prompted. |
| **Step 2** `configure terminal`  
Example:  
`Router# configure terminal` | Enters global configuration mode. |
| **Step 3** `router bgp autonomous-system-number`  
Example:  
`Router(config)# router bgp 900` | Configures a BGP routing process. |
| **Step 4** `neighbor {ipv4-address|ipv6-address} remote-as remote-as-number`  
Example: | Adds an entry to the BGP neighbor table. |
### Configure a Route Server Client To Receive Updates

In the prior task, you configured a route server. A route server does not put its own AS number in the AS-path; there is AS-path transparency. This means the route server client will receive updates in which the first AS number in the AS-path is not the sending router’s AS number.

By default, a router denies an update received from an eBGP peer that does not list its AS number at the beginning of the AS-path in an incoming update. Therefore, you must disable that behavior on the client in order for the client to receive the updates. To do so, perform this task.

### SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. no bgp enforce-first-as
5. neighbor {ipv4-address|ipv6-address} remote-as remote-as-number
6. address-family {ipv4 | ipv6} { unicast | multicast}
7. neighbor {ipv4-address|ipv6-address} activate
8. exit-address-family
**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>enable</td>
<td>- Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Router&gt; enable</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>configure terminal</td>
<td>Router# configure terminal</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Configures a BGP routing process.</td>
</tr>
<tr>
<td>router bgp autonomous-system-number</td>
<td>Router(config)# router bgp 900</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>Disables requirement that an update received from an eBGP peer list its AS number at the beginning of the AS_PATH.</td>
</tr>
<tr>
<td>no bgp enforce-first-as</td>
<td>- By default, a router is configured to deny an update received from an external BGP (eBGP) peer that does not list its autonomous system number at the beginning of the AS_PATH in the incoming update.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Router(config-router)# no bgp enforce-first-as</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>In order to receive updates from the route server, which will not have its AS first in the AS_PATH, specify no bgp enforce-first-as to disable the enforcement.</td>
</tr>
<tr>
<td>neighbor {ipv4-address</td>
<td>ipv6-address} remote-as remote-as-number</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Router(config-router)# neighbor 10.0.0.1 remote-as 100</td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>Enters address family configuration mode to configure a routing session using IPv4 or IPv6 unicast or multicast address prefixes.</td>
</tr>
<tr>
<td>address-family {ipv4</td>
<td>ipv6} {unicast</td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>Enables the exchange of information with a BGP neighbor.</td>
</tr>
<tr>
<td>neighbor {ipv4-address</td>
<td>ipv6-address} activate</td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td>Exits address family configuration mode.</td>
</tr>
<tr>
<td>exit-address-family</td>
<td></td>
</tr>
</tbody>
</table>
Configure a Route Server with Flexible Policy Handling

Perform this task if you need your BGP route server to support a customized, flexible policy in addition to basic route server functionality.

In order to configure flexible policy handling, create a route server context, which includes an import map. The import map references a standard route map.

In this particular configuration task, the policy is based on autonomous system number, so the `match as-path` command is used. The actual AS number is identified in the `ip as-path access-list` command. You may match on nhexthop, AS path, communities, and extended communities.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `route-server-context context-name`
5. `description string`
6. `address-family {ipv4 | ipv6} {unicast | multicast}
7. import-map route-map-name`
8. `exit-address-family`
9. `exit-route-server-context`
10. `exit`
11. `ip as-path access-list access-list-number {permit | deny} regexp`
12. `route-map route-map-name [permit | deny] sequence-number`
13. `match as-path access-list-number`
14. `exit`
15. `router bgp autonomous-system-number`
16. `neighbor {ipv4-address | ipv6-address} remote-as remote-as-number`
17. `address-family {ipv4 | ipv6} {unicast | multicast}
18. neighbor {ipv4-address | ipv6-address} activate`
19. `neighbor {ipv4-address | ipv6-address} route-server-client context ctx-name`
20. `end`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td></td>
</tr>
<tr>
<td><code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td><code>Router&gt; enable</code></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Enter your password if prompted.</td>
</tr>
</tbody>
</table>
### Command or Action

<table>
<thead>
<tr>
<th>Step 2</th>
<th><code>configure terminal</code></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td><code>Router# configure terminal</code></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 3</th>
<th><code>router bgp autonomous-system-number</code></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td><code>Router(config)# router bgp 900</code></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 4</th>
<th><code>route-server-context context-name</code></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td><code>Router(config-router)# route-server-context ONLY_AS27_CONTEXT</code></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 5</th>
<th><code>description string</code></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td><code>Router(config-router-rsctx)# description Permit only routes with AS 27 in AS path.</code></td>
</tr>
</tbody>
</table>

| Step 6 | `address-family {ipv4 | ipv6} { unicast | multicast}`  |
|--------|-----------------------------|
| **Example:** | `Router(config-router-rsctx)# address-family ipv4 unicast` |

<table>
<thead>
<tr>
<th>Step 7</th>
<th><code>import-map route-map-name</code></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td><code>Router(config-router-rsctx-af)# import-map only_AS27_routemap</code></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 8</th>
<th><code>exit-address-family</code></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td><code>Router(config-router-rsctx-af)# exit-address-family</code></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 9</th>
<th><code>exit-route-server-context</code></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td><code>Router(config-router-rsctx)# exit-route-server-context</code></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 10</th>
<th><code>exit</code></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td><code>Router(config-router)# exit</code></td>
</tr>
</tbody>
</table>

### Purpose

- **Step 2**: Enters global configuration mode.
- **Step 3**: Configures a BGP routing process.
- **Step 4**: Creates a route server context.
  - *In this example, a context named ONLY_AS27_CONTEXT is created.*
- **Step 5**: (Optional) Allows you to describe the context.
  - *Up to 80 characters are allowed.*
- **Step 6**: Enters address family configuration mode to configure a routing session using IPv4 or IPv6 unicast or multicast address prefixes.
- **Step 7**: Configures flexible policy handling by using the route map that you will create in Step 12 to control which routes will be added to the route server client virtual table.
- **Step 8**: Exits address family configuration mode.
- **Step 9**: Exits route server context configuration mode.
- **Step 10**: Exits router configuration mode.
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| Router(config-router)# exit                           | **Step 11** *ip as-path access-list access-list-number [permit | deny] regexp*  
**Example:**  
Router(config)# ip as-path access-list 5 permit 27  
Configures an AS path filter using a regular expression.  
- The *ip as-path* command is not necessarily the command you have to use. Determine what policy you want to create. |
| **Step 12** *route-map route-map-name [permit | deny] sequence-number*  
**Example:**  
Router(config)# route-map only_AS27_routemap permit 10  
Defines whether AS paths that match the subsequent *match as-path* command will be permitted or denied in the route map.  
- Use the same *route-map-name* that you specified in the *import-map* command above. |
| **Step 13** *match as-path access-list-number*  
**Example:**  
Router(config-route-map)# match as-path 5  
Identifies an access list that determines which AS paths are matched and become part of the route map configured in the prior step.  
- This particular example references the *access-list-number* configured in the *ip as-path access-list* command.  
- The *match as-path* command is not necessarily the command you have to use. Determine what policy you want to use.  
- You may match on nexthop, AS path, communities, and extended communities. |
| **Step 14** *exit*  
**Example:**  
Router(config-route-map)# exit  
Exits route map configuration mode. |
| **Step 15** *router bgp autonomous-system-number*  
**Example:**  
Router(config)# router bgp 900  
Configures a BGP routing process. |
| **Step 16** *neighbor {ipv4-address| ipv6-address} remote-as remote-as-number*  
**Example:**  
Router(config-router)# neighbor 10.0.0.1 remote-as 500  
Adds an entry to the BGP neighbor table. |
<table>
<thead>
<tr>
<th>Purpose</th>
<th>Command or Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 17</td>
<td>address-family {ipv4</td>
</tr>
<tr>
<td>Example:</td>
<td>Router(config-router)# address-family ipv4 unicast</td>
</tr>
<tr>
<td>Step 18</td>
<td>neighbor {ipv4-address</td>
</tr>
<tr>
<td>Example:</td>
<td>Router(config-router-af)# neighbor 10.0.0.1 activate</td>
</tr>
<tr>
<td>Step 19</td>
<td>neighbor {ipv4-address</td>
</tr>
<tr>
<td>Example:</td>
<td>Router(config-router-af)# neighbor 10.0.0.1 route-server-client context ONLY_AS27_CONTEXT</td>
</tr>
<tr>
<td>Step 20</td>
<td>end</td>
</tr>
<tr>
<td>Example:</td>
<td>Router(config-router-af)# end</td>
</tr>
</tbody>
</table>

**Displaying BGP Route Server Information and Troubleshooting Route Server**

From privileged EXEC mode, perform either of the steps in this task on a BGP route server to see information about the route server.

On a BGP route server client (not the route server), you can use the `show ip bgp ipv4 unicast` or `show ip bgp ipv6 unicast` command to display routing information.

**SUMMARY STEPS**

1. `enable`

2. `show ip bgp {ipv4 | ipv6} unicast route-server \{all | \{context context-name\}\} \{summary\}`

3. `debug ip bgp route-server \{client | context | event | import | policy\} \{detail\}`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>enable</td>
</tr>
<tr>
<td>Example:</td>
<td>Router&gt; enable</td>
</tr>
<tr>
<td></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>• Enter your password if prompted.</td>
</tr>
</tbody>
</table>
### Configuration Examples for BGP Route Server

#### Example BGP Route Server with Basic Functionality

In the following example, the neighbor at 10.0.0.1 is a route server client.

```plaintext
router bgp 65000
  neighbor 10.0.0.1 remote-as 100
  neighbor 10.0.0.5 remote-as 500
  address-family ipv4 unicast
  neighbor 10.0.0.1 activate
  neighbor 10.0.0.1 route-server-client

```

#### Example BGP Route Server Context for Flexible Policy (IPv4 Addressing)

In the following example, the local router is a BGP route server. Its neighbors at 10.10.10.12 and 10.10.10.13 are its route server clients. A route server context named ONLY_AS27_CONTEXT is created and applied to the neighbor at 10.10.10.13. The context uses an import map that references a route map named only_AS27_routemap. The route map matches routes permitted by access list 27. Access list 27 permits routes that have 27 in the AS path.

```plaintext
router bgp 65000
  route-server-context ONLY_AS27_CONTEXT
  address-family ipv4 unicast
    import-map only_AS27_routemap
    exit-address-family
  exit-route-server-context

```

---

### Purpose Command or Action

| Step 2 | show ip bgp {ipv4 | ipv6} unicast route-server {all | {context context-name}} [summary] |

**Example:**

Router#

| Step 3 | debug ip bgp route-server {client | context | event | import | policy} [detail] |

**Example:**

Router# debug ip bgp route-server client

**Purpose**

Displays the paths chosen for a particular route server context, which might include the global best path, an overriding policy path, or a suppressed path.

**Caution**

The `detail` keyword is used for more complex issues and should only be turned on when debugging with a Cisco representative.
neighbor 10.10.10.12 activate
closeneighbor 10.10.10.12 route-server-client
closeneighbor 10.10.10.13 activate
closeneighbor 10.10.10.13 route-server-client context ONLY_AS27_CONTEXT
closeneighbor 10.10.10.21 activate
closeneighbor 10.10.10.27 activate
closeexit-address-family

closeip as-path access-list 27 permit 27

closenroute-map only_AS27_routemap permit 10
closematch as-path 27

close

Example Using Show Commands to See That Route Server Context Routes Overwrite Normal Bestpath

In the following output, a BGP route server has two routes from AS 21 that have been selected as best:

Route-Server# show ip bgp ipv4 unicast
BGP table version is 31, local router ID is 100.100.100.100

Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,

r RIB-failure, S Stale, m multipath, b backup-path, x best-external, f RT-Filter

Origin codes: i - IGP, e - EGP, ? - incomplete

Network Next Hop Metric LocPrf Weight Path

*> 1.1.1.1/32 10.10.10.21 23 0 21 ?
*
* 100.1.1.1/32 10.10.10.27 878 0 27 89 ?
*> 10.10.10.27 878 0 27 89 ?

For Peer12, which has been configured as a route-server client, but not associated with any context, the bestpath is advertised in the following output. Note that AS-path, MED, and nexthop transparency have been maintained; the routes look as if they had not passed through the route server.

Peer12# show ip bgp ipv4 unicast
BGP table version is 31, local router ID is 10.10.10.12

Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,

r RIB-failure, S Stale, m multipath, b backup-path, x best-external, f RT-Filter

Origin codes: i - IGP, e - EGP, ? - incomplete

Network Next Hop Metric LocPrf Weight Path

*> 1.1.1.1/32 10.10.10.21 23 0 21 ?

Peer13 has also been configured as a route-server client, and it has been associated with a context named ONLY_AS27_CONTEXT. The context references a route map that permits only routes that contain AS 27 in the AS path. This means that the route-server should not send any routes to Peer13 unless they contains AS 27. In our scenario, the route server indeed sends the routes learned via AS 27, even though the routes learned via AS 21 are marked as best. The output below demonstrates that the normal best path was overridden by the best path based on policy. Again, MED, as-path, and nexthop transparency have been maintained.

Peer13# show ip bgp ipv4 unicast
BGP table version is 25, local router ID is 10.10.10.13

Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,

r RIB-failure, S Stale, m multipath, b backup-path, x best-external, f RT-Filter

Origin codes: i - IGP, e - EGP, ? - incomplete

Network Next Hop Metric LocPrf Weight Path

*> 1.1.1.1/32 10.10.10.21 23 0 21 ?
*> 100.1.1.1/32 10.10.10.21 23 0 21 ?
Example BGP Route Server Context with No Routes Satisfying the Policy

It is possible that, due to policy, no routes are sent to a client even though paths exist. For instance, if we take the prior example and change `ONLY_AS27_CONTEXT` to `ONLY_AS100_CONTEXT`, no paths would satisfy this policy and no routes will be sent to the client. The following is the configuration and resulting show output:

```
Route-Server# show run | begin router bgp
router bgp 1
    route-server-context ONLY_AS100_CONTEXT
        !
        address-family ipv4 unicast
        import-map only_AS100_routemap
        exit-address-family
exit-route-server-context
! neighbor 10.10.10.13 remote-as 13
neighbor 10.10.10.13 description Peer13
neighbor 10.10.10.21 remote-as 21
neighbor 10.10.10.27 remote-as 27
!
    address-family ipv4
    neighbor 10.10.10.13 activate
    neighbor 10.10.10.13 route-server-client context ONLY_AS100_CONTEXT
    neighbor 10.10.10.21 activate
    neighbor 10.10.10.27 activate
exit-address-family
!
ip as-path access-list 100 permit 100
!
route-map only_AS100_routemap permit 10
    match as-path 100
!
Because no routes satisfy the policy, no routes appear in the table of Peer13:

Peer13# show ip bgp ipv4 unicast
```

Example BGP Route Server Context for Flexible Policy (IPv6 Addressing)

In the following example under address-family IPv6, the local router is a BGP route server. Its neighbors at 2001:DB8:1::112 and 2001:DB8:1::113 are its route server clients. A route server context named `ONLY_AS27_CONTEXT` is created and applied to the neighbor at 2001:DB8:1::113. The context uses an import map that references a route map named `only_AS27_routemap`. The route map matches routes permitted by access list 27. Access list 27 permits routes that have 27 in the AS path.

```
Route-Server# show run | begin router bgp
router bgp 1
    route-server-context ONLY_AS27_CONTEXT
        !
        address-family ipv6 unicast
        import-map only_AS27_routemap
        exit-address-family
exit-route-server-context
```
neighbor 2001:DB8:1::112 remote-as 12
neighbor 2001:DB8:1::112 description Peer12
neighbor 2001:DB8:1::113 remote-as 13
neighbor 2001:DB8:1::113 description Peer13

! address-family ipv6
neighbor 2001:DB8:1::112 activate
neighbor 2001:DB8:1::112 route-server-client
neighbor 2001:DB8:1::113 activate
neighbor 2001:DB8:1::113 route-server-client context ONLY_AS27_CONTEXT
exit-address-family
!
ip as-path access-list 27 permit 27
!
route-map only_AS27_routemap permit 10
  match as-path 27
!
Route-Server# show ip bgp ipv6 unicast route-server all summary

Route server clients without assigned contexts:
  Neighbor   V  AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd
  2001:DB8:1::112 4 12 19 19 4 0 0 00:12:50 2

Route server clients assigned to context ONLY_AS27_CONTEXT:
  Neighbor   V  AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd
  2001:DB8:1::113 4 13 23 22 4 0 0 00:16:23 2

For Peer12, which has been configured as a route-server client, but not associated with any context, the bestpath is advertised. Note that AS-path, MED, and nexthop transparency have been maintained; the routes look as if they had not passed through the route server.

Peer12# show ip bgp ipv6 unicast
BGP table version is 9, local router ID is 2.2.2.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
r RIB-failure, S Stale, m multipath, b backup-path, x best-external, f RT-Filter
Origin codes: i - IGP, e - EGP, ? - incomplete

<table>
<thead>
<tr>
<th>Network</th>
<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>* 2001:DB8:1::/64</td>
<td>2001:DB8:1::113</td>
<td>0</td>
<td>0</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>-&gt;</td>
<td>::</td>
<td>0</td>
<td>32768</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* 2001:DB8:2::/64</td>
<td>2001:DB8:1::113</td>
<td>0</td>
<td>0</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>-&gt;</td>
<td>::</td>
<td>0</td>
<td>32768</td>
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<td></td>
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</tbody>
</table>

Additional References

Related Documents

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<td>Cisco IOS commands</td>
<td>Cisco IOS Master Commands List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
<tr>
<td>BGP configuration tasks</td>
<td>IP Routing: BGP Configuration Guide, Cisco IOS XE Release 3S</td>
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MIBs

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<thead>
<tr>
<th>MIB</th>
<th>MIBs Link</th>
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</thead>
<tbody>
<tr>
<td>-</td>
<td>To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
</tr>
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Technical Assistance

<table>
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<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

Feature Information for BGP Route Server

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.
Table 66: Feature Information for BGP Route Server

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP Route Server</td>
<td>Cisco IOS XE Release 3.3S 15.2(3)T</td>
<td>BGP route server is a feature designed for internet exchange (IX) operators that provides an alternative to full eBGP mesh peering among the service providers who have a presence at the IX. The route server provides eBGP route reflection with customized policy support for each service provider. That is, a route server context can override the normal BGP best path for a prefix with a different path based on a policy, or suppress all paths for a prefix and not advertise the prefix. The BGP route server provides reduced configuration complexity and reduced CPU and memory requirements on each border router. The route server also reduces overhead expense incurred by individualized peering agreements. The following commands were introduced:</td>
</tr>
</tbody>
</table>

  • `debug ip bgp route-server`  
  • `description` (route server context)  
  • `exit-route-server-context`  
  • `import-route-server-context`  
  • `import-map`  
  • `neighbor route-server-client`  
  • `route-server-context`  
  • `show ip bgp unicast route-server`
CHAPTER 51

BGP Diverse Path Using a Diverse-Path Route Reflector

The BGP Diverse Path Using a Diverse-Path Route Reflector feature allows Border Gateway Protocol (BGP) to distribute an alternative path other than the best path between BGP speakers when route reflectors are deployed. This feature is meant to provide path diversity within an autonomous system (AS), within a single cluster only. That is, a route reflector is allowed to advertise the diverse path to its client peers only.

- Finding Feature Information, on page 827
- Prerequisites for BGP Diverse Path Using a Diverse-Path Route Reflector, on page 827
- Restrictions for BGP Diverse Path Using a Diverse-Path Route Reflector, on page 828
- Information About BGP Diverse Path Using a Diverse-Path Reflector, on page 828
- How to Configure a BGP Diverse-Path Route Reflector, on page 831
- Configuration Examples for BGP Diverse Path Using a Diverse-Path Route Reflector, on page 834
- Additional References, on page 836
- Feature Information for BGP Diverse Path Using a Diverse-Path Route Reflector, on page 837

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see the Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for BGP Diverse Path Using a Diverse-Path Route Reflector

You should understand the BGP Best External feature.
Restrictions for BGP Diverse Path Using a Diverse-Path Route Reflector

- A diverse path can be configured on a route reflector only.
- Only one shadow route reflector is allowed per existing route reflector, which will calculate one additional best path (the second best path). That is, only one additional plane (topology) is configured.
- Path diversity is configured within an AS, within a single route reflector cluster. That is, the route reflector will advertise the diverse path to its route reflector client peers only.
- Diverse path functionality is not supported on a route server.

Information About BGP Diverse Path Using a Diverse-Path Reflector

Limitation that a BGP Diverse Path Overcomes

As a path vector routing protocol, BGP-4 requires a router to advertise to its neighbors only the best path for a destination. However, multiple paths to the same destination would allow mechanisms that can improve resilience, quickly recover from failures, and load balance, for example.

The use of route reflectors is one of the main reasons for poor path diversity within an autonomous system (AS). In a network with route reflectors, even if a prefix is learned from multiple egress routers, the route reflector reflects only the best path to its clients. The figure below shows how deploying route reflectors might reduce path diversity in an AS, even when the BGP Best External feature is deployed.

In the figure above, P1 and P2 are diverse paths for prefix p. Assume Path 2 (P2) has a lower MED and higher local preference than P1. The BGP Best External feature on PE1 will make sure that P1 is propagated to the
route reflectors, regardless of P2 having a lower MED and higher local preference. The route reflectors will have path diversity; they will learn both P1 and P2 with different exit points PE1 and PE2 (assuming that PE1 and PE2 have the set ip next-hop self command configured). However, both route reflectors select the best path as P2 due to its lower MED/higher local preference and advertise it to PE3. PE3 will not learn P1 (that is, PE3 will not learn about existing path diversity).

The BGP Diverse Path Using a Diverse-Path Route Reflector feature is a way to resolve that limitation and achieve path diversity.

**BGP Diverse Path Using a Diverse-Path Route Reflector**

The BGP Diverse Path Using a Diverse-Path Route Reflector feature overcomes the lack of path diversity in an AS containing route reflectors. This feature is meant to provide path diversity within an AS, within a single cluster only. That is, a route reflector is allowed to advertise the diverse path to its client peers only.

For each route reflector in the AS, a shadow route reflector is added to distribute the second best path, also known as the diverse path. The figure below shows the shadow route reflector for RR2. The shadow route reflector improves path diversity because PE3 can now learn both P1 (from RR1/RR2) and learn P2 from the shadow route reflector.

The primary route reflector and shadow route reflector must have the exact same connections (physical/control plane) to the rest of the routers in the network.

**Note**

Shadow route reflectors can be both control plane route reflectors and data plane route reflectors.

---

The figure below shows a diverse path in greater detail, indicating the next hops:

- BR2 announces to RR1 and shadow RR2 that R2 (BR2) is the Next Hop for those who want to reach Prefix Z. Likewise, BR3 announces to RR1 and shadow RR2 that R3 (BR3) is the Next Hop for those who want to reach Prefix Z.

- RR1 sends a packet to BR1 announcing that the Next Hop is R2 if BR1 wants to reach Prefix Z. The second best path (or diverse path) comes from shadow RR2, which sends a packet to BR1 announcing that the Next Hop is R3 if BR1 want to reach Prefix Z.
• At BR1 (far right), we see there are two (diverse) paths to Prefix Z.

**Triggers to Compute a BGP Diverse Path**

Computation of a diverse path per address family is triggered by any of the following commands:

- `bgp additional-paths install`
- `bgp additional-paths select`
- `maximum-paths ebgp`
- `maximum-paths ibgp`

The `bgp additional-paths install` command will install the type of path that is specified in the `bgp additional-paths select` command. If the `bgp additional-paths select` command specifies both keyword options (best-external and backup), the system will install a backup path.

The `maximum-paths ebgp` and `maximum-paths ibgp` commands trigger a multipath computation, and multipaths are automatically installed as primary paths.

On the other hand, the `bgp additional-paths install` command triggers computation of a backup path or best-external path.

If the `bgp additional-paths select` command is not configured, the `bgp additional-paths install` command will trigger both computation and installation of a backup path (as is done with the BGP PIC feature).

**IGP Metric Check**

Disabling the Interior Gateway Protocol (IGP) metric check and configuring the BGP Diverse Path feature are independent of each other. One does not imply the other. That is, configuring `bgp bestpath igp-metric ignore` does not imply that the BGP Diverse Path feature is enabled. Conversely, enabling the BGP Diverse Path feature might not require that `bgp bestpath igp-metric ignore` be configured (because, for example, the route reflector and shadow route reflector are co-located).

The `bgp bestpath igp-metric ignore` command can be configured at route reflectors and provider edges (PEs).
Per-VRF functionality for the `bgp bestpath igp-metric ignore` command is not supported. If you use it anyway, it is at your own risk.

**Route Reflector Determination**

If a router’s configuration includes either one of the following commands, the router is a route reflector:

- `bgp cluster-id`
- `neighbor route-reflector-client`

**How to Configure a BGP Diverse-Path Route Reflector**

**Determining Whether You Need to Disable the IGP Metric Check**

Before you configure a shadow route reflector in order to get a BGP diverse path, determine whether you need to disable the IGP metric check. The IGP metric is a configurable value indicating physical distance, and is used by an Interior Gateway Protocol, such as Open Shortest Path First (OSPF), Enhanced Interior Gateway Routing Protocol (EIGRP), or Routing Information Protocol (RIP). A smaller IGP metric is preferred over a larger IGP metric.

The locations of the route reflector and shadow route reflector determine whether or not you need to disable the IGP metric check, as follows:

- When the route reflector and shadow route reflector are collocated—They have the same IP subnetwork address and are connected to the Ethernet switch with different links. Failure of such a link is equivalent to the route reflector going down. When RRs are collocated, their IGP metrics cannot be different from each other; and therefore there is no need to disable the IGP metric check during the best path calculation at any route reflector. Because there is no need to disable the IGP metric check, the first plane route reflectors do not need to be upgraded to Cisco IOS XE Release 3.4S.

- When the shadow route reflector is in a different IGP place from the route reflector (it is not collocated with its best path route reflector)—In this case, the IGP metric check is ignored on both the best path route reflector and shadow route reflector when the best path and second best path are being calculated. The IGP metric check must be disabled on the primary route reflector by configuring the `bgp bestpath igp-metric ignore` command. This command is available beginning with Cisco IOS XE Release 3.4S, which means you need to upgrade to that release.

**Configuring the Route Reflector for BGP Diverse Path**

Perform this task to configure a route reflector for the BGP Diverse Path feature. This task specifies the IPv4 address family, but other address families are also supported.

**SUMMARY STEPS**

1. `enable`
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode for the BGP routing process.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config)# router bgp 1</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> neighbor ip-address remote-as autonomous-system-number</td>
<td>Adds an entry to the BGP or multiprotocol BGP neighbor table.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config-router)# neighbor 10.1.1.1 remote-as 1</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> address-family ipv4 unicast</td>
<td>Specifies the address family and enters address family configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>• Supported address families are IPv4 unicast, VPNv4 unicast, IPv6 unicast, VPNv6 unicast, IPv4+label, and IPv6+label.</td>
</tr>
<tr>
<td>Device(config-router)# address-family ipv4 unicast</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> neighbor ip-address activate</td>
<td>Enables the exchange of information with a BGP neighbor.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Device(config-router-af)# neighbor 10.1.1.1 activate</td>
<td>Controls the maximum number of parallel Internal BGP (IBGP) routes that can be installed in a routing table.</td>
</tr>
<tr>
<td><strong>Step 7</strong> maximum-paths ibgp number-of-paths</td>
<td>Controls the maximum number of parallel Internal BGP (IBGP) routes that can be installed in a routing table.</td>
</tr>
<tr>
<td>Example: Device(config-router-af)# maximum-paths ibgp 4</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong> bgp bestpath igp-metric ignore</td>
<td>Configures the system to ignore the Interior Gateway Protocol (IGP) metric during BGP best path selection.</td>
</tr>
<tr>
<td>Example: Device(config-router-af)# bgp bestpath igp-metric ignore</td>
<td></td>
</tr>
<tr>
<td><strong>Step 9</strong> bgp additional-paths select [backup]</td>
<td>Configures the system to calculate a second BGP best path.</td>
</tr>
<tr>
<td>Example: Device(config-router-af)# bgp additional-paths select backup</td>
<td></td>
</tr>
<tr>
<td><strong>Step 10</strong> bgp additional-paths install</td>
<td>Enables BGP to calculate a backup path for a given address family and to install it into the routing information base (RIB) and Cisco Express Forwarding (CEF).</td>
</tr>
<tr>
<td>Example: Device(config-router-af)# bgp additional-paths install</td>
<td></td>
</tr>
<tr>
<td><strong>Step 11</strong> neighbor ip-address route-reflector-client</td>
<td>Configures the router as a BGP route reflector and configures the specified neighbor as its client.</td>
</tr>
<tr>
<td>Example: Device(config-router-af)# neighbor 10.1.1.1 route-reflector-client</td>
<td></td>
</tr>
<tr>
<td><strong>Step 12</strong> neighbor ip-address advertise diverse-path [backup] [mpath]</td>
<td>(Optional) Configures a neighbor to receive the diverse path in an advertisement.</td>
</tr>
<tr>
<td>Example: Device(config-router-af)# neighbor 10.1.1.1 advertise diverse-path backup</td>
<td></td>
</tr>
<tr>
<td><strong>Step 13</strong> end</td>
<td>(Optional) Exits address family configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Device(config-router-af)# end</td>
<td></td>
</tr>
<tr>
<td><strong>Step 14</strong> show ip bgp neighbor ip-address advertised-routes</td>
<td>(Optional) Displays the routes advertised to the specified neighbor.</td>
</tr>
<tr>
<td>Example: Device# show ip bgp neighbor 10.1.1.1 advertised-routes</td>
<td></td>
</tr>
</tbody>
</table>
Configuration Examples for BGP Diverse Path Using a Diverse-Path Route Reflector

Example: Configuring BGP Diverse Path Where Additional Path Is the Backup Path

Diverse path functionality is contained within a single cluster; that is, only the clients of a route reflector can be configured to advertise the diverse path. A diverse path is advertised to the clients of a route reflector only if the client is configured to get the additional path.

A shadow route reflector can be added to calculate and advertise the additional path, or an existing route reflector can be configured to calculate and advertise the additional path. In the figure below, instead of adding a shadow route reflector, RR2 (the existing backup RR) is configured to calculate the additional path and advertise it to a particular neighbor.

In the figure below, assume that from the route reflectors, the path to CE1 via PE1 is preferred over the path via PE2. Without the diverse path feature, both route reflectors will advertise to PE3 that the path to CE1 is via PE1. If the connection between RR1 and PE1 fails (or the path between PE1 and CE1 fails), there is no other path.

In the following configuration example based on the figure above, RR2 is configured with an additional path, which is a backup path.

If RR1 and RR2 are not colocated, you must configure the `bgp bestpath igp-metric ignore` command before the additional path is calculated. (If RR1 and RR2 are colocated, do not configure that command.)

The `bgp additional-paths select backup` command triggers calculation of the backup path at RR2, which is the path via PE2.

The `bgp additional-paths install` command installs the backup path if RR2 is in the forwarding plane. (Do not configure this command if RR2 is in the control plane.)

The address of PE3 is 10.1.1.1, and that address is used in the `neighbor advertise diverse-path backup` command on RR2. This command triggers advertisement of the backup path to PE3. PE3 will learn the best path, (which is the path via PE1) from RR1, and it will learn the backup path from RR2.
Example: Configuring BGP Diverse Path Where Additional Path Is the Multipath

In the following example based on the figure above, assume that paths toward CE1 via PE1 and PE2 are multipaths. The **maximum-paths ibgp** command will trigger calculation of multipaths.

The address of PE3 is 10.1.1.1, and that address is used in the **neighbor advertise diverse-path mpath** command on RR2. This command will trigger advertisement of the multipath, that is, the second best path, to PE3. PE3 will learn the best path, path via PE1 from RR1, and will learn second best path from RR2.

Example: Configuring BGP Diverse Path Where Both Multipath and Backup Path Calculations Are Triggered

The following example is based on the figure above. The **maximum-paths ibgp** command will trigger calculation of multipaths. When both multipath and backup path calculations are triggered, the backup path and the second multipath (which is the second best path) are the same paths and it will be installed as the active path, regardless of whether the route reflector is in the control plane or forwarding plane.

The address of PE3 is 10.1.1.1, and that address is used in the **neighbor advertise diverse-path backup mpath** command on RR2. This command causes RR2 to advertise the second best path, which is the second multipath, to PE3.
Example: Configuring Triggering Computation and Installation of a Backup Path

When the `bgp additional-paths install` command is configured without configuring `bgp additional-paths select backup`, the former command will trigger both computation and installation of the backup path (as it is with the existing BGP PIC feature).

The address of PE3 is 10.1.1.1, and that address is used in the `neighbor advertise diverse-path backup` command on RR2. This command will trigger advertisement of a backup path to PE3. PE3 will learn the best path, a path via PE1 from RR1, and it will learn a backup path from RR2.

**RR2**

```
router bgp 1
neighbor 10.1.1.1 remote-as 1
address-family ipv4 unicast
neighbor 10.1.1.1 activate
maximum-paths ibgp 4
bgp additional-paths install
neighbor 10.1.1.1 remote-as 1
neighbor 10.1.1.1 route-reflector-client
neighbor 10.1.1.1 advertise diverse-path backup
```

### Additional References

**Related Documents**

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Commands List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
<tr>
<td>Configuring BGP Best External Path on a Route Reflector for Intercluster</td>
<td>BGP Best External module</td>
</tr>
<tr>
<td>BGP configuration tasks</td>
<td>Cisco IOS XE IP Routing: BGP Configuration Guide</td>
</tr>
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**Standards**

<table>
<thead>
<tr>
<th>Standard</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>draft-ietf-grow-diverse-bgp-path-dist-02.txt</td>
<td>Distribution of Diverse BGP Paths</td>
</tr>
</tbody>
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MIBs

<table>
<thead>
<tr>
<th>MIB</th>
<th>MIBs Link</th>
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<tr>
<td>No new or modified MIBs are supported by this feature, and support for existing MIBs has not been modified by this feature.</td>
<td>To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
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RFCs

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<tr>
<th>RFC</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFC 4271</td>
<td>A Border Gateway Protocol 4 (BGP-4)</td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

Feature Information for BGP Diverse Path Using a Diverse-Path Route Reflector

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.
Table 67: Feature Information for BGP Diverse Path Using a Diverse-Path Route Reflector

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
</table>
| BGP Diverse Path Using a Diverse-Path Route Reflector | Cisco IOS XE Release 3.4S | This feature allows BGP to distribute an alternative path other than the best path between BGP speakers when route reflectors are deployed. The following commands were introduced:  
  • `bgp additional-paths select`  
  • `bgp bestpath igp-metric ignore`  
  • `debug ip bgp igp-metric ignore`  
  • `neighbor advertise best-external`  
  • `neighbor advertise diverse-path` |
BGP Enhanced Route Refresh

The BGP Enhanced Route Refresh feature provides a way for Border Gateway Protocol (BGP) to find route inconsistencies, and in that unlikely event, to synchronize BGP peers without a hard reset. The feature is enabled by default; there are two optional timers.

• Finding Feature Information, on page 839
• Information About BGP Enhanced Route Refresh, on page 839
• How to Set Timers for BGP Enhanced Route Refresh, on page 840
• Configuration Examples for BGP Enhanced Route Refresh, on page 842
• Additional References, on page 842
• Feature Information for BGP Enhanced Route Refresh, on page 842

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information for BGP Enhanced Route Refresh, on page 842.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn . An account on Cisco.com is not required.

Information About BGP Enhanced Route Refresh

BGP Enhanced Route Refresh Functionality

During session establishment, BGP peers exchange with each other their capability to do the BGP Enhanced Route Refresh feature. The feature is enabled by default.

It is not expected that the peers will become inconsistent with each other. That might only happen in an extreme corner case, and if that happens, this feature helps to identify that and synchronize the peers without a hard reset.

If two peers are capable of Enhanced Route Refresh, each peer will generate a Route-Refresh Start-of-RIB (SOR) message before it advertises the Adj-RIB-Out, and will generate a Route-Refresh End-of-RIB (EOR)
message after it advertises the Adj-RIB-Out. A BGP speaker receiving an EOR message from its peer removes the routes that were not re-advertised as part of Route Refresh response by the peer.

In the unlikely event the router has stale routes remaining after receiving the EOR message or after the EOR timer expires, that means the peers were not consistent with each other. This information can be used to check whether routes are consistent.

**BGP Enhanced Route Refresh Timers**

These timers need not be configured under normal circumstances. You could configure one or both timers if you observe there is continuous route flapping to the extent that a Route Refresh EOR cannot be generated.

The first timer applies to the router when it should be receiving the EOR message, but is not receiving one. The second timer applies to the router when it should be sending the EOR message.

- **Stale path timer**—If the `bgp refresh stalepath-time` command is configured and the router does not receive a Route-Refresh EOR message after an Adj-RIB-Out, the router removes the stale routes from the BGP table after the timer expires. The stale path timer is started when the router receives a Route-Refresh SOR message.

- **Maximum EOR timer**—If the `bgp refresh max-eor-time` command is configured and the router is unable to generate a Route-Refresh EOR message, a Route-Refresh EOR message is generated after the timer expires.

Both timers are configurable. By default, they are both disabled (set to 0 seconds).

**Syslog Messages Generated by the BGP Enhanced Route Refresh**

The following are examples of syslog messages that are generated when a peer deletes stale routes after receiving the Route-Refresh EOR message or after the stale path timer expires. The messages help you to know whether the routers were inconsistent.

```
Net 300:300:3.3.0.0/0 from bgp neighbor IPv4 MDT 10.0.101.1 is stale after refresh EOR (rate-limited)
Net 300:300:3.3.0.0/0 from bgp neighbor IPv4 MDT 10.0.101.1 is stale after refresh stale-path timer expiry (rate-limited)
```

The following are examples of messages logged after a Route-Refresh EOR or after the stale path timer expires, which indicate the total number of stale paths that were from the neighbor.

```
3 stale-paths deleted from bgp neighbor IPv4 MDT 10.0.101.1 after refresh EOR
3 stale-paths deleted from bgp neighbor IPv4 MDT 10.0.101.1 after refresh stale-path timer expiry
```

**How to Set Timers for BGP Enhanced Route Refresh**

**Set Timers for BGP Enhanced Route Refresh**

The BGP Enhanced Route Refresh feature is enabled by default; the timers are disabled by default. Perform this task if you want to set the optional timers.
### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system`
4. `bgp refresh stalepath-time seconds`
5. `bgp refresh max-eor-time seconds`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Enters router configuration mode to create or configure a BGP routing process.</td>
</tr>
<tr>
<td>Router(config)# router bgp 65000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> bgp refresh stalepath-time seconds</td>
<td>(Optional) Causes the router to remove stale routes from the BGP table after the timer expires, even if the router does not receive a Route-Refresh End-of-RIB message.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>• Valid values are from 600 to 3600, or 0.</td>
</tr>
<tr>
<td>Router(config-router)# bgp refresh stalepath-time 1200</td>
<td>• The default is 0, meaning the stale-path timer is disabled.</td>
</tr>
<tr>
<td><strong>Step 5</strong> bgp refresh max-eor-time seconds</td>
<td>(Optional) Specifies that if BGP is unable to generate a Route-Refresh End-of-RIB (EOR) message, a Route-Refresh EOR is generated after the timer expires.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>• Valid values are from 600 to 3600, or 0.</td>
</tr>
<tr>
<td>Router(config-router)# bgp refresh max-eor-time 1200</td>
<td>• The default is 0, meaning the max-eor timer is disabled.</td>
</tr>
</tbody>
</table>
Configuration Examples for BGP Enhanced Route Refresh

Example: Setting Timers for BGP Enhanced Route Refresh

In the following example, if no Route-Refresh EOR message is received after 800 seconds, stale routes will be removed from the BGP table. If no Route-Refresh EOR message is generated after 800 seconds, one is generated.

```
router bgp 65000
bgp refresh stalepath-time 800
bgp refresh max-eor-time 800
```

Additional References

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
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<td>Cisco IOS IP Routing: BGP Command Reference</td>
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Technical Assistance

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</tr>
</tbody>
</table>

Feature Information for BGP Enhanced Route Refresh

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to [www.cisco.com/go/cfn](http://www.cisco.com/go/cfn). An account on Cisco.com is not required.
Table 68: Feature Information for BGP Enhanced Route Refresh

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
</table>
| BGP Enhanced Route Refresh    | Cisco IOS XE Release 3.4S| The BGP Enhanced Route Refresh feature provides a way for BGP to find route inconsistencies, and in that unlikely event, to synchronize BGP peers without a hard reset. The following commands were introduced:  
  - `bgp refresh max-eor-time`  
  - `bgp refresh stalepath-time` |
CHAPTER 53

Configuring BGP Consistency Checker

The BGP Consistency Checker feature provides a way to identify certain types of BGP route inconsistencies with peers: next-hop label inconsistency, RIB-out inconsistency, and aggregation inconsistency. Upon finding such an inconsistency, the system sends a syslog error message and takes appropriate action if configured to do so.

- Finding Feature Information, on page 845
- Information About BGP Consistency Checker, on page 845
- How to Configure BGP Consistency Checker, on page 846
- Configuration Examples for BGP Consistency Checker, on page 847
- Additional References, on page 847
- Feature Information for BGP Consistency Checker, on page 849

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About BGP Consistency Checker

BGP Consistency Checker

A BGP route inconsistency with a peer occurs when an update or a withdraw is not sent to a peer, and black-hole routing can result. To identify that issue, BGP consistency checker was created as a low-priority process that does next-hop-label, RIB-out, and aggregation consistency checks at a configurable interval. When enabled, BGP consistency checker is performed for all address families. Configuring BGP consistency checker is recommended.

Once the process identifies such an inconsistency, it will report the inconsistency with a syslog message and optionally take action if the auto-repair keyword is specified. The action taken depends on the type of inconsistency found.
• Next-Hop Label Consistency Check—When two paths have the same next hop because they are advertised by the same provider edge router (PE), they should also have the same next-hop label. If the labels are different, there is an inconsistency. If the `auto-repair` keyword is specified, the system will send a route-refresh request.

• RIB-Out Consistency Check—If a network passes an outbound policy and is not sent, or if a network does not pass an outbound policy and is sent, there is an inconsistency. If the `auto-repair` keyword is specified, the system will send a route-refresh request.

• Aggregation Consistency Check—If specific routes and the aggregated route become out of sync, an inconsistency can occur. Either the `error-message` keyword or the `auto-repair` keyword will trigger aggregation reevaluation.

In the unlikely event that you receive a syslog message about an inconsistency, notify your Cisco technical support representative with the syslog message exactly as it appears. The following are examples of such syslog messages:

• “Net 10.0.0.0/32 has Nexthop-Label inconsistency.”

• “Net 10.0.0.0/32 in IPv4 Unicast has rib-out inconsistency for update-group 4 - outbound-policy fails.”

### How to Configure BGP Consistency Checker

#### Configure BGP Consistency Checker

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `bgp consistency-checker {error-message | auto-repair} [interval minutes]`
5. `end`
6. `show ip bgp [vpng4 | vpng6] all inconsistency nexthop-label`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1**
| `enable`          | Enables privileged EXEC mode. |
| Example:
| `Router> enable` | - Enter your password if prompted. |
| **Step 2**
| `configure terminal` | Enters global configuration mode. |
| Example:
<p>| <code>Router# configure terminal</code> | |</p>
<table>
<thead>
<tr>
<th>Step 3</th>
<th><strong>Command or Action</strong></th>
<th><strong>Purpose</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><code>router bgp autonomous-system-number</code></td>
<td>Configures a BGP routing process.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>Router(config)# router bgp 500</code></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 4</th>
<th><strong>Command or Action</strong></th>
<th><strong>Purpose</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>Router(config-router)# bgp consistency-checker auto-repair interval 720</code></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 5</th>
<th><strong>Command or Action</strong></th>
<th><strong>Purpose</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><code>end</code></td>
<td>Ends the current configuration and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>Router(config-router)# end</code></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 6</th>
<th><strong>Command or Action</strong></th>
<th><strong>Purpose</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>`show ip bgp [vpnv4</td>
<td>vpng6] all inconsistency nexthop-label`</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>Router# show ip bgp all inconsistency nexthop-label</code></td>
<td></td>
</tr>
</tbody>
</table>

**Configuration Examples for BGP Consistency Checker**

**Example: Configuring BGP Consistency Checker**

The following example configures BGP consistency checker with auto-repair at the default interval of one day:

```
router bgp 65000
bgp consistency-checker auto-repair
```  

**Additional References**

**Related Documents**

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
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<tr>
<td>Related Topic</td>
<td>Document Title</td>
</tr>
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<tr>
<td>Enabling BGP MIB support</td>
<td>“BGP MIB Support” module in the IP Routing: BGP Configuration Guide</td>
</tr>
<tr>
<td>Configuring SNMP Support</td>
<td>SNMP Configuration Guide in the Cisco IOS Network Management Configuration Guide Library</td>
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<td>SNMP Commands</td>
<td>Cisco IOS SNMP Support Command Reference</td>
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### Standards

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### MIBs

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<th>MIBs Link</th>
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<td></td>
<td>To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
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### RFCs

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<tr>
<th>RFC</th>
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<tbody>
<tr>
<td>RFC 1657</td>
<td>BGP-4 MIB</td>
</tr>
<tr>
<td>RFC 1771</td>
<td>A Border Gateway Protocol 4 (BGP-4)</td>
</tr>
<tr>
<td>RFC 2547</td>
<td>BGP/MPLS VPNs</td>
</tr>
<tr>
<td>RFC 2858</td>
<td>Multiprotocol Extensions for BGP-4</td>
</tr>
</tbody>
</table>

### Technical Assistance

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<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>
Feature Information for BGP Consistency Checker

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Table 68: Feature Information for BGP Consistency Checker

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP Consistency Checker</td>
<td>Cisco IOS XE Release 3.3S</td>
<td>The BGP Consistency Checker feature provides a way to identify three types of BGP route inconsistencies with peers: next-hop label inconsistency, RIB-out inconsistency, and aggregation inconsistency. Upon finding such inconsistency, the system sends a syslog error message and takes appropriate action if configured to do so.</td>
</tr>
<tr>
<td></td>
<td>Cisco IOS XE Release 3.4SG</td>
<td>The following command was introduced: <code>bgp consistency-checker</code></td>
</tr>
<tr>
<td></td>
<td></td>
<td>The following command was modified: <code>show ip bgp vpnv4</code>.</td>
</tr>
</tbody>
</table>
BGP—Origin AS Validation

The BGP—Origin AS Validation feature helps prevent network administrators from inadvertently advertising routes to networks they do not control. This feature uses a Resource Public Key Infrastructure (RPKI) server to authenticate that certain BGP prefixes originated from an expected autonomous system before the prefixes are allowed to be advertised.

• Finding Feature Information, on page 851
• Information About BGP Origin AS Validation, on page 851
• How to Configure BGP Origin AS Validation, on page 855
• Configuration Examples for BGP Origin AS Validation, on page 862
• Additional References, on page 863
• Feature Information for eBGP Multipath for Non-VRF Interfaces (IPv4/IPv6), on page 864

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About BGP Origin AS Validation

Benefit of BGP—Origin AS Validation

Occasionally network administrators have unintentionally advertised routes to networks that they do not control. This security issue can be avoided by configuring the BGP—Origin AS Validation feature. This feature uses an RPKI server to authenticate certain BGP prefixes as having originated from an expected autonomous system before prefixes are accepted.
How BGP—Origin AS Validation Works

The network administrator must set up a Resource Public Key Infrastructure (RPKI) server, using third-party software. The RPKI server handles the actual authentication of public key certificates. The server is set up so that certain prefixes or prefix ranges are allowed to originate from certain autonomous systems.

The administrator then configures the router to establish a TCP connection to the RPKI server. This is done by configuring the `bgp rpki server` command. Upon such configuration or booting the router, the router opens a TCP connection to the indicated IP address and port number. The router downloads a list of prefixes and permitted origin AS numbers from one or more router/RPKI servers using the RPKI-Router protocol (RTR). Thus, the router obtains information from the server about which autonomous systems are permitted to advertise which routes, that is, from which AS a route may originate.

If the TCP connection attempt fails, the router retries the connection once per minute. In the meantime, BGP will behave without performing origin validation.

After the TCP session between the router and the server is established, the server will normally send to the router incremental updates with new prefixes that have been added to the RPKI database. The router might also query the server every refresh interval. The router will not send a serial query message or reset query message during the interval between when it sends a serial query or reset query and when it receives an End of Data (EOD) message. Serial queries in this interval are stripped, and reset queries in this interval are sent upon receipt of the EOD message.

A prefix or prefix range and the origin-AS corresponding to it are considered an SOVC record. Overlapping prefix ranges are allowed. An SOVC table containing three records might look like this:

```
10.0.1.0/20-25 AS 3
10.0.1.0/19-24 AS 4
10.0.1.0/23-27 AS 5
```

When a prefix (network) is received from an external BGP (eBGP) peer, the prefix is initially placed in the Not Found state. It is then examined and marked as Valid, Invalid, or Not Found:

- **Valid**—Indicates the prefix and AS pair are found in the SOVC table.
- **Invalid**—Indicates the prefix meets either of the following two conditions: 1. It matches one or more Route Origin Authorizations (ROAs), but there is no matching ROA where the origin AS matches the origin AS on the AS-PATH. 2. It matches the one or more ROAs at the minimum-length specified in the ROA, but for all ROAs where it matches the minimum length, it is longer than the specified maximum length. Origin AS does not matter for condition #2.
- **NotFound**—Indicates the prefix is not among the valid or invalid prefixes.

By default, a prefix that is marked Invalid is not advertised to any peer, will be withdrawn from the BGP routing table if it was already advertised, and will not be flagged as a bestpath or considered as a candidate for multipath (unless a BGP bestpath command indicates otherwise). Unless a BGP bestpath command is configured indicating otherwise, the bestpath computation prefers Valid prefixes over Not Found prefixes, and both types of prefixes are advertised.

A prefix marked as Valid is installed in the BGP routing table.

By default, a prefix marked as Not Found is installed in the BGP routing table and will only be flagged as a bestpath or considered as a candidate for multipath if there is no Valid alternative (independently of other BGP attributes such as Local Preference or AS_PATH).
If more than one RPKI server is configured, the router will connect to all configured servers and download prefix information from all of them. The SOVC table will be made of the union of all the records received from the different servers.

Once the `bgp rpki server` command (or the `neighbor announce rpki state` command) is configured for an address family, the router starts doing RPKI validation for every path in that address family.

### Option to Announce RPKI Validation State to Neighbors

You may optionally announce (and receive) the validation state of a prefix to (and from) internal BGP (iBGP) neighbors by using an extended community attribute. This option might be more convenient for some routers than configuring the `bgp rpki server` command, because it saves that router from having to connect to an RPKI server.

The `neighbor announce rpki state` command causes the router to send the RPKI status with the route to its iBGP neighbors in the BGP extended community attribute. The router also receives RPKI status with the route from its iBGP neighbor. The announcement works in both directions. The extended community attribute announced is:

0x4300 0x0000 (4 bytes indicating state)

The four bytes indicating state are treated as a 32-bit unsigned integer having one of the following values:

- 0—Valid
- 1—Not Found
- 2—Invalid

If the `neighbor announce rpki state` command is configured, upon receiving a route with this extended community attribute attached from an iBGP peer, the router assigns the route the corresponding validation state. If the `neighbor announce rpki state` command is not configured, all prefixes received from an iBGP peer will be marked as Valid, including the prefixes that must have marked as Not Found.

---

**Note**

This extended community attribute is not sent to eBGP neighbors, even if they are configured to allow sending of this attribute.

The RPKI state extended community follows these additional behaviors:

- The configuration of the `neighbor announce rpki state` command is possible only if the router is configured to send extended communities to that neighbor on that address family.

- The `neighbor announce rpki state` command is completely independent of whether RPKI is configured for the address family.

- Once the `neighbor announce rpki state` command or the `bgp rpki server` command is configured for an address family, the router starts doing RPKI validation for every path in that address family.

- The enabling and disabling of the `neighbor announce rpki state` command causes neighbors to be split into their own update groups based on whether this portion of their configuration is identical.

- If the `neighbor announce rpki state` command is not configured, the router will save the RPKI state received from other routers, but will use it only if at least one other neighbor in the address family is
configured with the `neighbor announce rpki state` command or if the topology is otherwise enabled for the use of RPKI.

- If the `neighbor send-community extended` or `neighbor send-community both` command is removed from the configuration, the `neighbor announce rpki state` configuration is also removed.

- When configuring a route reflector (RR), if the RR server receives a network that includes an RPKI state extended community from a client for whom the `neighbor announce rpki state` command is not configured, the RR will reflect the extended community to all its clients that are capable of receiving it.

- If a network has an RPKI state extended community and is received by an RR from a neighbor for which the `neighbor announce rpki state` command is configured, then it will be reflected to all RR clients that are configured to accept extended communities, regardless of whether the `neighbor announce rpki state` command is configured for those other RR clients.

- A `neighbor announce rpki state` command can be used in a peer policy template, and it is inherited.

- If a `neighbor announce rpki state` command is used in a peer policy template, it must be in the same template as the `send-community extended` command. The `neighbor announce rpki state` command and the `send-community extended` command must come from the same template or be configured for the same neighbor.

### Use of the Validation State in BGP Best Path Determination

There are two ways you can modify the default BGP best path selection process when using RPKI validation states:

- You can completely disable the validation of prefixes by the RPKI server and the storage of that validation information. This is done by configuring the `bgp bestpath prefix-validate disable` command. You might want to do this for configuration testing. The router will still connect to the RPKI server and download the validation information, but will not use the information.

- You can allow an invalid prefix to be used as the BGP best path, even if valid prefixes are available. This is the default behavior. The command to allow a BGP best path to be an invalid prefix, as determined by the BGP Origin AS Validation feature, is the `bgp bestpath prefix-validate allow-invalid` command. The prefix validation state will still be assigned to paths, and will still be communicated to iBGP neighbors that have been configured to receive RPKI state information. You can use a route map to set a local preference, metric, or other property based on the validation state.

During BGP best path selection, the default behavior, if neither of the above options is configured, is that the system will prefer prefixes in the following order:

- Those with a validation state of valid.

- Those with a validation state of not found.

- Those with a validation state of invalid (which, by default, will not be installed in the routing table).

These preferences override metric, local preference, and other choices made during the bestpath computation. The standard bestpath decision tree applies only if the validation state of the two paths is the same.

If both commands are configured, the `bgp bestpath prefix-validate disable` command will prevent the validation state from being assigned to paths, so the `bgp bestpath prefix-validate allow-invalid` command will have no effect.
These configurations can be in either router configuration mode or in address family configuration mode for the IPv4 unicast or IPv6 unicast address families.

**Use of a Route Map to Customize Treatment of Valid and Invalid Prefixes**

You can create a route map to match on any of the RPKI states, and thereby create a custom policy for handling valid or invalid prefixes.

By default, the router overrides all other preferences to reject routes that are in an invalid state. You must explicitly configure the `bgp bestpath prefix-validate allow-invalid` command if you want to use a route map to do something such as permit such prefixes, but with a nondefault local preference.

**How to Configure BGP Origin AS Validation**

**Enabling BGP—Origin AS Validation**

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `bgp rpki server tcp {ipv4-address | ipv6-address} port port-number refresh seconds`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# router bgp 65000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> bgp rpki server tcp {ipv4-address</td>
<td>ipv6-address} port port-number refresh seconds</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
</tbody>
</table>
Announcing the RPKI State to iBGP Neighbors

Perform this task to cause the router to announce the RPKI state with routes to its iBGP neighbors in the BGP extended community attribute and to also receive the RPKI state with routes from iBGP neighbors. This task might be more convenient than configuring the BGP—Origin AS Validation feature on the router.

**SUMMARY STEPS**

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. neighbor {ip-address | ipv6-address} send-community extended
5. neighbor {ip-address | ipv6-address} announce rpki state

**DETAILED STEPS**

<table>
<thead>
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<th>Step</th>
<th>Command or Action</th>
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</table>
| Step 1 | enable | Enables privileged EXEC mode.  
  Example:  
  Device> enable |
| Step 2 | configure terminal | Enters global configuration mode.  
  Example:  
  Device# configure terminal |
| Step 3 | router bgp autonomous-system-number | Enters router configuration mode for the specified routing process.  
  Example:  
  Device(config)# router bgp 65000 |
| Step 4 | neighbor {ip-address | ipv6-address} send-community extended | Specifies that a communities attribute should be sent to a BGP neighbor.  
  Example:  
  Device(config-router)# neighbor 192.168.1.2 send-community extended |
| Step 5 | neighbor {ip-address | ipv6-address} announce rpki state | Causes the router to send and receive the RPKI state to and from its iBGP neighbor in the BGP extended community attribute.  
  Example:  
  Device(config-router)# neighbor 192.168.1.2 announce rpki state |
Disabling the Validation of BGP Prefixes, But Still Downloading RPKI Information

Perform this task if the BGP—Origin AS Validation feature is enabled, but you want to disable the validation of prefixes based on origin AS and disable the storage of validation information. The router will still connect to the RPKI server and still download the validation information, but the information will not be used in any way. This task is useful for configuration testing.

**SUMMARY STEPS**

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. address-family {ipv4 | ipv6} unicast
5. bgp bestpath prefix-validate disable

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** | enable<br>Example: Device> enable | Enables privileged EXEC mode.  
- Enter your password if prompted. |
| **Step 2** | configure terminal<br>Example: Device# configure terminal | Enters global configuration mode. |
| **Step 3** | router bgp autonomous-system-number<br>Example: Device(config)# router bgp 45000 | Enters router configuration mode for the specified routing process. |
| **Step 4** | address-family {ipv4 | ipv6} unicast<br>Example: Device(config-router)# address-family ipv4 unicast | Enters address family configuration mode to configure BGP peers to accept address-family-specific configurations. |
| **Step 5** | bgp bestpath prefix-validate disable<br>Example: | Disables the validation of prefixes and the storage of validation information. |
### Allowing Invalid Prefixes as the Best Path

Perform this task if the BGP—Origin AS Validation feature is enabled, and you want to allow invalid prefixes to be used as the best path, even if valid prefixes are available. Thus, you have control over announcing invalid networks, but preferring them less than valid and not-found prefixes. Also, the downstream peer can modify path attributes based on a route map that matches invalid prefixes.

### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `address-family {ipv4 | ipv6} unicast`
5. `bgp bestpath prefix-validate allow-invalid`

### DETAILED STEPS

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<tr>
<td><strong>Step 1</strong></td>
<td><code>enable</code></td>
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<tr>
<td>Example:</td>
<td>Enables privileged EXEC mode.</td>
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<tr>
<td>Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td><code>configure terminal</code></td>
</tr>
<tr>
<td>Example:</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td><code>router bgp autonomous-system-number</code></td>
</tr>
<tr>
<td>Example:</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td>Device(config)# router bgp 45000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>`address-family {ipv4</td>
</tr>
<tr>
<td>Example:</td>
<td>Enters address family configuration mode to configure BGP peers to accept address-family-specific configurations.</td>
</tr>
<tr>
<td>Device(config-router)# address-family ipv4 unicast</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td><code>bgp bestpath prefix-validate allow-invalid</code></td>
</tr>
<tr>
<td>Example:</td>
<td>Allows invalid prefixes to be used as the best path, even if valid prefixes are available.</td>
</tr>
<tr>
<td>Device(config-router-af)# bgp bestpath prefix-validate allow-invalid</td>
<td></td>
</tr>
</tbody>
</table>
Configuring a Route Map Based on RPKI States

Perform this task to create a route map based on RPKI states. The route map in this particular task sets a policy for all three RPKI states based on local preference, but other `set` commands can be used to set a policy. This task does not include a command that makes use of this route map.

SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `address-family {ipv4 | ipv6} unicast`
5. `bgp bestpath prefix-validate allow-invalid`
6. `exit`
7. `exit`
8. `route-map map-tag {permit | deny} [sequence-number]`
9. `match rpki {not-found | invalid | valid}`
10. `set local-preference number`
11. `exit`
12. `route-map map-tag {permit | deny} [sequence-number]`
13. `match rpki {not-found | invalid | valid}`
14. `set local-preference number`
15. `exit`
16. `route-map map-tag {permit | deny} [sequence-number]`
17. `match rpki {not-found | invalid | valid}`
18. `set local-preference number`
19. `exit`
20. `route-map map-tag {permit | deny} [sequence-number]`
21. `end`

DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td></td>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td><code>configure terminal</code></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td><code>router bgp autonomous-system-number</code></td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config)# router bgp 45000</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> address-family {ipv4 | ipv6} unicast</td>
<td>Enters address family configuration mode to configure BGP peers to accept address-family-specific configurations.</td>
<td></td>
</tr>
<tr>
<td>Example: \Device(config-router)# address-family ipv4 unicast</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> bgp bestpath prefix-validate allow-invalid</td>
<td>Allows invalid prefixes to be used as the best path, even if valid prefixes are available.</td>
<td></td>
</tr>
<tr>
<td>Example: \Device(config-router-af)# bgp bestpath prefix-validate allow-invalid</td>
<td>- This command is necessary to allow invalid prefixes, which are part of the example route map in Step 16.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> exit</td>
<td>Exits a configuration mode to the next highest mode in the CLI mode hierarchy.</td>
<td></td>
</tr>
<tr>
<td>Example: \Device(config-router-af)# exit</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong> exit</td>
<td>Exits a configuration mode to the next highest mode in the CLI mode hierarchy.</td>
<td></td>
</tr>
<tr>
<td>Example: \Device(config-router)# exit</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong> route-map map-tag {permit | deny} [sequence-number]</td>
<td>Enters route map configuration mode and creates a route map that will permit routes that are allowed by the match clauses that follow.</td>
<td></td>
</tr>
<tr>
<td>Example: \Device(config)# route-map ROUTE-MAP-NAME-1 permit 10</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 9</strong> match rpki {not-found | invalid | valid}</td>
<td>Creates a match clause to permit prefixes with the specified RPKI state.</td>
<td></td>
</tr>
<tr>
<td>Example: \Device(config-route-map)# match rpki valid</td>
<td>- This example matches on the RPKI state of valid.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 10</strong> set local-preference number</td>
<td>Creates a set clause to set matched prefixes to a local preference of 200.</td>
<td></td>
</tr>
<tr>
<td>Example: \Device(config-route-map)# set local-preference 200</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 11</strong> exit</td>
<td>Exits a configuration mode to the next highest mode in the CLI mode hierarchy.</td>
<td></td>
</tr>
<tr>
<td>Example: \Device(config-route-map)# exit</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 12</strong> route-map map-tag {permit | deny} [sequence-number]</td>
<td>Continues in the same route map, but a later sequence number, and enters route map configuration mode.</td>
<td></td>
</tr>
<tr>
<td>Example: \Device(config)# route-map ROUTE-MAP-NAME-1 permit 20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Step 13 | match rpki {not-found | invalid | valid} | Creates a match clause to permit prefixes with the specified RPKI state.  
| Example: | |  
| Device(config-route-map)# match rpki not-found | • This example matches on the RPKI state of not found. |  
| Step 14 | set local-preference *number* | Sets the local preference of prefixes with the RPKI state of not found to 100.  
| Example: | |  
| Device(config-route-map)# set local-preference 100 |  
| Step 15 | exit | Exits a configuration mode to the next highest mode in the CLI mode hierarchy.  
| Example: | |  
| Device(config-route-map)# exit |  
| Step 16 | route-map *map-tag* {permit | deny} [sequence-number] | Continues in the same route map, but a later sequence number, and enters route map configuration mode.  
| Example: | |  
| Device(config)# route-map ROUTE-MAP-NAME-1 permit 30 |  
| Step 17 | match rpki {not-found | invalid | valid} | Creates a match clause to permit prefixes with the specified RPKI state.  
| Example: | |  
| Device(config-route-map)# match rpki invalid | • This example matches on the RPKI state of invalid. |  
| Step 18 | set local-preference *number* | Sets the local preference of prefixes with the RPKI state of invalid to 50.  
| Example: | |  
| Device(config-route-map)# set local-preference 50 |  
| Step 19 | exit | Exits a configuration mode to the next highest mode in the CLI mode hierarchy.  
| Example: | |  
| Device(config-route-map)# exit |  
| Step 20 | route-map *map-tag* {permit | deny} [sequence-number] | Continues in the same route map, but a later sequence number, and enters route map configuration mode.  
| Example: | |  
| Device(config)# route-map ROUTE-MAP-NAME-1 permit 40 | • This example permits other routes rather than deny all other routes. |  
| Step 21 | end | Exits route map configuration mode and enters privileged EXEC mode.  
| Example: | |  
| Device(config-route-map)# end |  

### Configuring a Route Map Based on RPKI States

**Purpose**

- **Step 13**: The `match rpki` command is used to create a match clause that permits prefixes with a specified RPKI state. The example demonstrates matching on the RPKI state of not found.

- **Step 14**: The `set local-preference` command sets the local preference of prefixes with the RPKI state of not found to 100.

- **Step 15**: Exiting a configuration mode to the next highest mode in the CLI mode hierarchy.

- **Step 16**: Continues in the same route map with a later sequence number and enters route map configuration mode.

- **Step 17**: Creates a match clause to permit prefixes with the specified RPKI state, matching on the RPKI state of invalid.

- **Step 18**: Sets the local preference of prefixes with the RPKI state of invalid to 50.

- **Step 19**: Exits a configuration mode to the next highest mode in the CLI mode hierarchy.

- **Step 20**: Continues in the same route map with a later sequence number and enters route map configuration mode, permitting other routes rather than denying all other routes.

- **Step 21**: Exits route map configuration mode and enters privileged EXEC mode.
Configuration Examples for BGP Origin AS Validation

Example: Configuring BGP to Validate Prefixes Based on Origin AS

In the following example, the router is configured to connect to two RPKI servers, from which it will receive SOVC records of BGP prefixes and AS numbers.

```
router bgp 65000
  no bgp log-neighbor changes
  bgp rpki server tcp 10.0.96.254 port 32001 refresh 600
  bgp rpki server tcp FEC0::1002 port 32002 refresh 600
```

Example: Announcing RPKI State to Neighbors

```
router bgp 65000
  neighbor 10.10.10.10 remote-as 65000
  address-family ipv4 unicast
  neighbor 10.10.10.10 send-community extended
  neighbor 10.10.10.10 announce rpki state
```

Example: Disabling the Checking of Prefixes

The following example, for the IPv4 address family, disables the checking of prefixes to ensure they are valid. It also disables the storage of validation information. However, the router will still connect to the RPKI server and download the validation information. This example is useful for configuration testing.

```
router bgp 65000
  bgp rpki server tcp 10.0.96.254 port 32001 refresh 600
  address-family ipv4 unicast
  bgp bestpath prefix-validate disable
```

Example: Allowing Invalid Prefixes as Best Path

In the following example, for the IPv6 address family, invalid prefixes are allowed to be used as the best path, even if valid prefixes are available.

```
router bgp 65000
  bgp rpki server tcp FEC0::1002 port 32002 refresh 600
  address-family ipv6 unicast
  bgp bestpath prefix-validate allow-invalid
```
Example: Using a Route Map Based on RPKI State

In the following example, a route map named rtmap-PEX1-3 sets a local preference of 50 for invalid prefix/AS pairs, 100 for not-found prefix/AS pairs, and 200 for valid prefix/AS pairs. The local preference values are set for incoming routes from the neighbor at 10.0.102.1. The neighbor at 10.0.102.1 is an eBGP peer. Note that the `bgp bestpath prefix-validate allow-invalid` command is required in order to permit invalid prefixes.

```
router bgp 65000
  address-family ipv4 unicast
  neighbor 10.0.102.1 route-map rtmap-PEX1-3 in
    bgp bestpath prefix-validate allow-invalid
  !
  route-map rtmap-PEX1-3 permit 10
    match rpki invalid
    set local-preference 50
  !
  route-map rtmap-PEX1-3 permit 20
    match rpki not-found
    set local-preference 100
  !
  route-map rtmap-PEX1-3 permit 30
    match rpki valid
    set local-preference 200
  !
  route-map rtmap-PEX1-3 permit 40
```

Additional References

<table>
<thead>
<tr>
<th>Related Documents</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Commands List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
<tr>
<td>download documentation, software, and tools. Use these resources to install</td>
<td></td>
</tr>
<tr>
<td>and configure the software and to troubleshoot and resolve technical issues</td>
<td></td>
</tr>
<tr>
<td>with Cisco products and technologies. Access to most tools on the Cisco</td>
<td></td>
</tr>
<tr>
<td>Support and Documentation website requires a Cisco.com user ID and password.</td>
<td></td>
</tr>
</tbody>
</table>
Feature Information for eiBGP Multipath for Non-VRF Interfaces (IPv4/IPv6)

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 70: Feature Information for eiBGP Multipath for Non-VRF Interfaces (IPv4/IPv6)

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>eiBGP Multipath for Non-VRF Interfaces (IPv4/IPv6)</td>
<td></td>
<td>The eiBGP Multipath for Non-VRF Interfaces (IPv4/IPv6) feature allows you to configure multipath load sharing among native IPv4 and IPv6 external Border Gateway Protocol (eBGP) and internal BGP (iBGP) paths for improved load balancing in deployments. The following command was modified: maximum-paths eibgp.</td>
</tr>
</tbody>
</table>

The following command was modified:

```
maximum-paths eibgp
```
BGP MIB Support

The BGP MIB Support Enhancements feature introduces support in the CISCO-BGP4-MIB for new SNMP notifications.

• Finding Feature Information, on page 865
• Information About BGP MIB Support, on page 865
• How to Enable BGP MIB Support, on page 867
• Configuration Examples for BGP MIB Support, on page 869
• Additional References, on page 869
• Feature Information for BGP MIB Support, on page 870

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About BGP MIB Support

BGP MIB Support

The Management Information Base (MIB) that supports BGP is the CISCO-BGP4-MIB. The BGP MIB Support Enhancements feature introduces support in the CISCO-BGP4-MIB for new SNMP notifications. The following sections describe the objects and notifications (traps) that are supported:

BGP FSM Transition Change Support

The cbgpRouteTable supports BGP Finite State Machine (FSM) transition state changes.

The cbgpFsmStateChange object allows you to configure SNMP notifications (traps) for all FSM transition state changes. This notification contains the following MIB objects:
The cbgpBackwardTransition object supports all BGP FSM transition state changes. This object is sent each time the FSM moves to either a higher or lower numbered state. This notification contains the following MIB objects:

- bgpPeerLastError
- bgpPeerState
- cbgpPeerLastErrorTxt
- cbgpPeerPrevState

The `snmp-server enable bgp traps` command allows you to enable the traps individually or together with the existing FSM backward transition and established state traps as defined in RFC 1657.

**BGP Route Received Route Support**

The cbgpRouteTable object supports the total number of routes received by a BGP neighbor. The following MIB object is used to query the CISCO-BGP4-MIB for routes that are learned from individual BGP peers:

- cbgpPeerAddrFamilyPrefixTable

Routes are indexed by the address-family identifier (AFI) or subaddress-family identifier (SAFI). The prefix information displayed in this table can also viewed in the output of the `show ip bgp` command.

**BGP Prefix Threshold Notification Support**

The cbgpPrefixMaxThresholdExceed and cbgpPrefixMaxThresholdClear objects were introduced to allow you to poll for the total number of routes received by a BGP peer.

The cbgpPrefixMaxThresholdExceed object allows you to configure SNMP notifications to be sent when the prefix count for a BGP session has exceeded the configured value. This notification is configured on a per address family basis. The prefix threshold is configured with the `neighbor maximum-prefix` command. This notification contains the following MIB objects:

- cbgpPeerPrefixAdminLimit
- cbgpPeerPrefixThreshold

The cbgpPrefixMaxThresholdClear object allows you to configure SNMP notifications to be sent when the prefix count drops below the clear trap limit. This notification is configured on a per address family basis. This notification contains the following objects:

- cbgpPeerPrefixAdminLimit
- cbgpPeerPrefixClearThreshold

Notifications are sent when the prefix count drops below the clear trap limit for an address family under a BGP session after the cbgpPrefixMaxThresholdExceed notification is generated. The clear trap limit is
calculated by subtracting 5 percent from the maximum prefix limit value configured with the neighbor maximum-prefix command. This notification will not be generated if the session goes down for any other reason after the cbgpPrefixMaxThresholdExceed is generated.

**VPNv4 Unicast Address Family Route Support**

The cbgpRouteTable object allows you to configure SNMP GET operations for VPNv4 unicast address-family routes.

The following MIB object allows you to query for multiple BGP capabilities (for example, route refresh, multiprotocol BGP extensions, and graceful restart):

- cbgpPeerCapsTable

The following MIB object allows you to query for IPv4 and VPNv4 address family routes:

- cbgpPeerAddrFamilyTable

Each route is indexed by peer address, prefix, and prefix length. This object indexes BGP routes by the AFI and then by the SAFI. The AFI table is the primary index, and the SAFI table is the secondary index. Each BGP speaker maintains a local Routing Information Base (RIB) for each supported AFI and SAFI combination.

**cbgpPeerTable Support**

The cbgpPeerTable has been modified to support the enhancements described in this document. The following new table objects are supported in the CISCO-BGP-MIB.my:

- cbgpPeerLastErrorTxt
- cbgpPeerPrevState

The following table objects are not supported. The status of these objects is listed as deprecated, and these objects are not operational:

- cbgpPeerPrefixAccepted
- cbgpPeerPrefixDenied
- cbgpPeerPrefixLimit
- cbgpPeerPrefixAdvertised
- cbgpPeerPrefixSuppressed
- cbgpPeerPrefixWithdrawn

### How to Enable BGP MIB Support

**Enabling BGP MIB Support**

SNMP notifications can be configured on the router and GET operations can be performed from an external management station only after BGP SNMP support is enabled. Perform this task on a router to configure SNMP notifications for the BGP MIB.
### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `snmp-server enable traps bgp [[state-changes [all] [backward-trans] [limited]] | [threshold prefix]]`
4. `exit`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td></td>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td><code>configure terminal</code></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>Device# configure terminal</td>
</tr>
<tr>
<td>3</td>
<td>`snmp-server enable traps bgp [[state-changes [all] [backward-trans] [limited]]</td>
<td>[threshold prefix]]`</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>• The <code>state-changes</code> keyword is used to enable support for FSM transition events.</td>
</tr>
<tr>
<td></td>
<td>Device(config)# snmp-server enable traps bgp</td>
<td>• The <code>all</code> keyword enables support for FSM transitions events.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The <code>backward-trans</code> keyword enables support only for backward transition state change events.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The <code>limited</code> keyword enables support for backward transition state changes and established state events.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The <code>threshold</code> and <code>prefix</code> keywords are used to enable notifications when the configured maximum prefix limit is reached on the specified peer.</td>
</tr>
<tr>
<td>4</td>
<td><code>exit</code></td>
<td>Exits global configuration mode, and enters privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>Device(config)# exit</td>
</tr>
</tbody>
</table>
**Configuration Examples for BGP MIB Support**

**Example: Enabling BGP MIB Support**

The following example enables SNMP support for all supported BGP events:

```
Device(config)# snmp-server enable traps bgp
```

The following verification example shows that SNMP support for BGP is enabled by displaying any lines in the running configuration file that include “snmp-server”:

```
Device# show run | include snmp-server
snmp-server enable traps bgp
```

**Additional References**

**Related Documents**

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>IP Routing: BGP Command Reference</td>
</tr>
<tr>
<td>MIB objects supported in CISCO-BGP-MIBv8.1</td>
<td>“Cisco-BGP-MIBv2” module in the IP Routing: BGP Configuration Guide</td>
</tr>
<tr>
<td>Information about SNMP and SNMP operations</td>
<td>SNMP Configuration Guide in the Network Management Configuration Guide Library</td>
</tr>
</tbody>
</table>

**MIBs**

<table>
<thead>
<tr>
<th>MIB</th>
<th>MIBs Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>CISCO-BGP4-MIB</td>
<td>To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
</tr>
</tbody>
</table>
Feature Information for BGP MIB Support

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 71: Feature Information for BGP MIB Support

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP MIB Support Enhancements</td>
<td>12.0(26)S</td>
<td>The BGP MIB Support Enhancements feature introduced support in the CISCO-BGP4-MIB for new SNMP notifications.</td>
</tr>
<tr>
<td></td>
<td>12.2(25)S</td>
<td>The following command was introduced: <code>snmp-server enable traps bgp</code>.</td>
</tr>
<tr>
<td></td>
<td>12.3(7)T</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12.2(33)SRA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12.2(22)SXH</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15.0(1)SY</td>
<td></td>
</tr>
</tbody>
</table>
BGP 4 MIB Support for Per-Peer Received Routes

This document describes BGP 4 MIB support for per-peer received routes. This feature introduces a table in the CISCO-BGP4-MIB that provides the capability to query (by using Simple Network Management Protocol [SNMP] commands) for routes that are learned from individual Border Gateway Protocol (BGP) peers.

- Finding Feature Information, on page 871
- Restrictions on BGP 4 MIB Support for Per-Peer Received Routes, on page 871
- Information About BGP 4 MIB Support for Per-Peer Received Routes, on page 872
- Additional References for BGP Restart Neighbor Session After Max-Prefix Limit Reached, on page 875
- Feature Information for BGP 4 MIB Support for Per-Peer Received Routes, on page 876
- Glossary, on page 876

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Restrictions on BGP 4 MIB Support for Per-Peer Received Routes

BGP 4 MIB Support for per-Peer Received Routes supports only routes that are contained in IPv4 AFIs and unicast SAFIs in the local BGP RIB table. The BGP 4 MIB Support for per-Peer Received Routes enhancement is supported only by BGP Version 4.
Information About BGP 4 MIB Support for Per-Peer Received Routes

Overview of BGP 4 MIB Support for Per-Peer Received Routes

The BGP 4 MIB support for per-peer received routes feature introduces a table in the CISCO-BGP4-MIB that provides the capability to query (by using SNMP commands) for routes that are learned from individual BGP peers.

Before this new MIB table was introduced, a network operator could obtain the routes learned by a local BGP-speaking router by querying the local BGP speaker with an SNMP command (for example, the `snmpwalk` command). The network operator used the SNMP command to query the bgp4PathAttrTable of the CISCO-BGP4-MIB. The routes that were returned from a bgp4PathAttrTable query were indexed in the following order:

- Prefix
- Prefix length
- Peer address

Because the bgp4PathAttrTable indexes the prefixes first, obtaining routes learned from individual BGP peers will require the network operator to "walk through" the complete bgp4PathAttrTable and filter out routes from the interested peer. A BGP Routing Information Base (RIB) could contain 10,000 or more routes, which makes a manual "walk" operation impossible and automated walk operations very inefficient.

BGP 4 MIB Support for per-Peer Received Routes introduces a Cisco-specific enterprise extension to the CISCO-BGP4-MIB that defines a new table called the cbgpRouterTable. The cbgpRouterTable provides the same information as the bgp4PathAttrTable with the following two differences:

- Routes are indexed in the following order:
  - Peer address
  - Prefix
  - Prefix length

The search criteria for SNMP queries of local routes are improved because peer addresses are indexed before prefixes. A search for routes that are learned from individual peers is improved with this enhancement because peer addresses are indexed before prefixes. A network operator will no longer need to search through potentially thousands of routes to obtain the learned routes of a local BGP RIB table.

- Support is added for multiprotocol BGP, Address Family Identifier (AFI), and Subsequent Address Family Identifier (SAFI) information. This information is added in the form of indexes to the cbgpRouterTable. The CISCO-BGP4-MIB can be queried for any combination of AFIs and SAFIs that are supported by the local BGP speaker.
The MIB will be populated only if the router is configured to run a BGP process. The present implementation of BGP 4 MIB Support for Per-Peer Received Routes will show only routes contained in IPv4 AFI and unicast SAFI BGP local RIB tables. Support for showing routes contained in other local RIB tables will be added in the future.

**BGP 4 Per-Peer Received Routes Table Elements and Objects**

The following sections describe new table elements, AFI and SAFI tables and objects, and network address prefixes in the Network Layer Reachability Information (NLRI) fields that have been introduced by the BGP 4 MIB Support for Per-Peer Received Routes enhancement.

**MIB Tables and Objects**

The table below describes the MIB indexes of the cbgpRouterTable.

For a complete description of the MIB, see the CISCO-BGP4-MIB file CISCO-BGP4-MIB.my, available through Cisco.com at the following URL:


<table>
<thead>
<tr>
<th>MIB Indexes</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>cbgpRouteAfi</td>
<td>Represents the AFI of the network layer protocol that is associated with the route.</td>
</tr>
<tr>
<td>cbgpRouteSafi</td>
<td>Represents the SAFI of the route. It gives additional information about the type of the route. The AFI and SAFI are used together to determine which local RIB (Loc-RIB) contains a particular route.</td>
</tr>
<tr>
<td>cbgpRoutePeerType</td>
<td>Represents the type of network layer address that is stored in the cbgpRoutePeer object.</td>
</tr>
<tr>
<td>cbgpRoutePeer</td>
<td>Represents the network layer address of the peer from which the route information has been learned.</td>
</tr>
<tr>
<td>cbgpRouteAddrPrefix</td>
<td>Represents the network address prefix that is carried in a BGP update message. See the table below for information about the types of network layer addresses that can be stored in specific types of AFI and SAFI objects.</td>
</tr>
<tr>
<td>cbgpRouteAddrPrefixLen</td>
<td>Represents the length in bits of the network address prefix in the NLRI field. See the table below for a description of the 13 possible entries.</td>
</tr>
</tbody>
</table>

**AFIs and SAFIs**

The table below lists the AFI and SAFI values that can be assigned to or held by the cbgpRouteAfi and cbgpRouteSafi indexes, respectively. The table below also displays the network address prefix type that can be held by specific combinations of AFIs and SAFIs. The type of network address prefix that can be carried in a BGP update message depends on the combination of AFIs and SAFIs.
**Table 73: AFIs and SAFIs**

<table>
<thead>
<tr>
<th>AFI</th>
<th>SAFI</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>ipv4(1)</td>
<td>unicast(1)</td>
<td>IPv4 address</td>
</tr>
<tr>
<td>ipv4(1)</td>
<td>multicast(2)</td>
<td>IPv4 address</td>
</tr>
<tr>
<td>ipv4(1)</td>
<td>vpn(128)</td>
<td>VPN-IPv4 address</td>
</tr>
<tr>
<td>ipv6(2)</td>
<td>unicast(1)</td>
<td>IPv6 address</td>
</tr>
</tbody>
</table>

**Note**

A VPN-IPv4 address is a 12-byte quantity that begins with an 8-byte Route Distinguisher (RD) and ends with a 4-byte IPv4 address. Any bits beyond the length specified by `cbgpRouteAddrPrefixLen` are represented as zeros.

---

**Network Address Prefix Descriptions for the NLRI Field**

The table below describes the length in bits of the network address prefix in the NLRI field of the `cbgpRouteTable`. Each entry in the table provides information about the route that is selected by any of the six indexes in the table below.

**Table 74: Network Address Prefix Descriptions for the NLRI Field**

<table>
<thead>
<tr>
<th>Table or Object (or Index)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>cbgpRouteOrigin</td>
<td>The ultimate origin of the route information.</td>
</tr>
<tr>
<td>cbgpRouteASPathSegment</td>
<td>The sequence of autonomous system path segments.</td>
</tr>
<tr>
<td>cbgpRouteNextHop</td>
<td>The network layer address of the autonomous system border router that traffic should pass through to get to the destination network.</td>
</tr>
<tr>
<td>cbgpRouteMedPresent</td>
<td>Indicates that the MULTI_EXIT_DISC attribute for the route is either present or absent.</td>
</tr>
<tr>
<td>cbgpRouteMultiExitDisc</td>
<td>Metric that is used to discriminate between multiple exit points to an adjacent autonomous system. The value of this object is irrelevant if the value of the <code>cbgpRouteMedPresent</code> object is &quot;false(2).&quot;</td>
</tr>
<tr>
<td>cbgpRouteLocalPrefPresent</td>
<td>Indicates that the LOCAL_PREF attribute for the route is either present or absent.</td>
</tr>
<tr>
<td>cbgpRouteLocalPref</td>
<td>Determines the degree of preference for an advertised route by an originating BGP speaker. The value of this object is irrelevant if the value of the <code>cbgpRouteLocalPrefPresent</code> object is &quot;false(2).&quot;</td>
</tr>
<tr>
<td>cbgpRouteAtomicAggregate</td>
<td>Determines if the system has selected a less specific route without selecting a more specific route.</td>
</tr>
<tr>
<td>cbgpRouteAggregatorAS</td>
<td>The autonomous system number of the last BGP speaker that performed route aggregation. A value of 0 indicates the absence of this attribute.</td>
</tr>
</tbody>
</table>
### Table or Object (or Index) | Description
---|---
cbgpRouteAggregatorAddrType | Represents the type of network layer address that is stored in the cbgpRouteAggregatorAddr object.
cbgpRouteAggregatorAddr | The network layer address of the last BGP 4 speaker that performed route aggregation. A value of all zeros indicates the absence of this attribute.
cbgpRouteBest | An indication of whether this route was chosen as the best BGP 4 route.
cbgpRouteUnknownAttr | One or more path attributes not understood by the local BGP speaker. A size of 0 indicates that this attribute is absent.

### Benefits of BGP 4 MIB Support for Per-Peer Received Routes

- Improved SNMP Query Capabilities--The search criteria for SNMP queries for routes that are advertised by individual peers are improved because the peer address is indexed before the prefix. A network operator will no longer need to search through potentially thousands of routes to obtain the learned routes of a local BGP RIB table.
- Improved AFI and SAFI Support--Support is added for multiprotocol BGP. AFI and SAFI are added as indexes to the table. The CISCO-BGP4-MIB can be queried for any combination of AFIs and SAFIs that are supported by the local BGP speaker.

### Additional References for BGP Restart Neighbor Session After Max-Prefix Limit Reached

**Related Documents**

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
</tbody>
</table>

**Standards and RFCs**

<table>
<thead>
<tr>
<th>Standard/RFC</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFC 2918</td>
<td>Route Refresh Capability for BGP-4</td>
</tr>
<tr>
<td>RFC 4486</td>
<td>Subcodes for BGP Cease Notification Message</td>
</tr>
</tbody>
</table>
Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

Feature Information for BGP 4 MIB Support for Per-Peer Received Routes

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

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Table 75: Feature Information for BGP 4 MIB Support for Per-Peer Received Routes

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP 4 MIB support for per-peer received routes</td>
<td>Cisco IOS XE Release 2.1</td>
<td>This feature was introduced on the Cisco ASR 1000 Series Aggregation Services Routers.</td>
</tr>
<tr>
<td>BGP received routes MIB</td>
<td>Cisco IOS XE Release 2.1</td>
<td>This feature was introduced on the Cisco ASR 1000 Series Routers.</td>
</tr>
</tbody>
</table>

Glossary

AFI--Address Family Identifier. Carries the identity of the network layer protocol that is associated with the network address.

BGP--Border Gateway Protocol. An interdomain routing protocol that exchanges reachability information with other BGP systems. It is defined by RFC 1163, A Border Gateway Protocol (BGP). The current implementation of BGP is BGP Version 4 (BGP4). BGP4 is the predominant interdomain routing protocol that is used on the Internet. It supports CIDR and uses route aggregation mechanisms to reduce the size of routing tables.

MBGP--multiprotocol BGP. An enhanced version of BGP that carries routing information for multiple network layer protocols and IP multicast routes. It is defined in RFC 2858, Multiprotocol Extensions for BGP-4.

MIB--Management Information Base. A group of managed objects that are contained within a virtual information store or database. MIB objects are stored so that values can be assigned to object identifiers and to assist managed agents by defining which MIB objects should be implemented. The value of a MIB object
can be changed or retrieved using SNMP or CMIP commands, usually through a GUI network management system. MIB objects are organized in a tree structure that includes public (standard) and private (proprietary) branches.

NLRI--Network Layer Reachability Information. Carries route attributes that describe a route and how to connect to a destination. This information is carried in BGP update messages. A BGP update message can carry one or more NLRI prefixes.

RIB--Routing Information Base (RIB). A central repository of routes that contains Layer 3 reachability information and destination IP addresses or prefixes. The RIB is also known as the routing table.

SAFI--Subsequent Address Family Identifier. Provides additional information about the type of the Network Layer Reachability Information that is carried in the attribute.


\texttt{snmpwalk} -- The \texttt{snmpwalk} command is an SNMP application that is used to communicate with a network entity MIB using SNMP.

VPN--Virtual Private Network. Enables IP traffic to travel securely over a public TCP/IP network by encrypting all traffic from one network to another. A VPN uses a tunnel to encrypt all information at the IP level.
The BGP Support for Nonstop Routing (NSR) with Stateful Switchover (SSO) feature enables using L2VPN VPLS provider edge (PE) routers to maintain Border Gateway Protocol (BGP) state with customer edge (CE) routers and ensure continuous packet forwarding during a Route Processor (RP) switchover or during a planned In-Service Software Upgrade (ISSU) for a PE router. CE routers do not need to be Nonstop Forwarding (NSF)-capable or NSF-aware to benefit from BGP NSR capabilities on PE routers. Only PE routers need to be upgraded to support BGP NSR—no CE router upgrades are required. BGP NSR with SSO, thus, enables service providers to provide the benefits NSF with the additional benefits of NSR without requiring CE routers to be upgraded to support BGP graceful restart.

- Finding Feature Information, on page 879
- Prerequisites for BGP Support for NSR with SSO, on page 879
- Information About BGP Support for Nonstop Routing (NSR) with Stateful Switchover (SSO), on page 880
- How to Configure BGP Support for Nonstop Routing (NSR) with Stateful Switchover (SSO), on page 881
- Configuration Examples for BGP Support for Nonstop Routing (NSR) with Stateful Switchover (SSO), on page 889
- Additional References, on page 891
- Feature Information for BGP Support for NSR with SSO, on page 892

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for BGP Support for NSR with SSO

- Your network must be configured to run BGP.
Information About BGP Support for Nonstop Routing (NSR) with Stateful Switchover (SSO)

Overview of BGP NSR with SSO

Prior to the introduction of BGP NSR with SSO in Cisco IOS Release 12.2(28)SB, BGP required that all neighboring devices participating in BGP NSF be configured to be either NSF-capable or NSF-aware (by configuring the devices to support the BGP graceful restart mechanism). BGP NSF, thus, required that all neighboring devices be upgraded to a version of Cisco IOS software that supports BGP graceful restart. However, in many MPLS VPN deployments, there are situations where PE routers engage in exterior BGP (eBGP) peering sessions with CE routers that do not support BGP graceful restart and cannot be upgraded to a software version that supports BGP graceful restart in the same time frame as the provider (P) routers.

BGP NSR with SSO provides a high availability (HA) solution to service providers whose PE routers engage in eBGP peering relationships with CE routers that do not support BGP graceful restart. BGP NSR works with SSO to synchronize BGP state information between the active and standby RP. SSO minimizes the amount of time a network is unavailable to its users following a switchover. When the BGP NSR with SSO feature is configured, in the event of an RP switchover, the PE router uses BGP NSR with SSO to maintain BGP state for eBGP peering sessions with CEs that are not NSF-aware (see the figure below). Additionally, the BGP NSR with SSO feature dynamically detects NSF-aware peers and runs graceful restart with those CE routers. For eBGP peering sessions with NSF-aware peers and for internal BGP (iBGP) sessions with BGP Route Reflectors (RRs) in the service provider core, the PE uses NSF to maintain BGP state. BGP NSR with SSO, thus, enables service providers to provide the benefits of NSF with the additional benefits of NSR without requiring CE routers to be upgraded to support BGP graceful restart.

Figure 80: BGP NSR with SSO Operations During an RP Switchover
BGP NSR with SSO is supported in BGP peer, BGP peer group, and BGP session template configurations. To configure support for BGP NSR with SSO in BGP peer and BGP peer group configurations, use the `neighbor ha-mode sso` command in address family configuration mode for IPv4 VRF address family BGP peer sessions. To include support for Cisco BGP NSR with SSO in a peer session template, use the `ha-mode` `sso` command in session-template configuration mode.

**Benefits of BGP NSR with SSO**

- Minimizes services disruptions--Border Gateway Protocol (BGP) Nonstop Routing (NSR) with Stateful Switchover (SSO) reduces impact on customer traffic during route processor (RP) switchovers (scheduled or unscheduled events), extending high availability (HA) deployments and benefits at the edge.

- Enhances high-availability Nonstop Forwarding (NSF) and SSO deployment at the edge--BGP NSR with SSO allows incremental deployment by upgrading the provider edge device with the NSR capability so that customer-facing edge devices are synchronized automatically and no coordination or NSF awareness is needed with the customer side Cisco or third-party customer edge devices. The BGP NSR feature dynamically detects NSF-aware peers and runs graceful restart with those CE devices.

- Provides transparent route convergence--BGP NSR with SSO eliminates route flaps by keeping BGP state on both active and standby RPs and ensures continuous packet forwarding with minimal packet loss during RP failovers.

**How to Configure BGP Support for Nonstop Routing (NSR) with Stateful Switchover (SSO)**

**Configuring a PE Device to Support BGP NSR with SSO**

Perform this task to enable a provider edge (PE) device to maintain BGP state with customer edge (CE) devices and ensure continuous packet forwarding during a route processor (RP) switchover or during a planned ISSU. Border Gateway Protocol (BGP) Nonstop Routing (NSR) with Stateful Switchover (SSO) enables service providers to provide the benefits Nonstop Forwarding (NSF) with the additional benefits of NSR without requiring CE devices to be upgraded to support BGP graceful restart.

BGP NSR with SSO is supported in BGP peer, BGP peer group, and BGP session template configurations. Perform one of the following tasks in this section on a PE device, depending on whether you want to configure support for BGP NSR with SSO in a peer, a peer group, or a session template configuration:

**Prerequisites**

- These tasks assume that you are familiar with BGP peer, BGP peer group, and BGP session template concepts. For more information, see the “Configuring a Basic BGP Network” module.

- The active and standby RP must be in SSO mode. For information about configuring SSO mode, see the “Configuring Stateful Switchover” module in the High Availability Configuration Guide.

- Graceful restart should be enabled on the PE device. We recommend that you enable graceful restart on all BGP peers in the provider core that participate in BGP NSF. For more information about configuring graceful restart, see the “Configuring Advanced BGP Features” module.
• CE devices must support the route refresh capability. For more information, see the “Configuring a Basic BGP Network” module.

## Configuring a Peer to Support BGP NSR with SSO

### SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. bgp graceful-restart [restart-time seconds ] [stalepath-time seconds]
5. neighbor ip-address remote-as autonomous-system-number
6. neighbor ip-address ha-mode sso
7. neighbor ip-address activate
8. end
9. show ip bgp vpnv4 all sso summary

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config)# router bgp 40000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> bgp graceful-restart [restart-time seconds ] [stalepath-time seconds]</td>
<td>Enables the Border Gateway Protocol (BGP) graceful restart capability and BGP Nonstop Forwarding (NSF) awareness.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config-router)# bgp graceful-restart</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> neighbor ip-address remote-as autonomous-system-number</td>
<td>Adds the IP address of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local router.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
</tbody>
</table>
### Configuring a Peer Group to Support BGP NSR with SSO

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `bgp graceful-restart [restart-time seconds] [stalepath-time seconds]`
5. `neighbor peer-group-name peer-group`
6. `neighbor ip-address remote-as autonomous-system-number`
7. `neighbor ip-address peer-group peer-group-name`
8. `neighbor peer-group-name ha-mode sso`
9. `neighbor peer-group-name activate`
10. `end`
11. `show ip bgp vpnv4 all sso summary`

---

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device(config-router-af)# neighbor 192.168.1.1 remote-as 45000</td>
<td>Configures the neighbor to support BGP Nonstop Routing (NSR) with Stateful Switchover (SSO).</td>
</tr>
<tr>
<td><strong>Step 6</strong> neighbor ip-address ha-mode sso</td>
<td>Enables the neighbor to exchange prefixes for the IPv4 address family with the local router.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router-af)# neighbor 192.168.1.1 ha-mode sso</td>
<td><strong>Note</strong> By default, neighbors that are defined using the <code>neighbor remote-as</code> command in router configuration mode exchange only unicast address prefixes.</td>
</tr>
<tr>
<td><strong>Step 7</strong> neighbor ip-address activate</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router-af)# neighbor testgroup activate</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong> end</td>
<td>Exits address family configuration mode and enters privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router-af)# end</td>
<td></td>
</tr>
<tr>
<td><strong>Step 9</strong> show ip bgp vpnv4 all sso summary</td>
<td>(Optional) Displays the number of BGP neighbors that are in SSO mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device# show ip bgp vpnv4 all sso summary</td>
<td></td>
</tr>
</tbody>
</table>
## DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td><code>enable</code>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Device&gt; enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td><code>configure terminal</code>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Device# configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td><code>router bgp autonomous-system-number</code>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Device(config)# router bgp 40000</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
</tbody>
</table>
| **Step 4** | `bgp graceful-restart [restart-time seconds] [stalepath-time seconds]`<br>**Example:**<br>Device(config-router)# bgp graceful-restart | Enables the Border Gateway Protocol (BGP) graceful restart capability and BGP Nonstop Forwarding (NSF) awareness.  
  - If you enter this command after the BGP session has been established, you must restart the session for the capability to be exchanged with the BGP neighbor.  
  - Use this command on the restarting device and all of its peers (NSF-capable and NSF-aware). |
| **Step 5** | `neighbor peer-group-name peer-group`<br>**Example:**<br>Device(config-router-af)# neighbor testgroup peer-group | Creates a BGP peer group. |
| **Step 6** | `neighbor ip-address remote-as autonomous-system-number`<br>**Example:**<br>Device(config-router-af)# neighbor 192.168.1.1 remote-as 45000 | Adds the IP address of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local device. |
| **Step 7** | `neighbor ip-address peer-group peer-group-name`<br>**Example:**<br>Device(config-router-af)# neighbor 192.168.1.1 peer-group testgroup | Assigns the IP address of a BGP neighbor to a BGP peer group. |
| **Step 8** | `neighbor peer-group-name ha-mode sso`<br>**Example:** | Configures the BGP peer group to support BGP Nonstop Routing (NSR) with Stateful Switchover (SSO). |
Device(config-router-af)# neighbor 192.168.1.1 ha-mode sso

**Enable the neighbor to exchange prefixes for the IPv4 address family with the local device.**

Step 9

**neighbor peer-group-name activate**

*Example:*

Device(config-router-af)# neighbor testgroup activate

**Enables the neighbor to exchange prefixes for the IPv4 address family with the local device.**

Step 10

**end**

*Example:*

Device(config-router-af)# end

**Exits address family configuration mode and returns to global configuration mode.**

Step 11

**show ip bgp vpnv4 all sso summary**

*Example:*

Device# show ip bgp vpnv4 all sso summary

(Optional) Displays the number of BGP neighbors that are in SSO mode.

---

**Configuring Support for BGP NSR with SSO in a Peer Session Template**

**SUMMARY STEPS**

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. template peer-session session-template-name
5. ha-mode sso
6. exit-peer-session
7. end
8. show ip bgp template peer-session [session-template-name]

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device&gt; enable</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device# configure terminal</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td></td>
</tr>
<tr>
<td>router bgp autonomous-system-number</td>
<td>Enters router configuration mode and creates a Border Gateway Protocol (BGP) routing process.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config)# router bgp 101</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td></td>
</tr>
<tr>
<td>template peer-session session-template-name</td>
<td>Enters session-template configuration mode and creates a peer session template.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config-router)# template peer-session CORE1</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td></td>
</tr>
<tr>
<td>ha-mode sso</td>
<td>Configures the neighbor to support BGP Nonstop Routing (NSR) with Stateful Switchover (SSO).</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config-router-stmp)# ha-mode sso</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td></td>
</tr>
<tr>
<td>exit-peer-session</td>
<td>Exits session-template configuration mode and returns to router configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config-router-stmp)# exit-peer-session</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td></td>
</tr>
<tr>
<td>end</td>
<td>Exits router configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config-router)# end</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td></td>
</tr>
<tr>
<td>show ip bgp template peer-session [session-template-name]</td>
<td>(Optional) Displays locally configured peer session templates.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device# show ip bgp template peer-session</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• The output can be filtered to display a single peer policy template with the session-template-name argument. This command also supports all standard output modifiers.</td>
</tr>
</tbody>
</table>

**What to Do Next**

After the peer session template is created, the configuration of the peer session template can be inherited by or applied to another peer session template with the `inherit peer-session` or `neighbor inherit peer-session` command.

For more information about configuring peer session templates, see the "Configuring a Basic BGP Network" chapter in the *Cisco IOS IP Routing: BGP Configuration Guide*.

**Verifying BGP Support for NSR with SSO**

**SUMMARY STEPS**

1. enable


2. `show ip bgp vpnv4 all sso summary`

3. `show ip bgpl2vpn vpls all neighbors`

**DETAILED STEPS**

**Step 1**

**enable**

Enables privileged EXEC mode.

**Example:**

```
Device> enable
```

**Step 2**

**show ip bgp vpnv4 all sso summary**

This command is used to display the number of Border Gateway Protocol (BGP) neighbors that are in Stateful Switchover (SSO) mode.

The following is sample output from the `show ip bgp vpnv4 all sso summary` command:

**Example:**

```
Device# show ip bgp vpnv4 all sso summary
Stateful switchover support enabled for 40 neighbors
```

**Step 3**

**show ip bgpl2vpn vpls all neighbors**

This command displays VPN address information from the BGP table.

The following is sample output from the `show ip bgpl2vpn vpls all neighbors` command. The "Stateful switchover support" field indicates whether SSO is enabled or disabled. The "SSO Last Disable Reason" field displays information about the last BGP session that lost SSO capability.

**Example:**

```
Device# show ip bgpl2vpn vpls all neighbors 10.3.3.3
BGP neighbor is 10.3.3.3, vrf vrf1, remote AS 3, external link
Inherits from template 10vrf-session for session parameters
BGP version 4, remote router ID 10.1.105.12
BGP state = Established, up for 04:21:39
Last read 00:00:05, last write 00:00:09, hold time is 30, keepalive interval is 10 seconds
Configured hold time is 30, keepalive interval is 10 seconds
Minimum holdtime from neighbor is 0 seconds
Neighbor capabilities:
  Route refresh: advertised and received(new)
Address family IPv4 Unicast: advertised and received
Stateful switchover support enabled
Message statistics:
  InQ depth is 0
  OutQ depth is 0
    Sent     Rcvd
  Opens:    1       1
  Notifications:  0     0
  Updates:    1       4
  Keepalives: 1534    1532
  Route Refresh: 0      0
  Total:    1536    1537
Default minimum time between advertisement runs is 30 seconds
For address family: L2VPN VPLS
```
**Troubleshooting Tips**

To troubleshoot BGP NSR with SSO, use the following commands in privileged EXEC mode, as needed:
• **debug ip bgp sso** -- Displays BGP-related SSO events or debugging information for BGP-related interactions between the active RP and the standby RP. This command is useful for monitoring or troubleshooting BGP sessions on a PE router during an RP switchover or during a planned ISSU.

• **debug ip tcp ha** -- Displays TCP HA events or debugging information for TCP stack interactions between the active RP and the standby RP. This command is useful for troubleshooting SSO-aware TCP connections.

• **show tcp** -- Displays the status of TCP connections. The display output will display the SSO capability flag and will indicate the reason that the SSO property failed on a TCP connection.

• **show tcp ha connections** -- Displays connection-ID-to-TCP mapping data.
**RR1 Configuration**

The following example shows the BGP configuration for RR1 in the figure above. RR1 is configured as a NSF-aware route reflector. In the event of an RP switchover, the PE router uses NSF to maintain the BGP state of the internal peering session with RR1.

```config
! router bgp 1
  no synchronization
  bgp log-neighbor-changes
  bgp graceful-restart restart-time 120
  bgp graceful-restart stalepath-time 360
  bgp graceful-restart neighbor 10.2.2.2 remote-as 1
  bgp graceful-restart stalepath-time 360
  bgp graceful-restart neighbor 10.2.2.2 update-source Loopback0
  no auto-summary
  !
  address-family vpnv4
  neighbor 10.2.2.2 activate
  neighbor 10.2.2.2 send-community both
  neighbor 10.2.2.2 route-reflector-client
  exit-address-family
!```

**PE Configuration**

The following example shows the BGP NSR with SSO configuration for the PE router in the figure above. The PE router is configured to support both NSF-awareness and the BGP NSR with SSO capability. In the event of an RP switchover, the PE router uses BGP NSR with SSO to maintain BGP state for the eBGP peering session with the CE-1 router, a CE router in this topology that is not NSF-aware, and uses NSF to maintain BGP state for the iBGP session with RR1. The PE router also detects if any of the other CE routers in the MPLS VPN network are NSF-aware and runs graceful restart with those CE routers.

```config
! router bgp 2
  no synchronization
  bgp log-neighbor-changes
  bgp graceful-restart restart-time 120
  bgp graceful-restart stalepath-time 360
  bgp graceful-restart neighbor 10.1.1.1 remote-as 1
  bgp graceful-restart stalepath-time 360
  bgp graceful-restart neighbor 10.1.1.1 update-source Loopback0
  no auto-summary
  !
  address-family vpnv4
  neighbor 10.1.1.1 activate
  neighbor 10.1.1.1 send-community both
  exit-address-family
  !
  address-family l2vpn vpls
  neighbor 10.3.3.3 remote-as 3
  neighbor 10.3.3.3 remote-as 3
  neighbor 10.3.3.3 ha-mode sso
  neighbor 10.3.3.3 activate
  neighbor 10.3.3.3 as-override
  no auto-summary
  no synchronization
  !
  exit-address-family
!```
CE-1 Configuration

The following example shows the BGP configuration for CE-1 in the figure above. The CE-1 router is configured as an external peer of the PE router. The CE-1 router is not configured to be NSF-capable or NSF-aware. The CE-1 router, however, does not need to be NSF-capable or NSF-aware to benefit from BGP NSR capabilities on the PE router nor does it need to be upgraded to support BGP NSR.

```bash
! router bgp 3
 neighbor 10.2.2.2 remote-as 1
```

Additional References

### Related Documents

<table>
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<tr>
<th>Related Topic</th>
<th>Document Title</th>
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<tbody>
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<td>Cisco IOS commands</td>
<td>Cisco IOS Master Commands List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS BGP Command Reference</td>
</tr>
<tr>
<td>MTR commands</td>
<td>Cisco IOS Multitopology Routing Command Reference</td>
</tr>
<tr>
<td>Configuring Multitopology Routing</td>
<td>Multitopology Routing Configuration Guide</td>
</tr>
<tr>
<td>BGP NSR Support for iBGP Peers</td>
<td>BGP Configuration Guide</td>
</tr>
<tr>
<td>BGP NSR Support for MPLS VPNv4 and VPNv6 Inter-AS Option B</td>
<td>BGP Configuration Guide</td>
</tr>
<tr>
<td>BGP-IPV6 NSR</td>
<td>BGP Configuration Guide</td>
</tr>
</tbody>
</table>

### Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>
## Feature Information for BGP Support for NSR with SSO

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to [www.cisco.com/go/cfn](http://www.cisco.com/go/cfn). An account on Cisco.com is not required.

**Table 76: Feature Information for BGP Support for NSR with SSO**

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
</table>
| BGP Support for NSR with SSO        | 12.2(28)SB     | The BGP Support for Nonstop Routing (NSR) with Stateful Switchover (SSO) feature enables provider edge (PE) routers to maintain Border Gateway Protocol (BGP) state with customer edge (CE) routers and ensure continuous packet forwarding during a Route Processor (RP) switchover or during a planned In-Service Software Upgrade (ISSU) for a PE router. CE routers do not need to be Nonstop Forwarding (NSF)-capable or NSF-aware to benefit from BGP NSR capabilities on PE routers. Only PE routers need to be upgraded to support BGP NSR--no CE router upgrades are required. BGP NSR with SSO, thus, enables service providers to provide the benefits NSF with the additional benefits of NSR without requiring CE routers to be upgraded to support BGP graceful restart. The following commands were introduced or modified:  
  - `debug ip bgp sso`
  - `debug ip tcp ha`
  - `neighbor ha-mode sso`
  - `show ip bgp vpnv4`
  - `show ip bgp vpnv4 all sso summary`
  - `show tcp`
  - `show tcp ha connections` |
|                                    | 15.0(1)S       |                                                                                                                                                    |
| BGP—NSR Enhancement                | Cisco IOS      | The global support for BGP NSR and NSR preference over graceful restart has been enabled. The optional keyword `prefer` has been added to the `bgp ha-mode sso` command. |
|                                    | Release XE     |                                                                                                                                                    |
|                                    | 3.13S          |                                                                                                                                                    |
BGP Support for Nonstop Routing (NSR) with Stateful Switchover (SSO) Using L2VPN VPLS

The BGP Support for Nonstop Routing (NSR) with Stateful Switchover (SSO) feature enables using L2VPN VPLS provider edge (PE) routers to maintain Border Gateway Protocol (BGP) state with customer edge (CE) routers and ensure continuous packet forwarding during a Route Processor (RP) switchover or during a planned In-Service Software Upgrade (ISSU) for a PE router. CE routers do not need to be Nonstop Forwarding (NSF)-capable or NSF-aware to benefit from BGP NSR capabilities on PE routers. Only PE routers need to be upgraded to support BGP NSR--no CE router upgrades are required. BGP NSR with SSO, thus, enables service providers to provide the benefits NSF with the additional benefits of NSR without requiring CE routers to be upgraded to support BGP graceful restart.

• Prerequisites for BGP Support for NSR with SSO, on page 893
• Information About BGP Support for Nonstop Routing (NSR) with Stateful Switchover (SSO), on page 894
• How to Configure BGP Support for Nonstop Routing (NSR) with Stateful Switchover (SSO), on page 895
• Configuration Examples for BGP Support for Nonstop Routing (NSR) with Stateful Switchover (SSO) using L2VPN VPLS, on page 903
• Additional References, on page 905
• Feature Information for BGP Support for Nonstop Routing (NSR) with Stateful Switchover (SSO) Using L2VPN VPLS, on page 905

Prerequisites for BGP Support for NSR with SSO

• Your network must be configured to run BGP.
• Multiprotocol Layer Switching (MPLS) Layer 3 VPNs must be configured.
• You must be familiar with NSF and SSO concepts and tasks.
Information About BGP Support for Nonstop Routing (NSR) with Stateful Switchover (SSO)

Overview of BGP NSR with SSO

Prior to the introduction of BGP NSR with SSO in Cisco IOS Release 12.2(28)SB, BGP required that all neighboring devices participating in BGP NSF be configured to be either NSF-capable or NSF-aware (by configuring the devices to support the BGP graceful restart mechanism). BGP NSF, thus, required that all neighboring devices be upgraded to a version of Cisco IOS software that supports BGP graceful restart. However, in many MPLS VPN deployments, there are situations where PE routers engage in exterior BGP (eBGP) peering sessions with CE routers that do not support BGP graceful restart and cannot be upgraded to a software version that supports BGP graceful restart in the same time frame as the provider (P) routers.

BGP NSR with SSO provides a high availability (HA) solution to service providers whose PE routers engage in eBGP peering relationships with CE routers that do not support BGP graceful restart. BGP NSR works with SSO to synchronize BGP state information between the active and standby RP. SSO minimizes the amount of time a network is unavailable to its users following a switchover. When the BGP NSR with SSO feature is configured, in the event of an RP switchover, the PE router uses BGP NSR with SSO to maintain BGP state for eBGP peering sessions with CEs that are not NSF-aware (see the figure below). Additionally, the BGP NSR with SSO feature dynamically detects NSF-aware peers and runs graceful restart with those CE routers. For eBGP peering sessions with NSF-aware peers and for internal BGP (iBGP) sessions with BGP Route Reflectors (RRs) in the service provider core, the PE uses NSF to maintain BGP state. BGP NSR with SSO, thus, enables service providers to provide the benefits of NSF with the additional benefits of NSR without requiring CE routers to be upgraded to support BGP graceful restart.

Figure 82: BGP NSR with SSO Operations During an RP Switchover

BGP NSR with SSO is supported in BGP peer, BGP peer group, and BGP session template configurations. To configure support for BGP NSR with SSO in BGP peer and BGP peer group configurations, use the `neighbor ha-mode sso` command in address family configuration mode for IPv4 VRF address family BGP.
peer sessions. To include support for Cisco BGP NSR with SSO in a peer session template, use the `ha-mode sso` command in session-template configuration mode.

**Benefits of BGP NSR with SSO**

- Minimizes services disruptions—Border Gateway Protocol (BGP) Nonstop Routing (NSR) with Stateful Switchover (SSO) reduces impact on customer traffic during route processor (RP) switchovers (scheduled or unscheduled events), extending high availability (HA) deployments and benefits at the edge.

- Enhances high-availability Nonstop Forwarding (NSF) and SSO deployment at the edge—BGP NSR with SSO allows incremental deployment by upgrading the provider edge device with the NSR capability so that customer-facing edge devices are synchronized automatically and no coordination or NSF awareness is needed with the customer side Cisco or third-party customer edge devices. The BGP NSR feature dynamically detects NSF-aware peers and runs graceful restart with those CE devices.

- Provides transparent route convergence—BGP NSR with SSO eliminates route flaps by keeping BGP state on both active and standby RPs and ensures continuous packet forwarding with minimal packet loss during RP failovers.

**How to Configure BGP Support for Nonstop Routing (NSR) with Stateful Switchover (SSO)**

**Configuring a PE Device to Support BGP NSR with SSO**

Perform this task to enable a provider edge (PE) device to maintain BGP state with customer edge (CE) devices and ensure continuous packet forwarding during a route processor (RP) switchover or during a planned ISSU. Border Gateway Protocol (BGP) Nonstop Routing (NSR) with Stateful Switchover (SSO) enables service providers to provide the benefits Nonstop Forwarding (NSF) with the additional benefits of NSR without requiring CE devices to be upgraded to support BGP graceful restart.

BGP NSR with SSO is supported in BGP peer, BGP peer group, and BGP session template configurations. Perform one of the following tasks in this section on a PE device, depending on whether you want to configure support for BGP NSR with SSO in a peer, a peer group, or a session template configuration:

**Prerequisites**

- These tasks assume that you are familiar with BGP peer, BGP peer group, and BGP session template concepts. For more information, see the “Configuring a Basic BGP Network” module.

- The active and standby RP must be in SSO mode. For information about configuring SSO mode, see the “Configuring Stateful Switchover” module in the High Availability Configuration Guide.

- Graceful restart should be enabled on the PE device. We recommend that you enable graceful restart on all BGP peers in the provider core that participate in BGP NSF. For more information about configuring graceful restart, see the “Configuring Advanced BGP Features” module.

- CE devices must support the route refresh capability. For more information, see the “Configuring a Basic BGP Network” module.
Configuring a Peer to Support BGP NSR with SSO

SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `bgp graceful-restart [restart-time seconds] [stalepath-time seconds]`
5. `address-family l2vpn vpls`
6. `neighbor ip-address remote-as autonomous-system-number`
7. `neighbor ip-address ha-mode sso`
8. `neighbor ip-address activate`
9. `end`
10. `show ip bgp vpnv4 all sso summary`

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# router bgp 40000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> bgp graceful-restart [restart-time seconds] [stalepath-time seconds]</td>
<td>Enables the Border Gateway Protocol (BGP) graceful restart capability and BGP Nonstop Forwarding (NSF) awareness.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router)# bgp graceful-restart</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• If you enter this command after the BGP session has been established, you must restart the session for the capability to be exchanged with the BGP neighbor.</td>
</tr>
<tr>
<td></td>
<td>• Use this command on the restarting device and all of its peers (NSF-capable and NSF-aware).</td>
</tr>
<tr>
<td><strong>Step 5</strong> address-family l2vpn vpls</td>
<td>Specifies activation of L2VPN VPLS peering.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router)# address-family l2vpn vpls</td>
<td></td>
</tr>
<tr>
<td>Step</td>
<td>Command or Action</td>
</tr>
<tr>
<td>------</td>
<td>-------------------</td>
</tr>
<tr>
<td>6</td>
<td><code>neighbor ip-address remote-as autonomous-system-number</code></td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td></td>
<td><code>Device(config-router-af)# neighbor 192.168.1.1 remote-as 45000</code></td>
</tr>
<tr>
<td>7</td>
<td><code>neighbor ip-address ha-mode sso</code></td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td></td>
<td><code>Device(config-router-af)# neighbor 192.168.1.1 ha-mode sso</code></td>
</tr>
</tbody>
</table>
| 8    | `neighbor ip-address activate` | Enables the neighbor to exchange prefixes for the IPv4 address family with the local router.  
**Note** By default, neighbors that are defined using the `neighbor remote-as` command in router configuration mode exchange only unicast address prefixes. |
|      | **Example:** | |
|      | `Device(config-router-af)# neighbor testgroup activate` | |
| 9    | `end` | Exits address family configuration mode and enters privileged EXEC mode. |
|      | **Example:** | |
|      | `Device(config-router-af)# end` | |
| 10   | `show ip bgp vpnv4 all sso summary` | (Optional) Displays the number of BGP neighbors that are in SSO mode. |
|      | **Example:** | |
|      | `Device# show ip bgp vpnv4 all sso summary` | |

### Configuring a Peer Group to Support BGP NSR with SSO

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `bgp graceful-restart [restart-time seconds] [stalepath-time seconds]`
5. `neighbor peer-group-name peer-group`
6. `neighbor ip-address remote-as autonomous-system-number`
7. `neighbor ip-address peer-group peer-group-name`
8. `neighbor peer-group-name ha-mode sso`
9. `address-family l2vpn vpls`
10. `neighbor peer-group-name activate`
11. `end`
12. `show ip bgp l2vpn vpls all sso summary`
## DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td><code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><code>Device&gt; enable</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td><code>configure terminal</code></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><code>Device# configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td><code>router bgp autonomous-system-number</code></td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><code>Device(config)# router bgp 40000</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td><code>bgp graceful-restart [restart-time seconds] [stalepath-time seconds]</code></td>
<td>Enables the Border Gateway Protocol (BGP) graceful restart capability and BGP Nonstop Forwarding (NSF) awareness.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><code>Device(config-router)# bgp graceful-restart</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td><code>neighbor peer-group-name peer-group</code></td>
<td>Creates a BGP peer group.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><code>Device(config-router-af)# neighbor testgroup peer-group</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td><code>neighbor ip-address remote-as autonomous-system-number</code></td>
<td>Adds the IP address of the neighbor in the specified autonomous system to the IPv4 multiprotocol BGP neighbor table of the local device.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><code>Device(config-router-af)# neighbor 192.168.1.1 remote-as 45000</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td><code>neighbor ip-address peer-group peer-group-name</code></td>
<td>Assigns the IP address of a BGP neighbor to a BGP peer group.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><code>Device(config-router-af)# neighbor 192.168.1.1 peer-group testgroup</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td><code>neighbor peer-group-name ha-mode sso</code></td>
<td>Configures the BGP peer group to support BGP Nonstop Routing (NSR) with Stateful Switchover (SSO).</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Configuring Support for BGP NSR with SSO in a Peer Session Template

#### SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router bgp** `autonomous-system-number`
4. **template peer-session** `session-template-name`
5. **ha-mode** `sso`
6. **exit-peer-session**
7. **end**
8. **show ip bgp template peer-session** `[session-template-name]`

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1**
| enable
| Example:
<p>| Device&gt; enable |
| Enables privileged EXEC mode. |</p>
<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>Device# configure terminal</td>
</tr>
<tr>
<td>3</td>
<td>router bgp autonomous-system-number</td>
<td>Enters router configuration mode and creates a Border Gateway Protocol (BGP) routing process.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>Device(config)# router bgp 101</td>
</tr>
<tr>
<td>4</td>
<td>template peer-session session-template-name</td>
<td>Enters session-template configuration mode and creates a peer session template.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>Device(config-router)# template peer-session CORE1</td>
</tr>
<tr>
<td>5</td>
<td>ha-mode sso</td>
<td>Configures the neighbor to support BGP Nonstop Routing (NSR) with Stateful Switchover (SSO).</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>Device(config-router-stmp)# ha-mode sso</td>
</tr>
<tr>
<td>6</td>
<td>exit-peer-session</td>
<td>Exits session-template configuration mode and returns to router configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>Device(config-router-stmp)# exit-peer-session</td>
</tr>
<tr>
<td>7</td>
<td>end</td>
<td>Exits router configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>Device(config-router)# end</td>
</tr>
<tr>
<td>8</td>
<td>show ip bgp template peer-session [session-template-name]</td>
<td>(Optional) Displays locally configured peer session templates.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>Device# show ip bgp template peer-session</td>
</tr>
</tbody>
</table>

**What to Do Next**

After the peer session template is created, the configuration of the peer session template can be inherited by or applied to another peer session template with the `inherit peer-session` or `neighbor inherit peer-session` command.

For more information about configuring peer session templates, see the "Configuring a Basic BGP Network" chapter in the *Cisco IOS IP Routing: BGP Configuration Guide*. 
Verifying BGP Support for NSR with SSO

SUMMARY STEPS

1. enable
2. show ip bgpl2vpnvpls all sso summary
3. show ip bgpl2vpnvpls all neighbors

DETAILED STEPS

Step 1 enable

Enables privileged EXEC mode.

Example:

Device> enable

Step 2 show ip bgpl2vpnvpls all sso summary

This command is used to display the number of Border Gateway Protocol (BGP) neighbors that are in Stateful Switchover (SSO) mode.

The following is sample output from the show ip bgp l2vpnvpls all sso summary command:

Example:

Device# show ip bgp l2vpn vpls all sso summary
Stateful switchover support enabled for 40 neighbors

Step 3 show ip bgpl2vpnvpls all neighbors

This command displays VPN address information from the BGP table.

The following is sample output from the show ip bgp l2vpnvpls all neighbors command. The “Stateful switchover support” field indicates whether SSO is enabled or disabled. The “SSO Last Disable Reason” field displays information about the last BGP session that lost SSO capability.

Example:

Device# show ip bgp l2vpn vpls all neighbors 10.3.3.3
BGP neighbor is 10.3.3.3, vrf vrf1, remote AS 3, external link
Inherits from template 10vrf-session for session parameters
BGP version 4, remote router ID 10.1.105.12
BGP state = Established, up for 04:21:39
Last read 00:00:05, last write 00:00:09, hold time is 30, keepalive interval is 10 seconds
Configured hold time is 30, keepalive interval is 10 seconds
Minimum holdtime from neighbor is 0 seconds
Neighbor capabilities:
Route refresh: advertised and received(new)
Address family IPv4 Unicast: advertised and received
Stateful switchover support enabled
Message statistics:
InQ depth is 0
OutQ depth is 0
OpenS: Sent Rcvd
1 1
Verifying BGP Support for NSR with SSO

BGP Support for Nonstop Routing (NSR) with Stateful Switchover (SSO) Using L2VPN VPLS

Notifications: 0 0
Updates: 1 4
Keepalives: 1534 1532
Route Refresh: 0 0
Total: 1536 1537
Default minimum time between advertisement runs is 30 seconds
For address family: L2VPN VPLS
BGP table version 25161, neighbor version 25161/0
Output queue size: 0
Index 7, Offset 0, Mask 0x80
7 update-group member
Inherits from template 10vrf-policy
Overrides the neighbor AS with my AS before sending updates
Outbound path policy configured
Route map for outgoing advertisements is Deny-CE-prefixes

<table>
<thead>
<tr>
<th>Prefix activity:</th>
<th>Sent</th>
<th>Rcvvd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prefixes Current:</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>Prefixes Total:</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>Implicit Withdraw:</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Explicit Withdraw:</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Used as bestpath:</td>
<td>n/a</td>
<td>0</td>
</tr>
<tr>
<td>Used as multipath:</td>
<td>n/a</td>
<td>0</td>
</tr>
</tbody>
</table>

Local Policy Denied Prefixes:

| route-map: | 150 | 0 |
| AS PATH loop: | n/a | 760 |
| Total: | 150 | 760 |

Number of NLRIs in the update sent: max 10, min 10
Address tracking is enabled, the RIB does have a route to 10.3.3.3
Address tracking requires at least a /24 route to the peer
Connections established: 1; dropped: 0
Last reset never
TCP session must be opened passively
Connection state is ESTAB, I/O status: 1, unread input bytes: 0 Connection is ECN Disabled Local host: 10.0.21.1, Local port: 179 Foreign host: 10.0.21.3, Foreign port: 51205 Connection tableid (VRF): 1
Enqueued packets for retransmit: 0, input: 0 mis-ordered: 0 (0 bytes)
Event Timers (current time is 0x1625488):

<table>
<thead>
<tr>
<th>Timer</th>
<th>Starts</th>
<th>Wakeups</th>
<th>Next</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retrans</td>
<td>1746</td>
<td>210</td>
<td>0x0</td>
</tr>
<tr>
<td>TimeWait</td>
<td>0</td>
<td>0</td>
<td>0x0</td>
</tr>
<tr>
<td>AckHold</td>
<td>1535</td>
<td>1525</td>
<td>0x0</td>
</tr>
<tr>
<td>SendWnd</td>
<td>0</td>
<td>0</td>
<td>0x0</td>
</tr>
<tr>
<td>KeepAlive</td>
<td>0</td>
<td>0</td>
<td>0x0</td>
</tr>
<tr>
<td>GiveUp</td>
<td>0</td>
<td>0</td>
<td>0x0</td>
</tr>
<tr>
<td>PmtuAger</td>
<td>0</td>
<td>0</td>
<td>0x0</td>
</tr>
<tr>
<td>DeadWait</td>
<td>0</td>
<td>0</td>
<td>0x0</td>
</tr>
<tr>
<td>Linger</td>
<td>0</td>
<td>0</td>
<td>0x0</td>
</tr>
</tbody>
</table>

iss: 2241977291 sndnua: 2242006573 sndnx: 2242006573 sndwnd: 13097
irs: 821359845 rcvnxt: 821391670 rcvwnd: 14883 delrcvwnd: 1501
SRRT: 300 ms, RTTO: 303 ms, RTV: 3 ms, KRTT: 0 ms
minRTT: 0 ms, maxRTT: 300 ms, ACK hold: 200 ms Status Flags: passive open, retransmission timeout, gen tcbs
0x1000
Option Flags: VRF id set, always push, md5
Datagrams (max data segment is 4330 bytes):
Rcvd: 3165 (out of order: 0), with data: 1535, total data bytes: 31824
Sent: 3162 (retransmit: 210 fastretransmit: 0), with data: 1537, total data bytes: 29300
SSO Last Disable Reason: Application Disable (Active)
Troubleshooting Tips

To troubleshoot BGP NSR with SSO, use the following commands in privileged EXEC mode, as needed:

- `debug ip bgp sso` -- Displays BGP-related SSO events or debugging information for BGP-related interactions between the active RP and the standby RP. This command is useful for monitoring or troubleshooting BGP sessions on a PE router during an RP switchover or during a planned ISSU.

- `debug ip tcp ha` -- Displays TCP HA events or debugging information for TCP stack interactions between the active RP and the standby RP. This command is useful for troubleshooting SSO-aware TCP connections.

- `show tcp` -- Displays the status of TCP connections. The display output will display the SSO capability flag and will indicate the reason that the SSO property failed on a TCP connection.

- `show tcp ha connections` -- Displays connection-ID-to-TCP mapping data.

Configuration Examples for BGP Support for Nonstop Routing (NSR) with Stateful Switchover (SSO) using L2VPN VPLS

Example: Configuring BGP NSR with SSO Using L2VPN VPLS

The illustration below illustrates a sample Border Gateway Protocol (BGP) Nonstop Routing (NSR) with Stateful Switchful (SSO) network topology using L2VPN VPLS technology, and the configuration examples that follow show configurations from two devices in the topology: the RR1 device and the provider edge (PE) device.

Note

The configuration examples omit some of the configuration required for Multiprotocol Label Switching (MPLS) VPNs because the purpose of these examples is to illustrate the configuration of BGP NSR with SSO.
**RR1 Configuration**

The following example shows the BGP configuration for RR1 in the illustration above. RR1 is configured as a Nonstop Forwarding (NSF)-aware route reflector (RR). In the event of an route processor (RP) switchover, the PE device uses NSF to maintain the BGP state of the internal peering session with RR1.

```
! router bgp 1
  no synchronization
  bgp log-neighbor-changes
  bgp graceful-restart restart-time 120
  bgp graceful-restart stalepath-time 360
  bgp graceful-restart
  neighbor 10.2.2.2 remote-as 1
  neighbor 10.2.2.2 update-source Loopback0
  no auto-summary
  !
  address-family l2vpn vpls
  neighbor 10.2.2.2 activate
  neighbor 10.2.2.2 send-community both
  neighbor 10.2.2.2 route-reflector-client
  exit-address-family
  !
```

**PE Configuration**

The following example shows the BGP NSR with SSO configuration for the PE device in the illustration above. The PE device is configured to support both NSF-awareness and the BGP NSR with SSO capability. In the event of an RP switchover, the PE device uses BGP NSR with SSO to maintain BGP state for the external BGP (eBGP) peering session and uses NSF to maintain BGP state for the internal BGP (iBGP) session with RR1.

```
! router bgp 2
  no synchronization
  bgp log-neighbor-changes
  bgp graceful-restart restart-time 120
  bgp graceful-restart stalepath-time 360
  bgp graceful-restart
  neighbor 10.1.1.1 remote-as 1
  neighbor 10.1.1.1 update-source Loopback0
  neighbor 10.3.3.3 remote-as 3
  neighbor 10.3.3.3 ha-mode sso
  neighbor 10.3.3.3 activate
  neighbor 10.3.3.3 as-override
  no auto-summary
  !
  address-family l2vpn vpls
  neighbor 10.1.1.1 activate
  neighbor 10.1.1.1 send-community both
  exit-address-family
  !
  no auto-summary
  no synchronization
  exit-address-family
  !```
Additional References

Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
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</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS BGP Command Reference</td>
</tr>
<tr>
<td>MTR commands</td>
<td>Cisco IOS Multitopology Routing Command Reference</td>
</tr>
<tr>
<td>Configuring Multitopology Routing</td>
<td>Multitopology Routing Configuration Guide</td>
</tr>
<tr>
<td>BGP NSR Support for iBGP Peers</td>
<td>BGP Configuration Guide</td>
</tr>
<tr>
<td>BGP NSR Support for MPLS VPNv4 and VPNv6 Inter-AS Option B</td>
<td>BGP Configuration Guide</td>
</tr>
<tr>
<td>BGP-IPV6 NSR</td>
<td>BGP Configuration Guide</td>
</tr>
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</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

Feature Information for BGP Support for Nonstop Routing (NSR) with Stateful Switchover (SSO) Using L2VPN VPLS

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.
Table 77: Feature Information for BGP Support for Nonstop Routing (NSR) with Stateful Switchover (SSO) Using L2VPN VPLS

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
</table>
| BGP Support for Nonstop Routing (NSR) with Stateful Switchover (SSO) Using L2VPN VPLS | Cisco IOS XE Fuji 16.7.1 | The BGP Support for Nonstop Routing (NSR) with Stateful Switchover (SSO) using L2VPN VPLS feature enables provider edge (PE) routers to maintain Border Gateway Protocol (BGP) state with customer edge (CE) routers and ensure continuous packet forwarding during a Route Processor (RP) switchover or during a planned In-Service Software Upgrade (ISSU) for a PE router. CE routers do not need to be Nonstop Forwarding (NSF)-capable or NSF-aware to benefit from BGP NSR capabilities on PE routers. Only PE routers need to be upgraded to support BGP NSR--no CE router upgrades are required. BGP NSR with SSO, thus, enables service providers to provide the benefits NSF with the additional benefits of NSR without requiring CE routers to be upgraded to support BGP graceful restart. The following commands were modified:  
  - debug ip bgp sso  
  - show ip bgp 12vpn |
BGP NSR Auto Sense

The BGP NSR Auto Sense feature is the default behavior implemented to reduce unnecessary churn in the event of a Route Processor (RP) failover. Prior to this feature, when an Active RP went down, the new Active RP that was taking over to provide Border Gateway Protocol (BGP) nonstop routing (NSR) would send a route-refresh request to all peers configured with NSR. However, the new Active RP had already received all the incoming updates while acting as the Standby RP. Sending route-refresh requests caused unnecessary BGP churn during switchover; this feature prevents such route-refresh requests by default. This feature also provides NSR support to peers that lack route-refresh capability. If you want to revert to the old behavior of sending route-refresh requests, a new command is available to make that happen.

• Finding Feature Information, on page 907
• Information About BGP NSR Auto Sense, on page 907
• How to Disable the BGP NSR Auto Sense Feature, on page 908
• Configuration Example for BGP NSR Auto Sense, on page 909
• Additional References, on page 910
• Feature Information for BGP NSR Auto Sense, on page 910

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About BGP NSR Auto Sense

Benefits of BGP NSR Auto Sense

The BGP NSR Auto Sense feature has the following benefits:

• This feature is a default behavior that reduces unnecessary churn in the event of a Route Processor (RP) failover. Prior to this feature, when an Active RP went down, the new Active RP that was taking over to provide BGP nonstop routing (NSR) would send a route-refresh request to all peers configured with...
NSR. However, the Active RP had already received all the incoming updates while acting as the Standby RP. Sending route-refresh requests caused unnecessary BGP churn during switchover; this feature prevents such route-refresh requests by default.

- This feature also provides NSR support to peers that lack route-refresh capability. Prior to this feature, NSR was not supported for peers that lack route-refresh capability.
- There is no need to configure this feature; it is the default behavior in releases where this feature is implemented.
- If you want to revert to the former behavior of a new Active RP sending route-refresh requests when an RP goes down, you can use the `bgp sso route-refresh-enable` command.

**Consequence of Reverting to NSR Without Auto Sense**

You might have a reason not to want the default behavior of the BGP NSR Auto Sense feature. If you want to revert to the former behavior of a new Active RP sending route-refresh requests when an RP goes down, you can use the `bgp sso route-refresh-enable` command. This action causes peers that did not exchange route-refresh capability in the received OPEN message to have NSR support disabled.

**How to Disable the BGP NSR Auto Sense Feature**

**Disabling the BGP NSR Auto Sense Feature**

The BGP NSR Auto Sense feature is enabled by default. Perform this task only if you want to disable the feature, for example, if routes that were being advertised at the point of switchover did not get processed by the Standby RP (new Active RP) for some reason. In that case, sending a route-refresh to request all the routes that the peer had ever advertised would be helpful. After performing this task, in the event of a failover, a new Active RP will send route-refresh requests to peers configured with NSR.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp as-number`
4. `bgp sso route-refresh-enable`
5. `end`
6. `show ip bgp vpnv4 all neighbor [ip-address]`
7. `show ip bgp vpnv4 all sso summary`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Router&gt; enable</td>
<td></td>
</tr>
<tr>
<td>Step</td>
<td>Command or Action</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------------------</td>
</tr>
<tr>
<td>Step 2</td>
<td><strong>configure terminal</strong></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router# configure terminal</td>
</tr>
<tr>
<td>Step 3</td>
<td><strong>router bgp as-number</strong></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router(config)# router bgp 6500</td>
</tr>
<tr>
<td></td>
<td><strong>• The as-number argument indicates the number of an autonomous system that identifies the router to other BGP routers and tags the routing information passed along. Valid numbers are from 0 to 65535. Private autonomous system numbers that can be used in internal networks range from 64512 to 65535.</strong></td>
</tr>
<tr>
<td></td>
<td><strong>• Regarding the 4-byte AS configuration, please see the <code>bgp asnotation dot</code> command in the IP Routing: BGP Command Reference.</strong></td>
</tr>
<tr>
<td>Step 4</td>
<td><strong>bgp sso route-refresh-enable</strong></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router(config-router)# bgp sso route-refresh-enable</td>
</tr>
<tr>
<td>Step 5</td>
<td><strong>end</strong></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router(config-router)# end</td>
</tr>
<tr>
<td>Step 6</td>
<td><strong>show ip bgp vpnv4 all neighbor [ip-address]</strong></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router# show ip bgp vpnv4 all neighbor 10.0.0.2</td>
</tr>
<tr>
<td>Step 7</td>
<td><strong>show ip bgp vpnv4 all sso summary</strong></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router# show ip bgp vpnv4 all sso summary</td>
</tr>
</tbody>
</table>

### Configuration Example for BGP NSR Auto Sense

#### Example: Disabling the BGP NSR Auto Sense Feature

```
router bgp 65600
```
bgp sso route-refresh-enable

Additional References

Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
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</thead>
<tbody>
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</tr>
<tr>
<td>download documentation, software, and tools. Use these resources to install</td>
<td>index.html</td>
</tr>
<tr>
<td>and configure the software and to troubleshoot and resolve technical issues</td>
<td></td>
</tr>
<tr>
<td>with Cisco products and technologies. Access to most tools on the Cisco</td>
<td></td>
</tr>
<tr>
<td>Support and Documentation website requires a Cisco.com user ID and password.</td>
<td></td>
</tr>
</tbody>
</table>

Feature Information for BGP NSR Auto Sense

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.
Table 78: Feature Information for BGP NSR Auto Sense

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP NSR Auto Sense</td>
<td>15.2(2)S</td>
<td>The BGP NSR Auto Sense feature is implemented by default to reduce unnecessary churn in the event of an RP failover. This feature also provides NSR support to peers that lack route-refresh support.</td>
</tr>
<tr>
<td></td>
<td>Cisco IOS XE Release 3.6S</td>
<td>The following command was introduced: <code>bgp sso route-refresh-enable</code>.</td>
</tr>
</tbody>
</table>
CHAPTER 60

BGP NSR Support for iBGP Peers

BGP NSR provides BGP nonstop routing (NSR) and nonstop forwarding (NSF) in the event of a switchover from an Active RP to the Standby RP. The BGP NSR Support for iBGP Peers feature provides NSR support for iBGP peers configured under the IPv4 unicast or IPv4 + label address family.

- Finding Feature Information, on page 913
- Restrictions on BGP NSR Support for iBGP Peers, on page 913
- Information About BGP NSR Support for iBGP Peers, on page 914
- How to Configure BGP NSR Support for iBGP Peers, on page 914
- Configuration Examples for BGP NSR Support for an iBGP Peer, on page 918
- Additional References, on page 918
- Feature Information for BGP NSR Support for iBGP Peers, on page 919

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Restrictions on BGP NSR Support for iBGP Peers

This feature applies to iBGP peers configured under IPv4 unicast or IPv4 + label address families.
Information About BGP NSR Support for iBGP Peers

Benefit of BGP NSR Support for iBGP Peers

Nonstop routing is beneficial for iBGP peers because it reduces the likelihood of dropped packets during switchover from the Active RP to the Standby RP. Switchover occurs when the Active RP fails for some reason, and the Standby RP takes control of Active RP operations.

How to Configure BGP NSR Support for iBGP Peers

Making an iBGP Peer NSR-Capable for the IPv4 Address Family

SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. address-family ipv4 [unicast | vrf vrf-name]
5. neighbor ip-address remote-as as-number
6. neighbor ip-address activate
7. neighbor ip-address ha-mode sso
8. end

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# router bgp 4000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> address-family ipv4 [unicast</td>
<td>vrf vrf-name]</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
</tbody>
</table>
Making an iBGP Peer NSR-Capable for the VPNv4 Address Family

SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. neighbor ip-address remote-as as-number
5. neighbor ip-address ha-mode sso
6. address-family vpnv4 [unicast]
7. neighbor ip-address activate
8. end
## DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1**        | Enables privileged EXEC mode.  
  **Example:**  
  Device> enable |
|                   | • Enter your password if prompted. |
| **Step 2**        | Enters global configuration mode.  
  **Example:**  
  Device# configure terminal |
| **Step 3**        | Enters router configuration mode for the specified routing process.  
  **Example:**  
  Device(config)# router bgp 4000 |
| **Step 4**        | Specifies the autonomous system of the neighbor.  
  **Example:**  
  Device(config-router)# neighbor 192.168.1.1 remote-as 4000 |
| **Step 5**        | Configures a BGP neighbor to support BGP NSR with stateful switchover (SSO).  
  **Example:**  
  Device(config-router)# neighbor 192.168.1.1 ha-mode sso |
| **Step 6**        | Specifies the VPNv4 address family and enters address family configuration mode.  
  **Example:**  
  Device(config-router)# address-family vpn4 [unicast] |
| **Step 7**        | Activates the specified peer.  
  **Example:**  
  Device(config-router-af)# neighbor 192.168.1.1 activate |
| **Step 8**        | Exits address family configuration mode and returns to privileged EXEC mode.  
  **Example:**  
  Device(config-router-af)# end |
Making an iBGP Peer NSR Capable at the Router Level

SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. neighbor ip-address remote-as as-number
5. neighbor ip-address activate
6. neighbor ip-address ha-mode sso
7. end
8. show ip bgp sso summary

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td><strong>Step 4</strong> neighbor ip-address remote-as as-number</td>
<td>Specifies the autonomous system of the neighbor.</td>
</tr>
<tr>
<td><strong>Step 5</strong> neighbor ip-address activate</td>
<td>Activates the specified neighbor.</td>
</tr>
<tr>
<td><strong>Step 6</strong> neighbor ip-address ha-mode sso</td>
<td>Configures the specified peer to be NSR capable in all of the NSR-supported address families under which that peer has been activated.</td>
</tr>
</tbody>
</table>

Example:

Device> enable
Example:
Device# configure terminal

Device(config)# router bgp 4000
Example:
Device(config-router)# neighbor 192.168.1.1 remote-as 4000

Device(config-router)# neighbor 192.168.1.1 activate

Device(config-router)# neighbor 192.168.1.1 ha-mode sso
### Purpose

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 7</strong> end</td>
<td>Exits configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config-router)# end</td>
<td></td>
</tr>
</tbody>
</table>

### Step 8

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>show ip bgp sso summary</strong></td>
<td>(Optional) Displays information about stateful switchover (sso) and whether a peer has NSR enabled or disabled.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device# show ip bgp sso summary</td>
<td></td>
</tr>
</tbody>
</table>

---

## Configuration Examples for BGP NSR Support for an iBGP Peer

### Example: Configuring an iBGP Peer To Be NSR Capable

### Configuring an iBGP Peer to Be NSR Capable at the Address Family Level

```plaintext
erouter bgp 4000
  address-family ipv4 unicast
  neighbor 192.168.1.1 remote-as 4000
  neighbor 192.168.1.1 activate
  neighbor 192.168.1.1 ha-mode sso
```

### Configuring an iBGP Peer to Be NSR Capable at the Router Level

```plaintext
erouter bgp 4000
  neighbor 192.168.1.1 remote-as 4000
  neighbor 192.168.1.1 activate
  neighbor 192.168.1.1 ha-mode sso
```

---

## Additional References

### Related Documents

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<tbody>
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<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
<tr>
<td>BFD commands</td>
<td>Cisco IOS IP Routing: Protocol Independent Command Reference</td>
</tr>
</tbody>
</table>
Feature Information for BGP NSR Support for iBGP Peers

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 79: Feature Information for BGP NSR Support for iBGP Peers

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP NSR Support for iBGP Peers</td>
<td>Cisco IOS XE Release 3.6S</td>
<td>BGP NSR provides BGP nonstop routing and nonstop forwarding in the event of a switchover from an active RP to the standby RP. The following commands were modified: neighbor ha-mode sso and show ip bgp vpnv4 all sso summary.</td>
</tr>
<tr>
<td></td>
<td>Cisco IOS XE Release 3.7S</td>
<td></td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>
CHAPTER 61

BGP Graceful Shutdown

The BGP Graceful Shutdown feature reduces or eliminates the loss of traffic along a link being shut down for maintenance. Routers always have a valid route available during the convergence process. This feature is used primarily for maintenance on a link between a Provider Edge (PE), PE-PE, PE-Route Reflector (RR), PE-Customer Edge (CE) and CE.

- Finding Feature Information, on page 921
- Information About BGP Graceful Shutdown, on page 921
- How to Configure BGP Graceful Shutdown, on page 922
- Configuration Examples for BGP Graceful Shutdown, on page 928
- Additional References, on page 930
- Feature Information for BGP Graceful Shutdown, on page 931

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About BGP Graceful Shutdown

Purpose and Benefits of BGP Graceful Shutdown

There are times when planned maintenance operations cause routing changes in BGP. After the shutdown of eBGP and iBGP peering sessions between autonomous system border routers (ASBRs), BGP devices are temporarily unreachable during BGP convergence. The goal of gracefully shutting down one or more BGP sessions is to minimize traffic loss during the planned shutdown and subsequent reestablishment of the sessions.

The BGP Graceful Shutdown feature reduces or eliminates the loss of inbound or outbound traffic flows that were initially forwarded along the peering link that is being shut down for maintenance. This feature is primarily for PE-CE, PE-RR and PE-PE links. Lowering the local preference for paths received over the session being shutdown renders the affected paths less preferred by the BGP decision process, but still allows the paths to
be used during the convergence while alternative paths are propagated to the affected devices. Therefore, devices always have a valid route available during the convergence process.

The feature also allows vendors to provide a graceful shutdown mechanism that does not require any router reconfiguration at maintenance time. The benefits of the BGP Graceful Shutdown feature are fewer lost packets and less time spent reconfiguring devices.

**GSHUT Community**

The GSHUT community is a well-known community used in conjunction with the BGP Graceful Shutdown feature. The GSHUT community attribute is applied to a neighbor specified by the `neighbor shutdown graceful` command, thereby gracefully shutting down the link in an expected number of seconds. The GSHUT community is always sent by the GSHUT initiator.

The GSHUT community is specified in a community list, which is referenced by a route map and then used to make policy routing decisions.

The GSHUT community can also be used in the `show ip bgp community` command to limit output to GSHUT routes.

**BGP GSHUT Enhancement**

The BGP Graceful Shutdown (GSHUT) Enhancement feature enables graceful shutdown of either all neighbors or only virtual routing and forwarding (VRF) neighbors across BGP sessions. To enable the BGP GSHUT enhancement feature on the device, you must configure either the `community` keyword or the `local-preference` keyword in the `bgp graceful-shutdown all` command. Use the `activate` keyword to activate graceful shutdown either across all neighbors or only across all VRF neighbors, across all BGP sessions.

**How to Configure BGP Graceful Shutdown**

**Shutting Down a BGP Link Gracefully**

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `neighbor {ipv4-address | ipv6-address} remote-as number`
5. `neighbor {ipv4-address | ipv6-address | peer-group-name} shutdown graceful seconds {community value [local-preference value] | local-preference value}`
6. `end`
7. `show ip bgp community gshut`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong> Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong> Device# configure terminal</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Configures a BGP routing process.</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# router bgp 5000</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> neighbor {ipv4-address</td>
<td>ipv6-address} remote-as number</td>
<td>Configures the autonomous system (AS) to which the neighbor belongs.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router)# neighbor 2001:db8:3::1 remote-as 5500</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> neighbor {ipv4-address</td>
<td>ipv6-address</td>
<td>peer-group-name} shutdown graceful seconds {community value</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router)# neighbor 2001:db8:3::1 shutdown graceful 600 community 1200 local-preference 300</td>
<td>• Make sure to specify an adequate amount of time for iBGP peers to converge and to choose an alternate path as the best path.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• If the <code>graceful</code> keyword is used in the <code>neighbor shutdown</code> command, at least one of the two attributes (a community or local preference) must be configured. You may configure both attributes.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• If the <code>graceful</code> keyword is used in the <code>neighbor shutdown</code> command, the route is advertised with the GSHUT community by default. You may also set one other community for policy routing purposes.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• In this particular example, the route to the neighbor is configured to shut down in 600 seconds, is advertised with the GSHUT community and community 1200, and is configured with a local preference of 300.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• The device receiving the advertisement looks at the community value(s) of the route and optionally uses the community value to apply routing policy. Filtering routes based on a community is done with the <code>ip community-list</code> command and a route map.</td>
<td></td>
</tr>
</tbody>
</table>
Filtering BGP Routes Based on the GSHUT Community

Perform this task on a BGP peer to the device where you enabled the BGP Graceful Shutdown feature.

SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `neighbor (ipv4-address | ipv6-address) remote-as number`
5. `neighbor (ipv4-address | ipv6-address) activate`
6. `neighbor (ipv4-address | ipv6-address) send-community`
7. `exit`
8. `route-map map-tag [permit | deny] [sequence-number]`
9. `match community {standard-list-number | expanded-list-number | community-list-name [exact]}
10. `exit`
11. `ip community-list {standard | standard list-name} {deny | permit} gshut`
12. `router bgp autonomous-system-number`
13. `neighbor address route-map map-name in`

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
</tr>
<tr>
<td><code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device&gt; enable</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td></td>
</tr>
<tr>
<td><code>configure terminal</code></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>--------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td></td>
</tr>
<tr>
<td><strong>router bgp 2000</strong></td>
<td>Configures a BGP routing process.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config)# router bgp 2000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td></td>
</tr>
<tr>
<td>**neighbor {ipv4-address</td>
<td>ipv6-address} remote-as number**</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config-router)# neighbor 2001::1 remote-as 1000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td></td>
</tr>
<tr>
<td>**neighbor {ipv4-address</td>
<td>ipv6-address} activate**</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config-router)# neighbor 2001::1 activate</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td></td>
</tr>
<tr>
<td>**neighbor {ipv4-address</td>
<td>ipv6-address} send-community**</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config-router)# neighbor 2001::1 send-community</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td></td>
</tr>
<tr>
<td><strong>exit</strong></td>
<td>Exits router configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config-router)# exit</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td></td>
</tr>
<tr>
<td>**route-map map-tag [permit</td>
<td>deny] [sequence-number]**</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config)# route-map RM_GSHUT deny 10</td>
<td></td>
</tr>
<tr>
<td><strong>Step 9</strong></td>
<td></td>
</tr>
<tr>
<td>**match community {standard-list-number</td>
<td>expanded-list-number</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config-route-map)# match community GSHUT</td>
<td></td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td></td>
</tr>
<tr>
<td><strong>exit</strong></td>
<td>Exits route-map configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config-route-map)# exit</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Step 11</strong></td>
<td><strong>ip community-list</strong> {standard</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><strong>Device(config)# ip community-list standard GSHUT permit gshut</strong></td>
</tr>
<tr>
<td></td>
<td>Configures a community list and permits or denies routes that have the GSHUT community to the community list.</td>
</tr>
<tr>
<td></td>
<td>• If you specify other communities in the same statement, there is a logical AND operation and all communities in the statement must match the communities for the route in order for the statement to be processed.</td>
</tr>
</tbody>
</table>

| **Step 12** | **router bgp** autonomous-system-number |
| **Example:** | **Device(config)# router bgp 2000** |
| | Configures a BGP routing process. |

| **Step 13** | **neighbor** address route-map map-name in |
| **Example:** | **Device(config)# neighbor 2001:db8:4::1 route-map RM_GSHUT in** |
| | Applies the route map to incoming routes from the specified neighbor. |
| | • In this example, the route map named RM_GSHUT denies routes from the specified neighbor that have the GSHUT community. |

### Configuring BGP GSHUT Enhancement

#### SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. bgp graceful-shutdown all \{neighbors | vrf\} shutdown-time \{community community-value [local-preference local-pref-value] \} activate
5. end
6. show ip bgp
7. show running-config

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>enable</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><strong>Device&gt; enable</strong></td>
</tr>
<tr>
<td></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>configure terminal</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><strong>Enters global configuration mode.</strong></td>
</tr>
</tbody>
</table>
### Command or Action

<table>
<thead>
<tr>
<th>Device# configure terminal</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode to create or configure a BGP routing process.</td>
</tr>
<tr>
<td>Example: Device(config)# router bgp 65000</td>
<td></td>
</tr>
</tbody>
</table>

| Device(config-router)# bgp graceful-shutdown all neighbors 180 local-preference 20 community 10 | Enables the BGP GSHUT enhancement feature on the device. |

| Step 5 bgp graceful-shutdown all {neighbors | vrfs} activate | Activates graceful shutdown across all neighbors or only across VRF neighbors for BGP sessions. |
| Example: Device(config-router)# bgp graceful-shutdown all neighbors activate | |

| Step 6 end | Returns to privileged EXEC mode. |
| Example: Device(config-router)# end | |

| Step 7 show ip bgp | Displays entries in the BGP routing table. |
| Example: Device# show ip bgp neighbors 10.2.2.2 | |

| Step 8 show running-config | Displays running configuration on the device. |
| Example: Device# show running-config |
Configuration Examples for BGP Graceful Shutdown

Example: Shutting Down a BGP Link Gracefully

**Graceful Shutdown While Setting a Local-Preference**

This example gracefully shuts down the link to the specified neighbor in 600 seconds, adds the GSHUT community to the route, and sets a local preference of 500 for the route.

```
router bgp 1000
neighbor 2001:db8:5::1 remote-as 2000
neighbor 2001:db8:5::1 shutdown graceful 600 local-preference 500
neighbor 2001:db8:5::1 send-community
exit
```

**Graceful Shutdown While Setting an Additional Community**

This example gracefully shuts down the link to the specified neighbor in 600 seconds, and adds the GSHUT community and numbered community to the route.

```
router bgp 1000
neighbor 2001:db8:5::1 remote-as 2000
neighbor 2001:db8:5::1 shutdown graceful 600 community 1400
neighbor 2001:db8:5::1 send-community
exit
```

**Graceful Shutdown while Setting an Additional Community and Local-Preference**

This example gracefully shuts down the link to the specified neighbor in 600 seconds, adds the GSHUT community and the numbered community to the route, and sets a local preference of 500 to the route.

```
router bgp 1000
neighbor 2001:db8:5::1 remote-as 2000
neighbor 2001:db8:5::1 shutdown graceful 600 community 1400 local-preference 500
neighbor 2001:db8:5::1 send-community
exit
```

Example: Filtering BGP Routes Based on the GSHUT Community

In additional to being able to gracefully shut down a BGP route, another use of the GSHUT community is to configure a community list to filter routes with this community from getting into the BGP routing table.
This example illustrates how to use a community list to filter incoming BGP routes based on the GSHUT community. In this example, a route map named RM_GSHUT denies routes based on a standard community list named GSHUT. The community list contains routes with the GSHUT community. The route map is then applied to incoming routes from the neighbor at 2001:db8:4::1.

```plaintext
router bgp 2000
neighbor 2001:db8:4::1 remote-as 1000
neighbor 2001:db8:4::1 activate
neighbor 2001:db8:4::1 send-community
exit
route-map RM_GSHUT deny 10
match community GSHUT
exit
ip community-list standard GSHUT permit gshut
router bgp 2000
neighbor 2001:db8:4::1 route-map RM_GSHUT in
```

**Example: BGP GSHUT Enhancement**

The following example shows how to enable and activate the BGP GSHUT enhancement feature across all neighbors. In this example, the neighbors are configured to gracefully shutdown within the specified duration of 180 seconds.

```plaintext
Device> enable
Device# configure terminal
Device(config)# router bgp 65000
Device(config-router)# bgp graceful-shutdown all neighbors 180 local-preference 20 community 10
Device(config-router)# bgp graceful-shutdown all neighbors activate
Device(config-router)# end
```

Following is sample output from the `show ip bgp` command, which displays the graceful shutdown time for each neighbor. In this example, there are two IPv4 neighbors configured with IP address 10.2.2.2 and 172.16.2.1 and one VRF neighbor, tagged v1, is configured with IP address 192.168.1.1.

```plaintext
Device# show ip bgp neighbors 10.2.2.2 | include shutdown
Graceful Shutdown Timer running, schedule to reset the peer in 00:02:47 seconds
Graceful Shutdown Localpref set to 20
Graceful Shutdown Community set to 10

Device# show ip bgp neighbors 172.16.2.1 | include shutdown
Graceful Shutdown Timer running, schedule to reset the peer in 00:02:38 seconds
Graceful Shutdown Localpref set to 20
Graceful Shutdown Community set to 10

Device# show ip bgp vpnv4 vrf v1 neighbors 192.168.1.1 | include shutdown
Graceful Shutdown Timer running, schedule to reset the peer in 00:01:45 seconds
Graceful Shutdown Localpref set to 20
Graceful Shutdown Community set to 10
```

Following is sample output from the `show running-config` command, which displays information associated with the BGP session in router configuration mode:
Device# show running-config | session router bgp

router bgp 65000
bgp log-neighbor-changes
bgp graceful-shutdown all neighbors 180 local-preference 20 community 10
network 10.1.1.0 mask 255.255.255.0
neighbor 10.2.2.2 remote-as 40
neighbor 10.2.2.2 shutdown
neighbor 172.16.2.1 remote-as 10
neighbor 172.16.2.1 shutdown
!
address-family vpnv4
neighbor 172.16.2.1 activate
neighbor 172.16.2.1 send-community both
exit-address-family
!
address-family ipv4 vrf v1
neighbor 192.168.1.1 remote-as 30
neighbor 192.168.1.1 shutdown
neighbor 192.168.1.1 activate
neighbor 192.168.1.1 send-community both
exit-address-family

Additional References

Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Commands List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
</tbody>
</table>

Standards and RFCs

<table>
<thead>
<tr>
<th>Standard/RFC</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFC 6198</td>
<td>Requirements for the Graceful Shutdown of BGP Sessions</td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
<tr>
<td>download documentation, software, and tools. Use these resources to</td>
<td></td>
</tr>
<tr>
<td>install and configure the software and to troubleshoot and resolve</td>
<td></td>
</tr>
<tr>
<td>technical issues with Cisco products and technologies. Access to</td>
<td></td>
</tr>
<tr>
<td>most tools on the Cisco Support and Documentation website requires a</td>
<td></td>
</tr>
<tr>
<td>Cisco.com user ID and password.</td>
<td></td>
</tr>
</tbody>
</table>
Feature Information for BGP Graceful Shutdown

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 80: Feature Information for BGP Graceful Shutdown

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP Graceful Shutdown</td>
<td>Cisco IOS XE Release 3.6S</td>
<td>The BGP Graceful Shutdown (GSHUT) Enhancement feature enables graceful shutdown of either all neighbors or only virtual routing and forwarding (VRF) neighbors across BGP sessions.</td>
</tr>
<tr>
<td></td>
<td>Cisco IOS XE Release 3.7S</td>
<td>The following commands were modified: ip community-list, neighbor shutdown, show ip bgp community, and show ip bgp vpnv4.</td>
</tr>
<tr>
<td>BGP GSHUT Enhancement</td>
<td>Cisco IOS XE Release 3.11S</td>
<td>The BGP Graceful Shutdown (GSHUT) Enhancement feature enables graceful shutdown of either all neighbors or only virtual routing and forwarding (VRF) neighbors across BGP sessions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The following command was introduced: bgp graceful-shutdown all.</td>
</tr>
</tbody>
</table>
CHAPTER 62

BGP — mVPN BGP sAFI 129 - IPv4

The BGP—mVPN BGP sAFI 129 IPv4 feature provides the capability to support multicast routing in the service provider’s core IPv4 network. This feature is needed to support BGP-based MVPNs. BGP MVPN provides a means for service providers to use different encapsulation methods (generic routing encapsulation [GRE], Multicast Label Distribution Protocol [MPDP], and ingress replication) for forwarding MVPN multicast data traffic in the service provider network.

- Finding Feature Information, on page 933
- Information About BGP--mVPN BGP sAFI 129 - IPv4, on page 933
- How to Configure BGP -- mVPN BGP sAFI 129 - IPv4, on page 934
- Configuration Examples for BGP--mVPN BGPsAFI 129 - IPv4, on page 937
- Additional References, on page 940
- Feature Information for BGP - mVPN BGP sAFI 129 - IPv4, on page 941

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About BGP--mVPN BGP sAFI 129 - IPv4

BGP — mVPN BGP sAFI 129 - IPv4 Overview

The Cisco BGP Address Family Identifier (AFI) model was introduced with multiprotocol BGP and is designed to be modular and scalable and to support multiple AFI and Subsequent Address Family Identifier (SAFI) configurations. SAFI provides additional information about the type of Network Layer Reachability Information (NLRI) that is used to describe a route and how to connect to a destination.

SAFI 129 provides the capability to support multicast routing in the service provider’s core IPv4 network. This feature is needed to support BGP-based MVPNs. The addition of SAFI 129 allows multicast to select an upstream multicast hop that may be independent of the unicast topology. Multicast routes learned from
the customer edge (CE) router or multicast VPN routes learned from remote provider edge (PE) routers are installed into the multicast Routing Information Base (RIB), whereas previously unicast routes in the unicast RIB were replicated into the multicast RIB.

The `address-family ipv4` command has been updated to support IP version 4 (IPv4) multicast address prefixes for a VPN routing and forwarding (VRF) instance, and the `address-family vpnv4` command has been updated to support VPN version 4 (VPNV4) multicast address prefixes.

### How to Configure BGP -- mVPN BGP sAFI 129 - IPv4

#### Configure BGP — mVPN BGP sAFI 129 - IPv4

#### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `vrf definition vrf1`
4. `rd route-distinguisher`
5. `route-target export route-target-ext-community`
6. `route-target import route-target-ext-community`
7. `address-family ipv4`
8. `mdt default group-address`
9. `exit`
10. `router bgp autonomous-system-number`
11. `address-family vpnv4 multicast`
12. `neighbor peer-group-name send-community extended`
13. `neighbor peer-group-name route-reflector-client`
14. `exit-address-family`
15. `address-family ipv4 vrf vrf-name`
16. `no synchronization`
17. `exit-address-family`
18. `address-family ipv4 multicast vrf vrf-name`
19. `no synchronization`
20. `exit-address-family`
21. `end`
22. `show running-config | b router bgp`

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td><code>Example:</code></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td></td>
<td><code>Device&gt; enable</code></td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong> Device# configure terminal</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> vrf definition vrf1</td>
<td>Defines a VRF instance and enters VRF configuration mode.</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# vrf definition vrf1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> rd route-distinguisher</td>
<td>Specifies a route distinguisher (RD) for a VRF instance.</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-vrf)# rd 1:1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> route-target export route-target-ext-community</td>
<td>Creates a route target export extended community for a VRF instance.</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-vrf)# route-target export 1:1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> route-target import route-target-ext-community</td>
<td>Creates a route target import extended community for a VRF instance.</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-vrf)# route-target import 1:1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong> address-family ipv4</td>
<td>Configures a routing session using IPv4 address prefixes and enters address family configuration mode.</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router)# address-family ipv4</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong> mdt default group-address</td>
<td>Configures a default multicast distribution tree (MDT) group for a VRF instance.</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-vrf)# mdt default 239.0.0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 9</strong> exit</td>
<td>Exits VRF configuration mode and returns to global configuration mode.</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-vrf)# exit</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 10</strong> router bgp autonomous-system-number</td>
<td>Configures the BGP routing process and enters router configuration mode.</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# router bgp 50000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Step 11 | address-family  vpnv4 multicast  
Example:  
Device(config-router)# address-family vpnv4 multicast  
| Purpose:  
Configures a routing session using VPN Version 4 multicast address prefixes and enters address family configuration mode.  
| Step 12 | neighbor peer-group-name  send-community extended  
Example:  
Device(config-router-af)# neighbor client1 send-community extended  
| Specifies that a communities attribute should be sent to a BGP neighbor.  
| Step 13 | neighbor peer-group-name  route-reflector-client  
Example:  
Device(config-router-af)# neighbor client1 route-reflector-client  
| (Optional) Configures the router as a BGP route reflector and configures the specified neighbor as its client.  
| Step 14 | exit-address-family  
Example:  
Device(config-router-af)# exit-address-family  
| Exits address family configuration mode and enters router configuration mode.  
| Step 15 | address-family  ipv4 vrf  vrf-name  
Example:  
Device(config-router)# address-family ipv4 vrf1  
| Places the router in address family configuration mode and specifies the name of the VRF instance to associate with subsequent IPv4 address family configuration mode commands.  
| Step 16 | no synchronization  
Example:  
Device(config-router-af)# no synchronization  
| Enables the Cisco software to advertise a network route without waiting for the Interior Gateway Protocol (IGP) system.  
| Step 17 | exit-address-family  
Example:  
Device(config-router-af)# exit-address-family  
| Exits address family configuration mode and enters router configuration mode.  
| Step 18 | address-family  ipv4 multicast vrf  vrf-name  
Example:  
Device(config-router)# address-family ipv4 multicast vrf1  
| Configures a routing session using IPv4 multicast address prefixes for a VRF instance and enters address family configuration mode.  
| Step 19 | no synchronization  
Example:  
<p>| Enables the Cisco software to advertise a network route without waiting for the IGP system. |</p>
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device(config-router-af)# no synchronization</td>
<td>Exits address family configuration mode and enters router configuration mode.</td>
</tr>
<tr>
<td><strong>Step 20</strong> exit-address-family</td>
<td>Exits router configuration mode and enters router configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router-af)# exit-address-family</td>
<td>Exits router configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Step 21</strong> end</td>
<td>(Optional) Displays the running configuration for specified device.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# end</td>
<td></td>
</tr>
<tr>
<td><strong>Step 22</strong> show running-config</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong> show running-config</td>
<td></td>
</tr>
<tr>
<td><strong>b router bgp</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Configuration Examples for BGP--mVPN BGPsAFI 129 - IPv4**

**Example: Configuring BGP - mVPN BGP sAFI 129 - IPv4**

This example uses the topology illustrated in the figure below.

![Network Topology Diagram](image-url)

The following example configures BGP SAFI 129 on the route reflector (RR):

```cisco
! ip multicast-routing!
!<<<< Define BGP update-source loopback0
!<<<< on RR as 192.0.2.10
interface loopback0
  ip pim sparse-dense-mode
  ip address 192.0.2.10 255.255.255.255!
.
.
.
```
router bgp 65000
  no synchronization
  neighbor 192.0.2.1 remote-as 65000
  neighbor 192.0.2.1 update-source loopback0
  neighbor 192.0.2.2 remote-as 65000
  neighbor 192.0.2.2 update-source loopback0
  neighbor 192.0.2.3 remote-as 65000
  neighbor 192.0.2.3 update-source loopback0

!.
.
address-family vpnv4 unicast
  neighbor 192.0.2.1 activate
  neighbor 192.0.2.1 send-community extended
  neighbor 192.0.2.1 route-reflector-client
  neighbor 192.0.2.2 activate
  neighbor 192.0.2.2 send-community extended
  neighbor 192.0.2.2 route-reflector-client
  neighbor 192.0.2.3 activate
  neighbor 192.0.2.3 send-community extended
  neighbor 192.0.2.3 route-reflector-client
  exit-address-family

!address-family vpnv4 multicast
  !<<< want route from CE1 with nexthop
  !<<< through PE3 in multicast routing table
  neighbor 192.0.2.1 activate
  neighbor 192.0.2.1 send-community extended
  neighbor 192.0.2.1 route-reflector-client
  neighbor 192.0.2.3 activate
  neighbor 192.0.2.3 send-community extended
  neighbor 192.0.2.3 route-reflector-client
  exit-address-family

!.
.

The following example configures BGP SAFI 129 on the PE1 router (PE2 and PE3 will have a similar configuration):

Hostname PE1
!
vrf definition vrf1
  rd 1:1
  route-target export 1:1
  route-target import 1:1
!
  address-family ipv4
    mdt default 239.0.0.1
  exit-address-family
!
ip multicast-routing
ip multicast-routing vrf vrf1
!
.
.
!<<< Define BGP update-source on Loopback0
!<<< on PE1
inteface loopback0
  ip pim sparse-dense-mode
  ip address 192.0.2.1 255.255.255.255
!
!<<< Define vrf vrf1 interface on PE1 to CE1
interface ethernet0/0
  vrf forwarding vrf1
  ip pim sparse-dense-mode
  ip address 192.0.2.1 255.255.255.0
!
!
!
router bgp 65000
!<<< PE peer neighbor with RR
neighbor 192.0.2.10 remote-as 65000
neighbor 192.0.2.10 update-source loopback0
  no synchronization
!
!
address-family vpnv4
  neighbor 192.0.2.10 activate
  neighbor 192.0.2.10 send-community extended
  exit-address-family
!

!<<< Define vpnv4 safi129 with neighbor
!<<< to RR
address-family vpnv4 multicast
  neighbor 192.0.2.10 activate
  neighbor 192.0.2.10 send-community extended
  exit-address-family
!
!

!<<< Define unicast address-family vrf vrf1.
!<<< PE-CE is eBGP in this case.
!<<< If PE-CE is not eBGP, please use
!<<< redistribute cli, instead of
!<<< neighbor cli below.
address-family ipv4 vrf vrf1
  no synchronization
  redistribute connected
  neighbor 192.0.2.5 remote-as 65011
  exit-address-family
!

!<<< Define multicast address-family vrf vrf1
!<<< (safi2. PE-CE is eBGP in this case.
!<<< If PE-CE is not eBGP, please use
!<<< redistribute cli, instead of
!<<< neighbor cli below.
address-family ipv4 multicast vrf vrf1
  no synchronization
  redistribute connected
  neighbor 192.0.2.5 remote-as 65011
  exit-address-family
!

The following example configures BGP SAFI 129 on the CE1 router. (In this case, PE-CE routing is eBGP. CE2 will have a similar configuration):

interface ethernet0/0
ip address 192.0.2.5 255.255.255.0
ip pim sparse-dense-mode
!
.
.
router bgp 65011
bgp router-id 192.0.2.5
bgp log-neighbor-changes
!
address-family ipv4
   redistribute connected
   neighbor 192.0.2.1 remote-as 65000
   exit-address-family
!
address-family ipv4 multicast
   redistribute connected
   neighbor 192.0.2.1 remote-as 65000
   exit-address-family
!

Additional References

Related Documents

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<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
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<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
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</table>

Standards and RFCs

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<th>Standard/RFC</th>
<th>Title</th>
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</thead>
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<tr>
<td>RFC 2547</td>
<td>BGP/MPLS VPNs</td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
</table>
Feature Information for BGP - mVPN BGP sAFI 129 - IPv4

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 81: Feature Information for BGP - mVPN BGP sAFI 129 - IPv4

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
</table>
| BGP - mVPN BGP sAFI 129 - IPv4 | 15.2(2)S  
15.2(4)S  
Cisco IOS XE Release 3.6S | The BGP - mVPN BGP sAFI 129 IPv4 feature provides the capability to support multicast routing in the service provider’s core IPv4 network. This feature is needed to support BGP-based MVPNs. BGP MVPN provides a means for service providers to use different encapsulation methods (generic route encapsulation (GRE), Multicast Label Distribution Protocol (MLDP), and ingress replication) for forwarding VPN multicast data traffic in the service provider network. In Cisco IOS Release 15.2(4)S, support was added for the Cisco 7200 series router.

The following commands were modified: `address-family ipv4, address-family vpnv4`. |
BGP-MVPN SAFI 129 IPv6

Subsequent Address Family Identifier (SAFI) 129, known as VPN Multicast SAIF, provides the capability to support multicast routing in the service provider's core IPv6 network.

Border Gateway Protocol (BGP) Multicast Virtual Private Network (MVPN) provides a means for service providers to use different encapsulation methods (generic routing encapsulation [GRE], Multicast Label Distribution Protocol [MLDP], and ingress replication) for forwarding MVPN multicast data traffic in the service provider network.

The BGP-MVPN SAFI 129 IPv6 feature is required to support BGP-based MVPNs.

- Finding Feature Information, on page 943
- Prerequisites for BGP-MVPN SAFI 129 IPv6, on page 943
- Information About BGP-MVPN SAFI 129 IPv6, on page 944
- How to Configure BGP-MVPN SAFI 129 IPv6, on page 944
- Configuration Examples for BGP-MVPN SAFI 129 IPv6, on page 947
- Additional References, on page 950
- Feature Information for BGP-MVPN SAFI 129 IPv6, on page 950

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

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Prerequisites for BGP-MVPN SAFI 129 IPv6

- Before you configure a SAFI 129 IPv6-related address family, the ipv6 unicast-routing command must be configured on the device.

- To create a multicast IPv6 VRF address family under BGP, IPv6 must first be activated on the VRF itself.
There is no separate multicast configuration on the VRF. Configuring the `address-family ipv6` command on the VRF will enable both unicast and multicast topologies.

- If you want prefixes to be installed into the Routing Information Base (RIB), you must configure the `pim` command on a VRF interface.

## Information About BGP-MVPN SAFI 129 IPv6

### Overview of BGP-MVPN SAFI 129 IPv6

MVPN utilizes the existing VPN infrastructure to allow multicast traffic to pass through the provider space. Information derived from VPN routes is one of the components needed to set up tunnels within the core. Currently, multicast traffic will derive this information from the unicast VPNv6 tables, which forces multicast traffic to be dependent on unicast topologies.

For scenarios in which multicast and unicast traffic would be better suited with separate topologies, the customer edge (CE) router may advertise a special set of routes to be used exclusively for multicast VPNs. Multicast routes learned from the CE router can be propagated to remote provider edge (PE) routers via SAFI 129. Multicast routes learned from the CE router or multicast VPN routes learned from remote PE routers can now be installed directly into the multicast RIB, instead of using replicated routes from the unicast RIB. Maintaining separate routes and entries for unicast and multicast allows you to create differing topologies for each service within the core.

## How to Configure BGP-MVPN SAFI 129 IPv6

### Configuring BGP-MVPN SAFI 129 IPv6

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `vrf definition vrf1`
4. `rd route-distinguisher`
5. `route-target export route-target-ext-community`
6. `route-target import route-target-ext-community`
7. `address-family ipv6`
8. `mdt default group-address`
9. `exit`
10. `exit`
11. `router bgp autonomous-system-number`
12. `address-family vpnv6 multicast`
13. `neighbor peer-group-name send-community extended`
14. `neighbor {ip-address | peer-group-name | ipv6-address %} activate`
15. `address-family ipv6 multicast vrf vrf-name`
16. `end`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><code>enable</code></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device&gt; enable</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><code>configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device# configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Defines a VRF instance and enters VRF configuration mode.</td>
</tr>
<tr>
<td><code>vrf definition vrf1</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config)# vrf definition vrf1</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>Specifies a route distinguisher (RD) for a VRF instance.</td>
</tr>
<tr>
<td><code>rd route-distinguisher</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config-vrf)# rd 1:1</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>Creates a route target export extended community for a VRF instance.</td>
</tr>
<tr>
<td><code>route-target export route-target-ext-community</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config-vrf)# route-target export 1:1</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>Creates a route target import extended community for a VRF instance.</td>
</tr>
<tr>
<td><code>route-target import route-target-ext-community</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config-vrf)# route-target import 1:1</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>Configures a routing session using IPv6 address prefixes and enters address family configuration mode.</td>
</tr>
<tr>
<td><code>address-family ipv6</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config-vrf)# address-family ipv6</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td>Configures a default multicast distribution tree (MDT) group for a VRF instance.</td>
</tr>
<tr>
<td><code>mdt default group-address</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config-vrf-af)# mdt default 239.0.0.1</code></td>
<td></td>
</tr>
<tr>
<td>Step</td>
<td>Command or Action</td>
</tr>
<tr>
<td>-------</td>
<td>--------------------------------------------------------</td>
</tr>
<tr>
<td>9</td>
<td>exit</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td>10</td>
<td>exit</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td>11</td>
<td>router bgp autonomous-system-number</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td>12</td>
<td>address-family vpnv6 multicast</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td>13</td>
<td>neighbor peer-group-name send-community extended</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td>14</td>
<td>neighbor {ip-address</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td>15</td>
<td>address-family ipv6 multicast vrf vrf-name</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td>16</td>
<td>end</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
</tbody>
</table>
Configuration Examples for BGP-MVPN SAFI 129 IPv6

Example: Configuring BGP-MVPN SAFI 129 IPv6

The example below shows the configuration for a PE router:

```
hostname PE1
!
!
vrf definition blue
dr 55:1111
route-target export 55:1111
route-target import 55:1111
!
address-family ipv6
 mdt default 232.1.1.1
 mdt data 232.1.200.0 0.0.0.0
exit-address-family
!
!ip multicast-routing
ip multicast-routing vrf blue
ip cef
!
ipv6 unicast-routing
ipv6 multicast-routing
ipv6 multicast-routing vrf blue
ipv6 cef
!
!interface Loopback0
ip address 205.1.0.1 255.255.255.255
ip pim sparse-dense-mode
ipv6 address FE80::205:1:1 link-local
ipv6 address 205::1:1:1/64
ipv6 enable
!
interface Ethernet0/0
! interface connect to the core vpn
bandwidth 1000
ip address 30.3.0.1 255.255.255.0
ip pim sparse-dense-mode
delay 100
ipv6 address FE80::70:1:1 link-local
ipv6 address 70::1:1:1/64
ipv6 enable
mpls ip
!
interface Ethernet1/1
! interface connect to CE (vrf interface)
bandwidth 1000
vrf forwarding blue
ip address 10.1.0.1 255.255.255.0
ip pim sparse-dense-mode
delay 100
ipv6 address FE80::20:1:1 link-local
ipv6 address 20::1:1:1/64
ipv6 enable
!
router ospf 200
```
redistribute connected subnets
redistribute bgp 55 metric 10
passive-interface Loopback0
network 30.3.0.0 0.0.255.255 area 1
! router bgp 55
bgp log-neighbor-changes
no bgp default route-target filter
! neighbor to another PE in core
neighbor 205.3.0.3 remote-as 55
neighbor 205.3.0.3 update-source Loopback0
! address-family ipv4 mdt
! neighbor to another PE in core
neighbor 205.3.0.3 activate
neighbor 205.3.0.3 send-community extended
exit-address-family
! address-family vpv6
! neighbor to another PE in core
neighbor 205.3.0.3 activate
neighbor 205.3.0.3 send-community extended
exit-address-family
! address-family vpv6 multicast
! neighbor to another PE in core
! this address-family is added to enable
! safi129 between two PEs
neighbor 205.3.0.3 activate
neighbor 205.3.0.3 send-community extended
exit-address-family
! address-family ipv6 vrf blue
! neighbor to CE1 in vrf
redistribute connected
redistribute static
neighbor FE80::20:1:6%Ethernet1/1 remote-as 56
neighbor FE80::20:1:6%Ethernet1/1 activate
exit-address-family
! address-family ipv6 multicast vrf blue
! neighbor to CE1 in vrf
! this address-family is added to enable
! safi2 on PE-CE
redistribute connected
redistribute static
neighbor FE80::20:1:6%Ethernet1/1 remote-as 56
neighbor FE80::20:1:6%Ethernet1/1 activate
exit-address-family
! ipv6 pim vrf blue rp-address 201::1:1:7 blue_bidir_acl bidir
ipv6 pim vrf blue rp-address 202::1:1:6 blue_sparse_acl
! ipv6 access-list black_bidir_acl
  permit ipv6 any FF06::/64
! ipv6 access-list black_sparse_acl
  permit ipv6 any FF04::/64
! ipv6 access-list blue_bidir_acl
  permit ipv6 any FF05::/64
! ipv6 access-list blue_sparse_acl
  permit ipv6 any FF03::/64
The example below shows the configuration for a CE router:

```conf
hostname CE1
!
ip multicast-routing
ip cef
ipv6 unicast-routing
ipv6 multicast-routing
ipv6 multicast rpf use-bgp
ipv6 cef
!
interface Ethernet1/1
  bandwidth 1000
  ip address 10.1.0.6 255.255.255.0
  no ip redirects
  no ip proxy-arp
  ip pim sparse-dense-mode
delay 100
ipv6 address FE80::20:1:6 link-local
ipv6 address 20::1:1:6/64
ipv6 enable
no keepalive
!
router bgp 56
  bgp log-neighbor-changes
  neighbor FE80::20:1:1%Ethernet1/1 remote-as 55
!
address-family ipv6
  redistribute connected
  redistribute static
  neighbor FE80::20:1:1%Ethernet1/1 activate
  exit-address-family
!
address-family ipv6 multicast
  redistribute connected
  redistribute static
  neighbor FE80::20:1:1%Ethernet1/1 activate
  exit-address-family
!
ipv6 pim rp-address 201::1:1:7 blue_bidir_acl bidir
ipv6 pim rp-address 202::1:1:6 blue_sparse_acl
!
ipv6 access-list blue_bidir_acl
  permit ipv6 any FE05::/64
!
ipv6 access-list blue_sparse_acl
  permit ipv6 any FF03::/64
!
end
```
Additional References

Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands: complete command syntax, command modes, command history, defaults, usage guidelines, and examples</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
</tbody>
</table>

Standards and RFCs

<table>
<thead>
<tr>
<th>Standard/RFC</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDT SAFI</td>
<td>Subsequent Address Family Identifiers (SAFI) Parameters</td>
</tr>
<tr>
<td>RFC 2547</td>
<td>BGP/MPLS VPNs</td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

Feature Information for BGP-MVPN SAFI 129 IPv6

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.
### Table 82: Feature Information for BGP—MVPN SAFI 129 IPv6

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP—MVPN SAFI 129 IPv6</td>
<td>15.2(4)S</td>
<td>SAFI 129, known as VPN Multicast SAFI, provides the capability to support multicast routing in the service provider's core IPv6 network. The following commands were introduced or modified: <strong>address-family ipv6</strong>, <strong>address-family vpnv6</strong>, and <strong>show bgp vpnv6 multicast</strong>.</td>
</tr>
<tr>
<td></td>
<td>Cisco IOS XE Release 3.7S</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15.3(1)T</td>
<td></td>
</tr>
</tbody>
</table>
Feature Information for BGP-MVPN SAFI 129 IPv6
CHAPTER 64

BFD—BGP Multihop Client Support, cBit (IPv4 and IPv6), and Strict Mode

The BFD—BGP Multihop Client Support feature enables Border Gateway Protocol (BGP) to use multihop Bidirectional Forwarding Detection (BFD) support, which improves BGP convergence as BFD detection and failure times are faster than the Interior Gateway Protocol (IGP) convergence times in most network topologies.

The BFD—BGP cBit feature allows BGP to determine if BFD failure is dependent or independent of the Control Plane. This allows BGP greater flexibility in handling BFD down events.

- Finding Feature Information, on page 953
- Restrictions for BFD—BGP Multihop Client Support, cBit (IPv4 and IPv6), and Strict Mode, on page 954
- Information About BFD—BGP Multihop Client Support, cBit (IPv4 and IPv6), and Strict Mode, on page 954
- How to Configure BFD—BGP Multihop Client Support, cBit (IPv4 and IPv6), and Strict Mode, on page 955
- Configuration Examples for BFD—BGP Multihop Client Support, cBit (IPv4 and IPv6), and Strict Mode, on page 957
- Additional References, on page 959
- Feature Information for BFD—BGP Multihop Client Support, cBit (IPv4/IPv6), and Strict Mode, on page 959

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.
Restrictions for BFD—BGP Multihop Client Support, cBit (IPv4 and IPv6), and Strict Mode

- For BGP IPv4 and BGP IPv6 peering sessions only, multihop BFD support is available for BGP for address-family IPv4 and IPv6 unicast.
- For multihop BGP sessions using IPv6 Link Local addresses, BFD multihop support is not available.
- Currently BFD Hardware offload is not supported for multihop BFD sessions and so C-bit will not be set for multihop sessions.
- Multihop BFD for IPv6 Virtual Routing and Forwarding (VRF) is not supported.
- BGP session attribute for BFD does not change dynamically when BGP session changes from single-hop to multihop, hence you need to clear the existing BGP session to reinitiate multihop BFD session.

Information About BFD - BGP Multihop Client Support, cBit (IPv4 and IPv6), and Strict Mode

BFD—BGP Multihop Client Support, cBit (IPv4 and IPv6), and Strict Mode

BFD is a detection protocol that is designed to provide fast forwarding path failure detection times for all media types, encapsulations, topologies, and routing protocols. In addition to fast forwarding path failure detection, BFD provides a consistent failure detection method for network administrators. Because the network administrator can use BFD to detect forwarding path failures at a uniform rate, rather than the variable rates for different routing protocol hello mechanisms, network profiling and planning is easier, and reconvergence time is consistent and predictable. The main benefit of implementing BFD for BGP is a significantly faster reconvergence time. For internal BGP (iBGP) sessions and external BGP (eBGP) sessions that are either single hop or multihop, BGP can use the multihop BFD support to help improve the BGP convergence because BFD detection and failure times are faster than the IGP convergence times in most of the network topologies. BGP needs the support of multihop BFD as described in RFC5882, Generic Application of Bidirectional Forwarding Detection (BFD).

BGP by default will purge the routes received from a specific peer when a BFD down event occurs and BFD informs BGP about it. The cBit in BFD determines whether BFD is dependent or independent of the Control Plane. Clients like BGP, whose peers are enabled with fast fall over feature with BFD support, can use this BFD cBit support to provide a more deterministic mechanism to do nonstop forwarding (NSF) when BGP graceful restart is enabled along with BFD fast-fallover support for BGP sessions.

When BGP is using BFD for the fast fallover feature for remote connectivity detection, BFD can detect some of those failures. If BFD is independent of the control plane, a BFD session failure means that data cannot be forwarded anymore (due to link control failures) and so the BGP graceful restart procedures should be aborted to avoid traffic black holes. On the other hand, when BFD is dependent on the control plane, a BFD failure cannot be separated out from the other events taking place in the control plane. When the control plane crashes, a switchover happens and BFD restarts. It is best for the clients (like BGP) to avoid any aborts due to the graceful restart taking place.
The table below describes the handling of BFD down events by BGP.

### Table 83: BGP handling of BFD Down Event

<table>
<thead>
<tr>
<th>BFD Down Event</th>
<th>Failure—Control Plane Independent?</th>
<th>BGP Action for NSF (when GR and BFD are enabled)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP control plane detection failure enabled</td>
<td>Yes</td>
<td>Purge Routes</td>
</tr>
<tr>
<td>BGP control plane detection failure enabled</td>
<td>No</td>
<td>Carry on NSF and keep stale routes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>in Routing Information Base (RIB)</td>
</tr>
<tr>
<td>BGP control plane detection failure disabled (the default behavior)</td>
<td>Yes</td>
<td>Purge Routes</td>
</tr>
<tr>
<td>BGP control plane detection failure disabled (the default behavior)</td>
<td>No</td>
<td>Purge Routes</td>
</tr>
</tbody>
</table>

BGP session establishment works independently from BFD state change, except for fast fall-over detection, that is, inaccessible next-hop and cause best path re-calculation. This means that the BGP session could be established while BFD state is down or dampened, even with neighbor fail-over bfd configured.

From the XE 3.17S release the new optional keyword strict-mode is introduced, which does not allow BGP session to become established, if BFD is in down state. When BFD is dampened or down the routing protocol states or sessions cannot come up.

### How to Configure BFD - BGP Multihop Client Support, cBit (IPv4 and IPv6), and Strict Mode

#### Configuring BFD—BGP Multihop Client Support, cBit (IPv4 and IPv6), and Strict Mode

**Before you begin**

**Note**
The multihop BFD minimum detection time should be higher than IGP convergence times in your network to ensure that down events are not mistakenly identified during reconvergences, causing multihop BGP sessions to flap.

**Note**
For the BFD strict mode to work, configure BFD on both the neighboring devices.
SUMMARY STEPS

1. enable
2. configure
terminal
3. router
terminal
bgp
autonomous-system-number
4. neighbor
ip-address
remote-as
autonomous-system-number
5. neighbor
ip-address
update-source
interface-type
interface-number
6. neighbor
ip-address
remote-as
autonomous-system-number
7. neighbor
ip-address
ebgp-multihop
ttl
8. neighbor
ip-address
fall-over
bfd
multi-hop
check-control-plane-failure
strict-mode
9. end

DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
</tbody>
</table>
| Step 2 | configure
terminal | Enters global configuration mode. |
| Example: | Device# configure terminal | |
| Step 3 | router
bgp
autonomous-system-number | Configures the Border Gateway Protocol (BGP) routing process and enters router configuration mode. |
| Example: | Device(config)# router bgp 50000 | |
| Step 4 | neighbor
ip-address
remote-as
autonomous-system-number | Adds an entry to the BGP or multiprotocol BGP neighbor table. |
| Example: | Device(config-router)# neighbor 10.0.0.2 remote-as 100 | |
| Step 5 | neighbor
ip-address
update-source
interface-type
interface-number | Allows BGP sessions to use any operational interface for TCP connections. |
| Example: | Device(config-router)# neighbor 10.0.0.2 update-source GigabitEthernet 0/0/0 | |
| Step 6 | neighbor
ip-address
remote-as
autonomous-system-number | Adds an entry to the BGP or multiprotocol BGP neighbor table. |
<p>| Example: | | |</p>
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device(config-router)# neighbor 10.0.0.2 remote-as 100</td>
<td>Accepts and attempts BGP connections to external peers residing on networks that are not directly connected.</td>
</tr>
<tr>
<td><strong>Step 7</strong> neighbor ip-address ebgp-multihop ttl</td>
<td>Enables BGP to monitor the peering session of a specified neighbor for adjacency changes and to deactivate the peering session.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router)# neighbor 10.0.0.2 ebgp-multihop 4</td>
<td>• Enables BGP to monitor the peering session of a specified neighbor for adjacency changes and to deactivate the peering session.</td>
</tr>
<tr>
<td><strong>Step 8</strong> neighbor ip-address fall-over bfd [multi-hop] [check-control-plane-failure] [ strict-mode]</td>
<td>Configures BGP BFD with control plane independence enabled for BFD cBit support.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router)# neighbor 10.0.0.2 fall-over bfd multi-hop check-control-plane-failure strict-mode</td>
<td>• Configures BGP BFD with control plane independence enabled for BFD cBit support.</td>
</tr>
<tr>
<td><strong>Step 9</strong> end</td>
<td>Exits router configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router)# end</td>
<td></td>
</tr>
</tbody>
</table>

### Configuration Examples for BFD - BGP Multihop Client Support, cBit (IPv4 and IPv6), and Strict Mode

**Example: Configuring BFD—BGP Multihop Client Support, cBit (IPv4/IPv6), and Strict Mode**

```
R1 e0/0 ---------------e0/0 R2

Router 1 configuration
hostname R1
! bfd map ipv4 2.2.2.2/32 1.1.1.1/32 mh1
! bfd-template multi-hop mh1
interval min-tx 50 min-rx 50 multiplier 3
! interface Loopback1
ip address 1.1.1.1 255.255.255.255
ip ospf 1 area 0
! interface Ethernet0/0
ip address 10.0.0.1 255.255.255.0
ip ospf 1 area 0
! 
```
router ospf 1
!
router bgp 1
neighbor 2.2.2.2 remote-as 1
neighbor 2.2.2.2 update-source Loopback1
neighbor 2.2.2.2 fall-over bfd multi-hop check-control-plane-failure strict-mode
!
address-family ipv4
neighbor 2.2.2.2 activate
exit-address-family
!
Router 2 configuration:

hostname R2
!
bfd map ipv4 1.1.1.1/32 2.2.2.2/32 mh1
bfd-template multi-hop mh1
interval min-tx 50 min-rx 50 multiplier 3
!
interface Loopback1
ip address 2.2.2.2 255.255.255.255
ip ospf 1 area 0
!
interface Ethernet0/0
ip address 10.0.0.2 255.255.255.0
ip ospf 1 area 0
!
router ospf 1
!
router bgp 1
neighbor 1.1.1.1 remote-as 1
neighbor 1.1.1.1 update-source Loopback1
neighbor 1.1.1.1 fall-over bfd multi-hop check-control-plane-failure strict-mode
!
address-family ipv4
neighbor 1.1.1.1 activate
exit-address-family
!

Verifying BFD—BGP Multihop Client Support, cBit (IPv4 and IPv6), and Strict Mode

The following examples show how to verify if BFD is enabled on the neighbor, peer-group.

R801-ASBR#sh ip bgp neighbor 11.1.0.2
BGP neighbor is 11.1.0.2, remote AS 65000, external link
Fall over configured for session
BFD is configured. BFD peer is Up. Using BFD to detect fast fallover (single-hop) in strict-mode.
BGP version 4, remote router ID 10.10.10.10
BGP state = Established, up for 00:04:12
Last read 00:00:49, last write 00:00:24, hold time is 180, keepalive interval is 60 seconds
...

If BFD is up and running, the following is displayed:
Fall over configured for session
BFD is configured. BFD peer is Up. Using BFD to detect fast failover (single-hop) in strict-mode (will be verified).

If BFD is not up and running, the following is displayed:

Fall over configured for session
BFD is configured. BFD peer is Down. Using BFD to detect fast failover (single-hop) in strict-mode.

Additional References

Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

Feature Information for BFD—BGP Multihop Client Support, cBit (IPv4/IPv6), and Strict Mode

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.
### Feature Information for BFD—BGP Multihop Client Support, cBit (IPv4/IPv6), and Strict Mode

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BFD—BGP Multihop Client Support and cBit (IPv4/IPv6)</td>
<td>15.2(4)S, Cisco IOS XE Release 3.6S, Cisco IOS XE Release 3.7S</td>
<td>The BFD—BGP Multihop Client Support feature enables Border Gateway Protocol (BGP) to use multihop Bidirectional Forwarding Detection (BFD) support, which improves BGP convergence as BFD detection and failure times are faster than the Interior Gateway Protocol (IGP) convergence times in most of network topologies. The BFD—BGP cBit feature allows BGP to determine if BFD failure is dependent or independent of the Control Plane. This allows BGP greater flexibility in handling BFD down events. In Cisco IOS XE Release 3.7S, support was added for the Cisco ASR 903 router. The following commands were modified: <code>neighbor fall-over</code> and <code>show ip bgp neighbors</code>.</td>
</tr>
<tr>
<td>BFD—BGP Multihop Client Support, cBit (IPv4/IPv6), and Strict Mode</td>
<td>Cisco IOS XE Release 3.17S</td>
<td>In Cisco IOS XE Release 3.17S, the following command was modified: `neighbor ip-address fall-over bfd [multi-hop</td>
</tr>
</tbody>
</table>
CHAPTER 65

BGP Attribute Filter and Enhanced Attribute Error Handling

The BGP Attribute Filter feature allows you to “treat-as-withdraw” updates that contain specific path attributes. The prefixes contained in the update are removed from the routing table. The feature also allows you to remove specific path attributes from incoming updates. Both behaviors provide an increased measure of security. The BGP Enhanced Attribute Error Handling feature prevents peer sessions from flapping due to errors from any malformed update, thereby saving resources.

- Finding Feature Information, on page 961
- Information About BGP Attribute Filtering, on page 961
- How to Filter BGP Path Attributes, on page 963
- Configuration Examples for BGP Attribute Filter, on page 966
- Additional References, on page 967
- Feature Information for BGP Attribute Filter and Enhanced Attribute Error Handling, on page 967

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

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Information About BGP Attribute Filtering

BGP Attribute Filter and Enhanced Attribute Error Handling

The BGP Attribute Filter feature provides two ways to achieve an increased measure of security:

- The feature allows you to treat-as-withdraw an Update coming from a specified neighbor if the Update contains a specified attribute type. When an Update is treat-as-withdraw, the prefixes in the Update are removed from the BGP routing table (if they existed in the routing table).
The feature also allows you to drop specified path attributes from an Update, and then the system processes the rest of the Update as usual.

The BGP Enhanced Attribute Error Handling feature prevents peer sessions from flapping due to a malformed Update. The malformed Update is treat-as-withdraw and does not cause the BGP session to be reset. This feature is enabled by default, but can be disabled.

The features are implemented in the following order:

1. Received Updates that contain user-specified path attributes are treat-as-withdraw (as long as the NLRI can be parsed successfully). If there is an existing prefix in the BGP routing table, it will be removed. The `neighbor path-attribute treat-as-withdraw` command configures this feature.

2. User-specified path attributes are discarded from received Updates, and the rest of the Update is processed normally. The `neighbor path-attribute discard` command configures this feature.

3. Received Updates that are malformed are treat-as-withdraw. This feature is enabled by default; it can be disabled by configuring the `no bgp enhanced-error` command.

**Details About Specifying Attributes as Treat-as-Withdraw**

Attribute types 1, 2, 3, 4, 8, 14, 15, and 16 cannot be configured for path attribute treat-as-withdraw.

Attribute type 5 (localpref), type 9 (Originator,) and type 10 (Cluster-id) can be configured for treat-as-withdraw for eBGP neighbors only.

Configuring path attributes to be treated as withdrawn will trigger an inbound Route Refresh to ensure that the routing table is up to date.

**Details About Specifying Attributes as Discard**

Attribute types 1, 2, 3, 4, 8, 14, 15, and 16 cannot be configured for path attribute discard.

Attribute type 5 (localpref), type 9 (Originator), and type 10 (Cluster-id) can be configured for discard for eBGP neighbors only.

Configuring path attributes to be discarded will trigger an inbound Route Refresh to ensure that the routing table is up to date.

**Details About Enhanced Attribute Error Handling**

If a malformed Update is received, it is treat-as-withdraw to prevent peer sessions from flapping due to the processing of BGP path attributes. This feature applies to eBGP and iBGP peers. This feature is enabled by default; it can be disabled.

If the BGP Enhanced Attribute Error Handling feature is enabled or disabled, BGP places the MP_REACH attribute (attribute 14) at the beginning of an attribute list while formatting an update. Enhanced attribute error handling functions more easily when the MP_REACH attribute is at the beginning of the attribute list.
# How to Filter BGP Path Attributes

## Treat-as-Withdraw BGP Updates Containing a Specified Path Attribute

Performing this task will trigger an inbound Route Refresh to ensure that the routing table is up to date.

### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `router bgp as-number`
4. `neighbor {ip-address | ipv6-address} path-attribute treat-as-withdraw {attribute-value | range start-value end-value} in`
5. Repeat Step 4 to configure other attributes not in a range or to configure a different neighbor.
6. `end`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device&gt; enable</td>
<td>* Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp as-number</td>
<td>Configures a BGP routing process and enters router configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# router bgp 65000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> neighbor {ip-address</td>
<td>ipv6-address} path-attribute treat-as-withdraw {attribute-value</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router)# neighbor 2001:DB8:1::1 path-attribute treat-as-withdraw 100 in</td>
<td>* Any prefixes in an Update that is treat-as-withdraw are removed from the BGP routing table.</td>
</tr>
<tr>
<td></td>
<td>* The specific attribute value and the range of attribute values are independent of each other.</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Step 5</td>
<td>Repeat Step 4 to configure other attributes not in a range or to configure a different neighbor.</td>
</tr>
<tr>
<td>Step 6</td>
<td>end</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-router)# end</td>
</tr>
</tbody>
</table>

## Discarding Specific Path Attributes from an Update Message

**Note**
Performing this task will trigger an inbound Route Refresh to ensure that the routing table is up to date.

### SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router bgp** *as-number*
4. **neighbor** *(ip-address | ipv6-address)* **path-attribute discard** *(attribute-value | range start-value end-value)* **in**
5. Repeat Step 4 to configure other attributes not in a range or to configure a different neighbor.
6. **end**

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td><strong>enable</strong></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Device&gt; enable</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td><strong>configure terminal</strong></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Device# configure terminal</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td><strong>router bgp</strong> <em>as-number</em></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config)# router bgp 6500</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td><strong>neighbor</strong> *(ip-address</td>
</tr>
</tbody>
</table>
**Displaying Withdrawn or Discarded Path Attributes**

Perform any of these steps in any order to display information about treat-as-withdraw, discarded, or unknown path attributes. You can use the `show ip bgp` command with any address family that BGP supports, such as `show ip bgp ipv4 multicast`, `show ip bgp ipv6 unicast`, etc.

**SUMMARY STEPS**

1. `enable`
2. `show ip bgp neighbor [ip-address | ipv6-address]`
3. `show ip bgp path-attribute unknown`
4. `show ip bgp path-attribute discard`
5. `show ip bgp vpnv4 all prefix`
6. `show ip bgp neighbors prefix`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** enable | Enables privileged EXEC mode.  
  Example:  
  Device> enable |
| **Step 2** show ip bgp neighbor [ip-address | ipv6-address] | (Optional) Displays the configured discard and treat-as-withdraw attribute values for the neighbor, counts of Updates with such attributes discarded or treat-as-withdraw, and the count of malformed treat-as-withdraw Updates.  
  Example:  
  Device# show ip bgp neighbor 2001:DB8:1::1 |
| **Step 3** show ip bgp path-attribute unknown | (Optional) Displays all prefixes that have an unknown attribute.  
  Example:  
  Device# show ip bgp path-attribute unknown |
### Configuration Examples for BGP Attribute Filter

#### Examples: Withdraw Updates Based on Path Attribute

The following example shows how to configure the device to treat-as-withdraw any Update messages from the specified neighbor that contain the unwanted path attribute 100 or 128:

```plaintext
router bgp 65600
neighbor 2001:DB8:1::2 path-attribute treat-as-withdraw 100 in
neighbor 2001:DB8:1::2 path-attribute treat-as-withdraw 128 in
```

The following example shows how to configure the device to treat-as-withdraw any Update messages from the specified neighbor that contain the unwanted path attributes in the range from 21 to 255:

```plaintext
router bgp 65600
neighbor 2001:DB8:1::2 path-attribute treat-as-withdraw 21 255 in
```

#### Examples: Discard Path Attributes from Updates

The following example shows how to configure the device to discard path attributes 100 and 128 from incoming Update messages from the specified neighbor. The rest of the Update message will be processed as usual.

```plaintext
router bgp 65600
neighbor 2001:DB8:1::1 path-attribute discard 100 in
neighbor 2001:DB8:1::1 path-attribute discard 128 in
```
The following example shows how to configure the device to discard path attributes in the range from 17 to 255 from incoming Update messages from the specified neighbor. The rest of the Update message will be processed as usual.

```
router bgp 65600
neighbor 2001:DB8:1::1 path-attribute discard 17 255 in
```

### Additional References

#### Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Commands List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
</tbody>
</table>

#### Standards and RFCs

<table>
<thead>
<tr>
<th>Standard/RFC</th>
<th>Title</th>
</tr>
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<tbody>
<tr>
<td>draft-ietf-idr-error-handling</td>
<td>Revised Error Handling for BGP Updates from External Neighbors</td>
</tr>
</tbody>
</table>

#### Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

### Feature Information for BGP Attribute Filter and Enhanced Attribute Error Handling

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to [www.cisco.com/go/cfn](http://www.cisco.com/go/cfn). An account on Cisco.com is not required.
Table 85: Feature Information for BGP Attribute Filter and Enhanced Attribute Error Handling

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP Attribute Filter and Enhanced Attribute Error Handling</td>
<td>Cisco IOS XE Release 3.7S</td>
<td>The BGP Attribute Filter allows you to “treat-as-withdraw” updates that contain specific path attributes. The prefixes contained in the update are removed from the routing table. The feature also allows you to remove specific path attributes from incoming updates. Both behaviors provide an increased measure of security. The BGP Enhanced Attribute Error Handling feature prevents peer sessions from flapping due to errors from any malformed update, thereby saving resources. The following commands were introduced: <code>bgp enhanced-error</code>, <code>neighbor path-attribute discard</code>, <code>neighbor path-attribute treat-as-withdraw</code>, <code>show ip bgp path-attribute discard</code>, and <code>show ip bgp path-attribute unknown</code>. The following commands were modified: <code>show ip bgp</code>, <code>show ip bgp neighbor</code>, and <code>show ip bgp vpnv4 all</code>.</td>
</tr>
</tbody>
</table>
BGP Additional Paths

The BGP Additional Paths feature allows the advertisement of multiple paths through the same peering session for the same prefix without the new paths implicitly replacing any previous paths. This behavior promotes path diversity and reduces multi-exit discriminator (MED) oscillations.

- Finding Feature Information, on page 969
- Information About BGP Additional Paths, on page 969
- How to Configure BGP Additional Paths, on page 973
- Configuration Examples for BGP Additional Paths, on page 983
- Additional References, on page 985
- Feature Information for BGP Additional Paths, on page 986

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About BGP Additional Paths

Problem That Additional Paths Can Solve

BGP routers and route reflectors (RRs) propagate only their best path over their sessions. The advertisement of a prefix replaces the previous announcement of that prefix (this behavior is known as an implicit withdraw). The implicit withdraw can achieve better scaling, but at the cost of path diversity.

Path hiding can prevent efficient use of BGP multipath, prevent hitless planned maintenance, and can lead to MED oscillations and suboptimal hot-potato routing. Upon nexthop failures, path hiding also inhibits fast and local recovery because the network has to wait for BGP control plane convergence to restore traffic. The BGP Additional Paths feature provides a generic way of offering path diversity; the Best External or Best Internal features offer path diversity only in limited scenarios.
The BGP Additional Paths feature provides a way for multiple paths for the same prefix to be advertised without the new paths implicitly replacing the previous paths. Thus, path diversity is achieved instead of path hiding.

**Path-Hiding Scenario**

This section describes in more detail how path hiding can occur. In the following figure, we have prefix p with paths p1 and p2 advertised from BR1 and BR4 to RR1. RR1 selects the best path of the two and then advertises to PE only p1.

*Figure 84: RR Hiding an Additional Path*

In the figure above, we also see prefix x with path x1 being advertised from BR2 to BR3 (which has path x2) with local preference 100. BR3 also has path x2, but due to routing policy, BR3 will advertise to the RRs x1 (not shown) instead of x2, and x2 will be suppressed. A user could enable the advertisement of best external on BR3 and thereby advertise x2 to the RRs, but, again, the RRs advertise only the best path.

**Suboptimal Hot-Potato Routing Scenario**

In order to minimize internal transport costs, transit ISPs try to forward packets to the closest exit point (according to Interior Gateway Protocol [IGP] cost). This behavior is known as hot-potato routing. In the distributed RR cluster model of the figure below, assume traffic coming from LA must go to Mexico. All links have the same IGP cost. If there are two exit points toward Mexico—one toward Austin and one toward Atlanta—the border router will try to send traffic to Austin based on the lower IGP cost from LA toward Austin than toward Atlanta. In a centralized RR model where the central RR resides where RR3 is (and RR1, RR2, RR4, and RR5 do not exist), the closest exit point toward Mexico, as seen from RR3, might be Atlanta. Sending the traffic from LA toward Atlanta results in suboptimal hot-potato routing, which is not desirable.
DMVPN Scenario

In Dynamic Multipoint Virtual Private Network (DMVPN) deployments, BGP is being used for scaling. In the figure below, Z is connected to both spokes S6 (NY) and S7 (Boston). The S7 links to the hubs have lower IGP costs than the S6 links to the hubs. There are physical links not shown that connect S5 to S6 and S6 to S7, with IGP costs lower than those to the hubs. Spokes S6 and S7 will send an update to both hubs H1 (Chicago) and H2 (Detroit). The RR hubs will then select the best path based on their lower IGP cost, which might be S7. The spoke S5 (Raleigh) will receive two updates from the RRs for Z with S7 being the next hop, even though, in this scenario, it might be preferable to pick S6 (NY) as the next hop.
Benefits of BGP Additional Paths

BGP routers and route reflectors (RR) propagate only their best path over their sessions. The advertisement of a prefix replaces the previous announcement of that prefix (this in known as an implicit withdraw).

While this behavior may achieve better scaling, it can prevent path diversity, which tends to be poor or completely lost. The behavior in turn prevents efficient use of BGP multipath, prevents hitless planned maintenance, and can lead to multi-exit discriminator (MED) oscillations and suboptimal hot-potato routing. It also inhibits fast and local recovery upon next-hop failures, because the network has to wait for BGP control plane convergence to restore traffic.

The BGP Additional Paths feature is a BGP extension that allows the advertisement of multiple paths for the same prefix without the new paths implicitly replacing any previous paths. This behavior promotes path diversity and reduces MED oscillations.

BGP Additional Paths Functionality

The BGP Additional Paths feature is implemented by adding a path identifier to each path in the NLRI. The path identifier (ID) can be considered as something similar to a route distinguisher (RD) in VPNs, except that a path ID can apply to any address family. Path IDs are unique to a peering session and are generated for each network. The path identifier is used to prevent a route announcement from implicitly withdrawing the previous one. The Additional Paths feature allows the advertisement of more paths, in addition to the bestpath. The Additional Paths feature allows the advertisement of multiple paths for the same prefix, without the new paths implicitly replacing any previous paths.

The BGP Additional Paths feature requires the user to take three general steps:

1. Specify whether the device can send, receive, or send and receive additional paths. This is done at the address family level or the neighbor level, and is controlled by either the `bgp additional-paths {send [receive] | receive}` command or the `neighbor additional-paths {send [receive] | receive}` command, respectively. During session establishment, two BGP neighbors negotiate the Additional Path capabilities (whether they can send and/or receive) between them.

2. Select a set or sets of candidate paths for advertisement by specifying selection criteria (using the `bgp additional-paths select` command).

3. Advertise for a neighbor a set or sets of additional paths from the candidate paths marked (using the `neighbor advertise additional-paths` command).

To send or receive additional paths, the Additional Path capability must be negotiated. If it isn't negotiated, even if the selection criteria are such that more than the bestpath is marked and the neighbor is configured to advertise the marked paths, the selections would be useless because without the capability negotiated, only the bestpath can be sent.

Configuring BGP to send or receive additional paths triggers negotiation of additional path capability with the device's peers. Neighbors that have negotiated the capability will be grouped together in an update group (if other update group policies allow), and in a separate update group from those peers that have not negotiated the capability. Therefore, additional path capability causes the neighbor's update group membership to be recalculated.

Additional Path Selection

There are three path selection (path marking) policies, and they are not mutually exclusive. They are specified per address family, using the `bgp additional-paths select` command. They are:
• **best 2** or **best 3** (**best 2** means the best path and 2nd best path; the 2nd best path is the one computed by eliminating best-path from the best-computation algorithm. Similarly, **best 3** means the best path, 2nd best path, and 3rd best path; the 3rd best path is the one computed by eliminating best path and 2nd best path from the best-computation algorithm.)

• **group-best** (calculates the group-best for prefixes during bestpath calculation; described further below)

• **all** (all paths with unique next hops are eligible for selection)

**Definition of the group-best Selection**

The **group-best** keyword is part of the following commands:

• advertise additional-paths

• bgp additional-paths select

• match additional-paths advertise-set

• neighbor advertise additional-paths

The **group-best** is the set of paths that are the best paths from the paths of the same AS. For example, suppose there are three autonomous systems: AS 100, 200, and 300. Paths p101, p102, and p103 are from AS 100; p201, p202, and p203 are from AS 200; and p301, p302, and p303 are from AS 300. If we run the BGP bestpath algorithm on the paths from each AS, the algorithm will select one bestpath from each set of paths from that AS. Assuming p101 is the best from AS 100, p201 is the best from AS 200, and p301 is the best from AS 300, then the **group-best** is the set of p101, p201, and p301.

**Advertise a Subset of the Paths Selected**

Take care when you select a set of paths but want to advertise a different set of paths. If the set of paths you want to advertise is not a subset of the selected paths, then you will not advertise the paths you want advertised.

The following example configures the additional paths selected to be the group-best and all selections. However, the paths configured to be advertised to the neighbor are the best 3 paths. Because the selection and advertise policy are not the same, the subsequent message is displayed. In these cases, only the bestpath is advertised.

```
Device(config)# router bgp 100
Device(config-router)# address-family ipv4
Device(config-router-af)# bgp additional-paths send receive
Device(config-router-af)# bgp additional-paths select group-best all
Device(config-router-af)# neighbor 192.168.2.2 advertise additional-paths best 3
```

This is a reminder that AF level ‘bgp additional-paths select’ more restrictive than advertising policy.

---

**How to Configure BGP Additional Paths**

**Configuring Additional Paths per Address Family**

To select which paths are candidates to be additional paths, you can perform any combination of Steps 6, 7, and 8, as long as you perform at least one of those steps.

If you want to disable additional paths per neighbor, see the “Disabling Additional Paths per Neighbor” section.
SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp as-number
4. address-family ipv4 [unicast | multicast]
5. bgp additional-paths {send [receive] | receive}
6. bgp additional-paths select group-best
7. bgp additional-paths select best number
8. bgp additional-paths select all
9. neighbor {ip-address | ipv6-address | peer-group-name} advertise additional-paths [best number] [group-best] [all]
10. end

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example: Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp as-number</td>
<td>Configures a BGP routing process and enters router configuration mode.</td>
</tr>
<tr>
<td>Example: Device(config)# router bgp 65000</td>
<td>• The as-number argument indicates the number of an autonomous system that identifies the router to other BGP routers and tags the routing information passed along. Valid numbers are from 0 to 65535. Private autonomous system numbers that can be used in internal networks range from 64512 to 65535.</td>
</tr>
<tr>
<td><strong>Step 4</strong> address-family ipv4 [unicast</td>
<td>multicast]</td>
</tr>
<tr>
<td>Example: Device(config-router)# address-family ipv4</td>
<td>• The following address families are supported: IPv4 unicast, IPv4 multicast, IPv4 unicast + label, IPv6 unicast, IPv6 multicast, and IPv6 multicast + label.</td>
</tr>
<tr>
<td><strong>Step 5</strong> bgp additional-paths {send [receive]</td>
<td>receive}</td>
</tr>
<tr>
<td>Example: Device(config-router-af)# bgp additional-paths send receive</td>
<td>• This example enables additional paths to be sent and received.</td>
</tr>
<tr>
<td>Step</td>
<td>Command or Action</td>
</tr>
<tr>
<td>------</td>
<td>------------------</td>
</tr>
<tr>
<td>6</td>
<td><code>bgp additional-paths select group-best</code></td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong> Device(config-router-af)# bgp additional-paths select group-best</td>
</tr>
<tr>
<td>7</td>
<td><code>bgp additional-paths select best number</code></td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong> Device(config-router-af)# bgp additional-paths select best 3</td>
</tr>
<tr>
<td>8</td>
<td><code>bgp additional-paths select all</code></td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong> Device(config-router-af)# bgp additional-paths select all</td>
</tr>
<tr>
<td>9</td>
<td>`neighbor {ip-address</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong> Device(config-router-af)# neighbor 192.168.0.1 advertise additional-paths best 3 group-best all</td>
</tr>
<tr>
<td>10</td>
<td><code>end</code></td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong> Device(config-router-af)# end</td>
</tr>
</tbody>
</table>

**Configuring Additional Paths per Neighbor**

To select which paths are candidates to be additional paths, you can perform any combination of Steps 6, 7, and 8, as long as you perform at least one of those steps.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp as-number`
4. `address-family ipv4 [unicast | multicast]`
5. `neighbor {ip-address | ipv6-address | peer-group-name} additional-paths {send [receive] | receive}`
6. `bgp additional-paths select group-best`
7. `bgp additional-paths select best number`
8. `bgp additional-paths select all`
9. `neighbor {ip-address | ipv6-address | peer-group-name} advertise additional-paths [best number] [group-best] [all]`
10. `end`
## DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><code>enable</code></td>
<td>- Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device&gt; enable</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><code>configure</code></td>
<td></td>
</tr>
<tr>
<td><code>terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device# configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Configures a BGP routing process and enters router configuration mode.</td>
</tr>
<tr>
<td><code>router bgp</code></td>
<td>- The <em>as-number</em> argument indicates the number of an autonomous system that identifies the router to other BGP routers and tags the routing information passed along. Valid numbers are from 0 to 65535. Private autonomous system numbers that can be used in internal networks range from 64512 to 65535.</td>
</tr>
<tr>
<td><code>as-number</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config)# router bgp 65000</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>Enters address family configuration mode.</td>
</tr>
<tr>
<td><code>address-family ipv4</code></td>
<td>- The following address families are supported: IPv4 unicast, IPv4 multicast, IPv4 unicast + label, IPv6 unicast, IPv6 multicast, and IPv6 multicast + label.</td>
</tr>
<tr>
<td>`{unicast</td>
<td>multicast}`</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config-router)# address-family ipv4 unicast</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>Enables the neighbor to send or receive additional paths after negotiation is completed.</td>
</tr>
<tr>
<td><code>neighbor</code></td>
<td>- This example enables the neighbor to send and receive additional paths.</td>
</tr>
<tr>
<td>`{ip-address</td>
<td>ipv6-address</td>
</tr>
<tr>
<td><code>additional-paths</code></td>
<td></td>
</tr>
<tr>
<td>`{send</td>
<td>receive}`</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config-router-af)# neighbor 192.168.1.2 additional-paths send receive</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>(Optional) Calculates the group-best for prefixes during bestpath calculation.</td>
</tr>
<tr>
<td><code>bgp additional-paths select group-best</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config-router-af)# bgp additional-paths select group-best</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>(Optional) Calculates the specified number of best paths, including the selection of the bestpath.</td>
</tr>
<tr>
<td><code>bgp additional-paths select best</code></td>
<td>- The value of <em>number</em> can be 2 or 3.</td>
</tr>
<tr>
<td><code>number</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config-router-af)# bgp additional-paths select best 3</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td>(Optional) Specifies that all paths with unique next hops are eligible for selection.</td>
</tr>
<tr>
<td><code>bgp additional-paths select all</code></td>
<td></td>
</tr>
</tbody>
</table>
### Purpose

**Command or Action**

```bash
Device(config-router-af)# bgp additional-paths select all
```

**Purpose**

Specifies the selection methods that control which additional paths are advertised for the neighbor.

### Step 9

**neighbor** `{ip-address | ipv6-address | peer-group-name}`

advertise additional-paths `[best number] [group-best] [all]`

**Example:**

```bash
Device(config-router-af)# neighbor 192.168.1.2 advertise additional-paths best 3 group-best all
```

### Step 10

**end**

**Example:**

```bash
Device(config-router-af)# end
```

(Optional) Exits to privileged EXEC mode.

---

### Configuring Additional Paths Using a Peer Policy Template

In this configuration task example, the capability to send and receive additional paths and the selection criteria are configured for the address family, and then the template is configured.

#### SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. `router bgp autonomous-system-number`
4. `address-family ipv4 unicast`
5. `bgp additional-paths {send [receive] | receive}`
6. `bgp additional-paths select [best number] [group-best] [all]`
7. `template peer-policy policy-template-name`
8. `additional-paths {send [receive] | receive}`
9. `advertise additional-paths [best number] [group-best] [all]`
10. **exit**
11. `address-family ipv4 unicast`
12. **neighbor** `{ip-address | ipv6-address | peer-group-name} remote-as autonomous-system-number`
13. **neighbor** `ip-address inherit peer-policy policy-template-name`
14. **end**

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><code>Device&gt; enable</code></td>
<td></td>
</tr>
</tbody>
</table>
### Command or Action

<table>
<thead>
<tr>
<th>Step 2</th>
<th>configure terminal</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Device# configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 3</th>
<th>router bgp autonomous-system-number</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config)# router bgp 45000</td>
<td>Enters router configuration mode and creates a BGP routing process.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 4</th>
<th>address-family ipv4 unicast</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config-router)# address-family ipv4 unicast</td>
<td>Configures the IPv4 address family.</td>
</tr>
</tbody>
</table>

| Step 5 | bgp additional-paths {send [receive] | receive} | Purpose |
|--------|--------------------------------|---------|
| **Example:** | Device(config-router)# bgp additional-paths send receive | Enables BGP additional paths to be sent only, received only, or sent and received for the peers in the address family. |

<table>
<thead>
<tr>
<th>Step 6</th>
<th>bgp additional-paths select [best number] [group-best] [all]</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config-router)# bgp additional-paths select best 3 group-best all</td>
<td>Causes the system to calculate BGP additional paths that can be candidates for advertisement in addition to a bestpath.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 7</th>
<th>template peer-policy policy-template-name</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config-router)# template peer-policy rr-client-pltl</td>
<td>Enters policy-template configuration mode and creates a peer policy template.</td>
</tr>
</tbody>
</table>

| Step 8 | additional-paths {send [receive] | receive} | Purpose |
|--------|--------------------------------|---------|
| **Example:** | Device(config-router-pltm)# additional-paths send receive | Enables BGP additional paths to be sent only, received only, or sent and received for the peers covered by the peer policy template. |

<table>
<thead>
<tr>
<th>Step 9</th>
<th>advertise additional-paths [best number] [group-best] [all]</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config-router-pltm)# advertise additional-paths best 3 group-best all</td>
<td>Specifies the selection methods that control which additional paths are advertised for the peers covered by the peer policy template.</td>
</tr>
</tbody>
</table>
### Purpose

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 10</strong> exit</td>
<td>Exits policy-template configuration mode and returns to router configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-router-ptmp)# exit</td>
</tr>
<tr>
<td><strong>Step 11</strong> address-family ipv4 unicast</td>
<td>Configures the IPv4 address family.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-router)# address-family ipv4 unicast</td>
</tr>
<tr>
<td><strong>Step 12</strong> neighbor {ip-address</td>
<td>ipv6-address</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-router-af)# neighbor 192.168.1.1 remote-as 45000</td>
</tr>
<tr>
<td><strong>Step 13</strong> neighbor ip-address inherit peer-policy policy-template-name</td>
<td>Sends a peer policy template to a neighbor so that the neighbor can inherit the configuration.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-router-af)# neighbor 192.168.1.1 inherit peer-policy rr-client-pt1</td>
</tr>
<tr>
<td><strong>Step 14</strong> end</td>
<td>Exits address family configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-router-af)# end</td>
</tr>
</tbody>
</table>

### Filtering and Setting Actions for Additional Paths

You can optionally use a route map to filter the paths to be advertised by matching on the tags of additional paths that are candidates to be advertised. (These tags are the advertise-sets that are configured with the `bgp additional-paths select` command.) Paths that have the same path marking (tag) as the marking that is configured in the `match additional-paths advertise-set` command match the route map entry (and are permitted or denied).

You can also optionally set one or more actions to take for those paths that pass the route map. This task happens to use the `set metric` command to illustrate using a route map with the `match additional-paths advertise-set` command. Of course, other `set` commands are available that are not shown in this task.

Why set a metric for paths marked with `all` (all paths with a unique next hop)? Suppose the neighbor 2001:DB8::1037 is receiving the same route from different neighbors. Routes received from the local device have a metric of 565 and routes from another device perhaps have a metric of 700. Routes with metric 565 will have precedence over the routes with metric 700.

### SUMMARY STEPS

1. enable
### Filtering and Setting Actions for Additional Paths

2. `configure terminal`  
3. `route-map map-tag [permit | deny] [sequence-number]`  
4. `match additional-paths advertise-set [best number] [best-range start-range end-range] [group-best] [all]`  
5. `set metric metric-value`

#### Detailed Steps

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** | enable<br>**Example:**<br>Device> enable | Enables privileged EXEC mode.  
  - Enter your password if prompted. |
| **Step 2** | configure terminal<br>**Example:**<br>Device# configure terminal | Enters global configuration mode. |
| **Step 3** | route-map map-tag [permit | deny] [sequence-number]<br>**Example:**<br>Device(config)# route-map additional_path1 permit 10 | Creates a route map. |
| **Step 4** | match additional-paths advertise-set [best number] [best-range start-range end-range] [group-best] [all]<br>**Example:**<br>Device(config-route-map)# match additional-paths advertise-set best 3 | Matches on any path that is tagged with the specified path selection policy.  
  - You must specify at least one selection method; you can specify more than one selection method in the command.  
  - Specifying `best number` is incompatible with specifying `best-range`.  
  - Specifying `best 1` will match only the bestpath.  
  - Specifying `best-range 1 1` will match only the bestpath.  
  - Only one `match additional-paths advertise-set` command is allowed per route map. A subsequent `match additional-paths advertise-set` command will overwrite the previous command. |
| **Step 5** | set metric metric-value<br>**Example:**<br>Device(config-route-map)# set metric 500 | Sets the metric of the additional paths that pass the match criteria.  
  - Note that other set commands can be used to take action on the paths that pass the route map. This example happens to use the set metric command. |
What to do next

After creating the route map, you would reference the route map in the `neighbor route-map out` command. Thus, the route map is applied to paths being advertised (outgoing) to neighbors. Then you would use the `neighbor advertise additional-paths` command to advertise the additional paths. See the “Example: BGP Additional Paths” section to see the route map in context.

Displaying Additional Path Information

Perform either Step 2 or Step 3 in this task to see information about BGP additional paths.

**SUMMARY STEPS**

1. `enable`
2. `show ip bgp neighbors [ip-address]`
3. `show ip bgp [network]`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
</tr>
<tr>
<td><code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td></td>
</tr>
<tr>
<td><code>show ip bgp neighbors [ip-address]</code></td>
<td>Displays the capabilities of the neighbor to send and receive additional paths.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device# show ip bgp neighbors 192.168.1.1</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td></td>
</tr>
<tr>
<td><code>show ip bgp [network]</code></td>
<td>Displays the additional path selections and path ID for the network.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device# show ip bgp 192.168.0.0</td>
<td></td>
</tr>
</tbody>
</table>

Disabling Additional Paths per Neighbor

If you had configured the sending or receiving of additional paths on a per neighbor basis (with the `neighbor additional-paths` command), and you wanted to disable that functionality, you would use the `no neighbor additional-paths` command.

However, if you had configured the sending or receiving of additional paths for an address family (with the `bgp additional-paths` command), and you wanted to disable that functionality for a neighbor, you would use the `neighbor additional-paths disable` command. Disabling additional paths also works if the functionality was inherited from a template.

Perform this task to disable additional path capability for a neighbor.
SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp as-number
4. address-family ipv6 [unicast | multicast]
5. bgp additional-paths {send [receive] | receive}
6. neighbor {ip-address | ipv6-address | peer-group-name} additional-paths disable
7. end

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example: Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp as-number</td>
<td>Configures a BGP routing process and enters router configuration mode.</td>
</tr>
<tr>
<td>Example: Device(config)# router bgp 65000</td>
<td>• The as-number argument indicates the number of an autonomous system that identifies the router to other BGP routers and tags the routing information passed along. Valid numbers are from 0 to 65535. Private autonomous system numbers that can be used in internal networks range from 64512 to 65535.</td>
</tr>
<tr>
<td><strong>Step 4</strong> address-family ipv6 [unicast</td>
<td>multicast]</td>
</tr>
<tr>
<td>Example: Device(config-router)# address-family ipv6 unicast</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> bgp additional-paths {send [receive]</td>
<td>receive}</td>
</tr>
<tr>
<td>Example: Device(config-router-sf)# bgp additional-paths send receive</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> neighbor {ip-address</td>
<td>ipv6-address</td>
</tr>
<tr>
<td>Example: Device(config-router-af)# neighbor 2001:DB8::1 additional-paths disable</td>
<td>• The additional path functionality is still enabled for the rest of the neighbors in the address family.</td>
</tr>
</tbody>
</table>
### Configuration Examples for BGP Additional Paths

#### Example: BGP Additional Path Send and Receive Capabilities

In this example, R1’s address is 192.168.1.1; its neighbor is R2, which has address 192.168.1.2. Updates are sent from R2 to R1 with additional-paths (all paths advertised). Updates are sent from R1 to R2 with only the classic BGP bestpath advertised because R2 is only able to send additional paths, not receive additional paths.

**R1**

```conf
router bgp 1
    address-family ipv4 unicast
    bgp additional-paths select all
    neighbor 192.168.1.2 additional-paths send receive
    neighbor 192.168.1.2 advertise additional-paths all
```

**R2**

```conf
router bgp 2
    address-family ipv4 unicast
    bgp additional-paths select all
    neighbor 192.168.1.1 additional-paths send
    neighbor 192.168.1.1 advertise additional-paths all
```

#### Example: BGP Additional Paths

In the following example, for every address family, there are one or more eBGP neighbors not shown in the configuration that are sending routes to the local device. The eBGP routes learned from those neighbors are advertised toward the neighbors shown in the configuration below and the path attributes are changed. The example configures that:

- The route map called `add_path1` specifies that all the paths are advertised toward neighbor 192.168.101.15, but any path that is marked with `best 2` will have its metric set to 780 before being sent toward that neighbor.
- The route map called `add_path2` specifies that any path that is marked with `best 3` will have its metric set to 640 and will be advertised toward neighbor 192.168.25.
- The route map called `add_path3` specifies that any path that is marked with `group-best` will have its metric set to 825 and will be advertised toward neighbor 2001:DB8::1045.
- In the IPv6 multicast address family, all paths are candidates to be advertised and will be advertised toward neighbor 2001:DB8::1037.
router bgp 1
neighbor 192.168.101.15 remote-as 1
neighbor 192.168.101.25 remote-as 1
neighbor 2001:DB8::1045 remote-as 1
neighbor 2001:DB8::1037 remote-as 1
! address-family ipv4 unicast
  bgp additional-paths send receive
  bgp additional-paths select all best 3 group-best
  neighbor 192.168.101.15 activate
  neighbor 192.168.101.15 route-map add_path1 out
  neighbor 192.168.101.15 advertise additional-paths best 2
  exit-address-family
! address-family ipv4 multicast
  bgp additional-paths send receive
  bgp additional-paths select all best 3 group-best
  neighbor 192.168.101.25 activate
  neighbor 192.168.101.25 route-map add_path2 out
  neighbor 192.168.101.25 advertise additional-paths best 3
  exit-address-family
! address-family ipv6 unicast
  bgp additional-paths send receive
  bgp additional-paths select group-best
  neighbor 2001:DB8::1045 activate
  neighbor 2001:DB8::1045 route-map add_path3 out
  neighbor 2001:DB8::1045 advertise additional-paths all group-best
  exit-address-family
! address-family ipv6 multicast
  bgp additional-paths send receive
  bgp additional-paths select all
  neighbor 2001:DB8::1037 activate
  neighbor 2001:DB8::1037 route-map add_path4 out
  neighbor 2001:DB8::1037 advertise additional-paths all
  exit-address-family
route-map add_path1 permit 10
  match additional-paths advertise-set best 2
  set metric 780
route-map add_path1 permit 20
! route-map add_path2 permit 10
  match additional-paths advertise-set best 3
  set metric 640
! route-map add_path3 permit 10
  match additional-paths advertise-set group-best
  set metric 825
!

Example: Neighbor Capabilities Override Address Family Capabilities

In the following example, the receive-only capability of the neighbor overrides the send and receive capability of the address family:

```text
router bgp 65000
```
Example: BGP Additional Paths Using a Peer Policy Template

```
router bgp 45000
address-family ipv4 unicast
  bgp additional-paths send receive
  bgp additional-paths select all group-best best 3
  template peer-policy rr-client-pt1
    additional-paths send receive
    advertise additional-paths group-best best 3
  exit
address-family ipv4 unicast
neighbor 192.168.1.1 remote-as 45000
neighbor 192.168.1.1 inherit peer-policy rr-client-pt1
end
```

Additional References

### Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
</tbody>
</table>

### Standards and RFCs

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<thead>
<tr>
<th>Standard/RFC</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFC 3107</td>
<td>Carrying Label Information in BGP-4</td>
</tr>
<tr>
<td>RFC 4271</td>
<td>A Border Gateway Protocol (BGP-4)</td>
</tr>
<tr>
<td>RFC 4760</td>
<td>Multiprotocol Extensions for BGP-4</td>
</tr>
</tbody>
</table>
### Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

### Feature Information for BGP Additional Paths

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to [www.cisco.com/go/cfn](http://www.cisco.com/go/cfn). An account on Cisco.com is not required.
The BGP Additional Paths feature allows the advertisement of multiple paths for the same prefix without the new paths implicitly replacing any previous paths.

The following commands were introduced:

- `additional-paths`
- `advertise additional-paths`
- `bgp additional-paths`
- `bgp additional-paths select`
- `match additional-paths advertise-set`
- `neighbor additional-paths`
- `neighbor advertise additional-paths`

The following commands were modified:

- `show ip bgp`
- `show ip bgp neighbors`

### Table 86: Feature Information for BGP Additional Paths

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
</table>
| BGP Additional Paths   | Cisco IOS XE Release 3.7S | The BGP Additional Paths feature allows the advertisement of multiple paths for the same prefix without the new paths implicitly replacing any previous paths.

The following commands were introduced:

- `additional-paths`
- `advertise additional-paths`
- `bgp additional-paths`
- `bgp additional-paths select`
- `match additional-paths advertise-set`
- `neighbor additional-paths`
- `neighbor advertise additional-paths`

The following commands were modified:

- `show ip bgp`
- `show ip bgp neighbors`
BGP-Multiple Cluster IDs

The BGP—Multiple Cluster IDs feature allows an iBGP neighbor (usually a route reflector) to have multiple cluster IDs: a global cluster ID and additional cluster IDs that are assigned to clients (neighbors). Prior to the introduction of this feature, a device could have a single, global cluster ID.

When a network administrator configures per-neighbor cluster IDs:

- The loop prevention mechanism based on a CLUSTER_LIST is automatically modified to take into account multiple cluster IDs.
- A network administrator can disable client-to-client route reflection based on cluster ID.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About BGP-Multiple Cluster IDs

Benefit of Multiple Cluster IDs Per Route Reflector

The BGP—Multiple Cluster IDs feature allows a route reflector (RR) to belong to multiple clusters, and therefore have multiple cluster IDs. An RR can have a cluster ID configured on a global basis and a per-neighbor
basis. A single cluster ID can be assigned to two or more iBGP neighbors. Prior to this feature, an RR had a single, global cluster ID, which was configured by the `bgp cluster-id` router configuration command.

When a cluster ID is configured per neighbor (by the `neighbor cluster-id` router configuration command), the following two changes occur:

- The loop prevention mechanism based on the CLUSTER_LIST attribute is automatically modified to take into account multiple cluster IDs.
- The network administrator can disable client-to-client route reflection based on cluster ID, which allows the network design to change.

The loop prevention mechanism and the CLUSTER_LIST propagation rules are described in the section “How a CLUSTER_LIST Attribute is Used.” Disabling client-to-client reflection is described in the section “Behaviors When Disabling Client-to-Client Route Reflection.”

**How a CLUSTER_LIST Attribute is Used**

The CLUSTER_LIST propagation rules differ among releases, depending on whether the device is running a Cisco software release generated before or after the BGP—Multiple Cluster IDs feature was implemented. The same is true for loop prevention based on the CLUSTER_LIST.

The CLUSTER_LIST behavior is described below. Classic refers to the behavior of software released before the multiple cluster IDs feature was implemented; MCID refers to the behavior of software released after the feature was implemented.

**CLUSTER_LIST Propagation Rules**

- **Classic**—Before reflecting a route, the RR appends the global cluster ID to the CLUSTER_LIST. If the received route had no CLUSTER_LIST attribute, the RR creates a new CLUSTER_LIST attribute with that global cluster ID.

- **MCID**—Before reflecting a route, the RR appends the cluster ID of the neighbor the route was received from to the CLUSTER_LIST. If the received route had no CLUSTER_LIST attribute, the RR creates a new CLUSTER_LIST attribute with that cluster ID. This behavior includes a neighbor that is not a client of the speaker. If the nonclient neighbor the route was received from does not have an associated cluster ID, the RR uses the global cluster ID.

**Loop Prevention Based on CLUSTER_LIST**

- **Classic**—When receiving a route, the RR discards the route if the RR’s global cluster ID is contained in the CLUSTER_LIST of the route.

- **MCID**—When receiving a route, the RR discards the route if the RR’s global cluster ID or any of the cluster IDs assigned to any of the iBGP neighbors is contained in the CLUSTER_LIST of the route.

**Behaviors When Disabling Client-to-Client Route Reflection**

With the introduction of multiple cluster IDs per iBGP neighbor, it is possible to disable route reflection from client to client on the basis of cluster ID. Disabling route reflection allows you to change the network design. A typical (but not required) scenario after disabling route reflection is that clients are fully meshed, so they have to send more updates, and the RR has client-to-client reflection disabled, so that it has to send fewer updates.
You might want to disable route reflection in a scenario similar to the one in the figure below. An RR has several clients [Provider-Edge (PE) routers] with which it has sessions. The iBGP neighbors that should belong to one cluster were assigned the same cluster ID.

Because the PEs belonging to the same cluster are fully meshed (PE1 and PE2 have a session between them; PE3 and PE4 have a session between them), there is no need to reflect the routes between them. That is, routes from PE1 should be forwarded to PE3 and PE4, but not to PE2.

It is important to know that when the software changes reflection state for a given cluster ID, BGP sends an outbound soft refresh to all clients.

Disabling client-to-client route reflection is done differently and has different results, depending on whether the device is running Cisco software generated before or after the multiple cluster IDs feature was implemented. Classic refers to the behavior of software released before the multiple cluster IDs feature was implemented; MCID refers to the behavior of software released after the multiple cluster IDs feature was implemented.

• Classic—When receiving a route from a client, the RR does not reflect it to any other client. Other scenarios for reflection (client-to-nonclient and nonclient-to-client) are maintained. Disabling of route reflection from client to client is usually done when all the clients are fully meshed (the routes are advertised between the clients via that mesh, so there is no need for reflection). The command to disable client-to-client route reflection is entered in router configuration mode (after the `router bgp` command) and it applies globally to all address families:

```
no bgp client-to-client reflection
```

• MCID—When receiving a route from a client, the RR does not reflect it to another client if both clients belong to a cluster for which client-to-client reflection has been disabled. Therefore, route reflection is disabled only intracluster (within the cluster specified). Other cases for reflection (client-to-nonclient, nonclient-to-client, and intercluster) are maintained. This functionality is usually configured when all the clients for a particular cluster are fully meshed among themselves (but not with clients of other clusters). The command to disable client-to-client route reflection for a particular cluster is entered in router configuration mode and it applies globally to all address families:

```
nobgp client-to-client reflection intra-cluster cluster-id {any | cluster-id1 cluster-id2...}
```

The `any` keyword is used to disable client-to-client reflection for any cluster.

The Classic, previously released command for disabling all client-to-client reflection is also still available during this post-MCID release timeframe:

```
nobgp client-to-client reflection [all]
```

(The optional `all` keyword has no effect in either the positive or negative form of the command, and does not appear in configuration files. It is just to remind the network administrator that both intercluster and intracluster client-to-client reflection are enabled or disabled.)

In summary, after the introduction of the multiple cluster IDs feature, there are three levels of configuration that can disable client-to-client reflection. The software performs them in the following order, from least specific to most specific:


When BGP is advertising updates, the software evaluates each level of configuration in order. Once any level of configuration disables client-to-client reflection, no further evaluation of more specific policies is necessary.

Note the results of the base (positive) and negative (no) forms of the three commands listed above:

- A negative configuration (that is, with the no keyword) overwrites any less specific configuration.
- A positive configuration (that is, without the no keyword) will lose out to (default to) what is configured in a less specific configuration.
- Configurations at any level appear in the configuration file only if they are negative.

All levels can be configured independently and all levels appear in the configuration file independently of the configuration of other levels.

Note that negative configuration makes any more specific configuration unnecessary (because even if the more specific configuration is positive, it is not processed after the negative configuration; if the more specific configuration is negative, it is functionally the same as the earlier negative configuration). The following examples illustrate this behavior.

**Example 1**

```plaintext
no bgp client-to-client reflection
no bgp client-to-client reflection intra-cluster cluster-id any
```

Intercluster and intracluster reflection are disabled (based on the first command). The second command disables intracluster reflection, but it is unnecessary because intracluster reflection is already disabled by the first command.

**Example 2**

```plaintext
no bgp client-to-client reflection intra-cluster cluster-id any
bgp client-to-client reflection intra-cluster cluster-id 1.1.1.1
```

Cluster ID 1.1.1.1 has intracluster route reflection disabled (even though the second command is positive), because the first command is used to evaluate the update. The first command was negative, and once any level of configuration disables client-to-client reflection, no further evaluation is performed.

Another way to look at this example is that the second command, because it is in a positive form, defaults to the behavior of the first command (which is less specific). Thus, the second command is unnecessary.

Note that the second command would not appear in a configuration file because it is not a negative command.

### How to Use BGP-Multiple Cluster IDs

#### Configuring a Cluster ID per Neighbor

Perform this task on an iBGP peer (usually a route reflector) to configure a cluster ID per neighbor. Configuring a cluster ID per neighbor causes the loop-prevention mechanism based on the CLUSTER_LIST to be automatically modified to take into account multiple cluster IDs. Also, you gain the ability to disable client-to-client route reflection on the basis of cluster ID. The software tags the neighbor so that you can
disableroute reflection with the use of another command. (See the tasks for disabling client-to-client reflection later in this module.)

**Note**

When you change a cluster ID for a neighbor, BGP automatically does an inbound soft refresh and an outbound soft refresh for all iBGP peers.

**SUMMARY STEPS**

1. **enable**
2. **configure terminal**
3. **router bgp** *as-number*
4. **neighbor** `{ip-address | ipv6-address}` **remote-as** *autonomous-system-number*
5. **neighbor** `{ip-address | ipv6-address}` **cluster-id** *cluster-id*
6. **end**
7. **show ip bgp cluster-ids**

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp <strong>as-number</strong></td>
<td>Configures a BGP routing process and enters router configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# router bgp 65000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• The <strong>as-number</strong> argument indicates the number of an autonomous system that identifies the router to other BGP routers and tags the routing information passed along. Valid numbers are from 0 to 65535. Private autonomous system numbers that can be used in internal networks range from 64512 to 65535.</td>
</tr>
<tr>
<td><strong>Step 4</strong> neighbor `{ip-address</td>
<td>ipv6-address}` <strong>remote-as</strong> <em>autonomous-system-number</em></td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router)# neighbor 192.168.1.2 remote-as 65000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> neighbor `{ip-address</td>
<td>ipv6-address}` <strong>cluster-id</strong> <em>cluster-id</em></td>
</tr>
</tbody>
</table>
### Purpose

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config-router)# neighbor 192.168.1.2</code>  <code>&lt;br&gt;</code> <code>cluster-id 0.0.0.1</code></td>
<td>• The cluster ID can be in dotted decimal format (such as <code>192.168.7.4</code>) or decimal format (such as <code>23</code>), with a maximum of 4 bytes.  <code>&lt;br&gt;</code> • A cluster ID that is configured in decimal format (such as <code>23</code>) is modified to dotted decimal format (such as <code>0.0.0.23</code>) when it appears in a configuration file.  <code>&lt;br&gt;</code> • When you change a cluster ID for a neighbor, BGP automatically does an inbound soft refresh and an outbound soft refresh for all iBGP peers.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 6</th>
<th><strong>end</strong></th>
<th>(Optional) Exits to privileged EXEC mode.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td><code>Device(config-router)# end</code></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 7</th>
<th><code>show ip bgp cluster-ids</code></th>
<th>(Optional) Lists:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td><code>Device# show ip bgp cluster-ids</code></td>
<td>• the global cluster ID (whether configured or not)  <code>&lt;br&gt;</code> • all cluster IDs that are configured to a neighbor  <code>&lt;br&gt;</code> • all cluster IDs for which the network administrator has disabled reflection</td>
</tr>
</tbody>
</table>

### Disabling Intracluster and Intercluster Client-to-Client Reflection

Perform the following task on a route reflector if you want to disable both intracluster and intercluster client-to-client reflection. Doing so is the broadest (least specific) way to disable client-to-client reflection. Before advertising updates, the software evaluates each level of configuration in order from least specific to most specific. Once any level of configuration disables client-to-client reflection, no further evaluation of more specific policies is needed.

![Note](image)

When the software changes reflection state for a given cluster ID, BGP sends an outbound soft refresh to all clients.

### SUMMARY STEPS

1. enable  
2. configure terminal  
3. `router bgp as-number`  
4. `no bgp client-to-client reflection [all]`
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
</tr>
<tr>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device&gt; enable</td>
<td></td>
</tr>
</tbody>
</table>

| **Step 2**        |         |
| configure terminal| Enters global configuration mode. |
| **Example:**      |         |
| Device# configure terminal | |

| **Step 3**        |         |
| router bgp *as-number* | Configures a BGP routing process and enters router configuration mode. |
| **Example:**      |         |
| Device(config)# router bgp 65000 |   |

| **Step 4**        |         |
| **Example:**      |         |
| Device(config-router)# no bgp client-to-client reflection all |   |

#### Disabling Intracluster Client-to-Client Reflection for Any Cluster ID

Perform the following task on a route reflector to disable intracluster client-to-client reflection for any cluster ID. Doing so is considered to be the middle of the three levels of commands available to disable client-to-client reflection. That is, it is more specific than disabling intracluster and intercluster client-to-client reflection, but it is not as specific as disabling intracluster client-to-client reflection for certain cluster IDs.

Before advertising updates, the software evaluates each level of configuration in order from least specific to most specific. Once any level of configuration disables client-to-client reflection, no further evaluation of more specific policies is needed.

#### Note

When the software changes reflection state for a given cluster ID, BGP sends an outbound soft refresh to all clients.
### SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router bgp as-number**
4. **no bgp client-to-client reflection intra-cluster cluster-id any**

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td></td>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td>Step 2</td>
<td><strong>configure terminal</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td><strong>router bgp as-number</strong></td>
<td>Configures a BGP routing process and enters router configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>• The <em>as-number</em> argument indicates the number of an autonomous system that identifies the router to other BGP routers and tags the routing information passed along. Valid numbers are from 0 to 65535. Private autonomous system numbers that can be used in internal networks range from 64512 to 65535.</td>
</tr>
<tr>
<td></td>
<td>Device(config)# router bgp 65000</td>
<td></td>
</tr>
<tr>
<td>Step 4</td>
<td><strong>no bgp client-to-client reflection intra-cluster cluster-id any</strong></td>
<td>Disables intracluster client-to-client route reflection for any cluster.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config-router)# no bgp client-to-client reflection intra-cluster cluster-id any</td>
<td></td>
</tr>
</tbody>
</table>

### Disabling Intracluster Client-to-Client Reflection for Specified Cluster IDs

Perform the following task on a route reflector to disable intracluster client-to-client reflection for specified cluster IDs. Doing so is considered to be the most specific of the three levels of commands available to disable client-to-client reflection. Before advertising updates, the software evaluates each level of configuration in order from least specific to most specific. Once any level of configuration disables client-to-client reflection, no further evaluation of more specific policies is needed.

**Note**

When the software changes reflection state for a given cluster ID, BGP sends an outbound soft refresh to all clients.
SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp as-number
4. no bgp client-to-client reflection intra-cluster cluster-id cluster-id1 [cluster-id2...]

DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td></td>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td>Step 2</td>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td>router bgp as-number</td>
<td>Configures a BGP routing process and enters router configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>• The as-number argument indicates the number of an autonomous system</td>
</tr>
<tr>
<td></td>
<td>Device(config)# router bgp 6500</td>
<td>that identifies the router to other BGP routers and tags the routing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>information passed along. Valid numbers are from 0 to 65535. Private</td>
</tr>
<tr>
<td></td>
<td></td>
<td>autonomous system numbers that can be used in internal networks range</td>
</tr>
<tr>
<td></td>
<td></td>
<td>from 64512 to 65535.</td>
</tr>
<tr>
<td>Step 4</td>
<td>no bgp client-to-client reflection intra-cluster cluster-id 0.0.0.1 [cluster-id2...]</td>
<td>Disables intracluster client-to-client route reflection within</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>each of the specified clusters.</td>
</tr>
<tr>
<td></td>
<td>Device(config-router)# no bgp client-to-client reflection intra-cluster cluster-id 0.0.0.1 0.0.0.3 105</td>
<td>• Note that this example command will appear in the configuration file</td>
</tr>
<tr>
<td></td>
<td></td>
<td>as “no bgp client-to-client reflection intra-cluster cluster-id 0.0.0.1 0.0.0.3 0.0.0.105” because decimal cluster ID numbers appear in the dotted decimal format.</td>
</tr>
</tbody>
</table>

Configuration Examples for BGP-Multiple Cluster IDs

Example: Per-Neighbor Cluster ID

The following example is configured on a route reflector. The neighbor (client) at IPv6 address 2001:DB8:1::1 is configured to have the cluster ID of 0.0.0.6:

```
router bgp 6500
```
Example: Disabling Client-to-Client Reflection

The following example disables all intracluster and intercluster client-to-client reflection:

```plaintext
router bgp 65000  
  no bgp client-to-client reflection all
```

The following example disables intracluster client-to-client reflection for any cluster ID:

```plaintext
router bgp 65000  
  no bgp client-to-client reflection intra-cluster cluster-id any
```

The following example disables intracluster client-to-client reflection for the specified cluster IDs 0.0.0.1, 14, 15, and 0.0.0.6:

```plaintext
router bgp 65000  
  no bgp client-to-client reflection intra-cluster cluster-id 0.0.0.1 14 15 0.0.0.6
```

Remember that a cluster ID specified in the `neighbor cluster-id` command in decimal format (such as 23) will appear in a configuration file in dotted decimal format (such as 0.0.0.23). The decimal format does not appear in the configuration file. The running configuration might look like this:

```plaintext
router bgp 65000  
  no bgp client-to-client reflection intra-cluster cluster-id 0.0.0.1  
  no bgp client-to-client reflection intra-cluster cluster-id 0.0.0.6  
  no bgp client-to-client reflection intra-cluster cluster-id 0.0.0.14  
  no bgp client-to-client reflection intra-cluster cluster-id 0.0.0.15
```

Additional References

### Related Documents

<table>
<thead>
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<th>Related Topic</th>
<th>Document Title</th>
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<tr>
<td>Cisco IOS commands</td>
<td><a href="http://www.cisco.com/go/mibs">Cisco IOS Master Command List, All Releases</a></td>
</tr>
<tr>
<td>BGP commands</td>
<td><a href="http://www.cisco.com/go/mibs">Cisco IOS IP Routing: BGP Command Reference</a></td>
</tr>
</tbody>
</table>

### MIBs

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<thead>
<tr>
<th>MIB</th>
<th>MIBs Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>To locate and download MIbs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
</tr>
</tbody>
</table>
Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation,</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
<tr>
<td>software, and tools. Use these resources to install and configure the software and to troubleshoot</td>
<td></td>
</tr>
<tr>
<td>and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco</td>
<td></td>
</tr>
<tr>
<td>Support and Documentation website requires a Cisco.com user ID and password.</td>
<td></td>
</tr>
</tbody>
</table>

Feature Information for BGP-Multiple Cluster IDs

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.
The BGP—Multiple Cluster IDs feature allows an iBGP neighbor (usually a route reflector) to have multiple cluster IDs: a global cluster ID and additional cluster IDs that are assigned to clients (neighbors). Prior to the introduction of this feature, a device could have a single, global cluster ID.

When a network administrator configures per-neighbor cluster IDs:

- The loop prevention mechanism based on a CLUSTER LIST is automatically modified to take into account multiple cluster IDs.
- A network administrator can disable client-to-client route reflection based on cluster ID.

The following commands were introduced:

- `bgp client-to-client reflection intra-cluster`
- `neighbor cluster-id`
- `show ip bgp cluster-ids`

The following commands were modified:

- `bgp client-to-client reflection`
- `show ip bgp neighbors`
- `show ip bgp template peer-session`
- `show ip bgp update-group`
CHAPTER 68

BGP-VPN Distinguisher Attribute

The BGP—VPN Distinguisher Attribute feature allows a network administrator to keep source route targets (RTs) private from an Autonomous System Border Router (ASBR) in a destination autonomous system. An RT at an egress ASBR is mapped to a VPN distinguisher, the VPN distinguisher is carried through the eBGP, and then it is mapped to an RT at the ingress ASBR.

- Finding Feature Information, on page 1001
- Information About BGP-VPN Distinguisher Attribute, on page 1001
- How to Configure BGP-VPN Distinguisher Attribute, on page 1003
- Configuration Examples for BGP-VPN Distinguisher Attribute, on page 1009
- Additional References, on page 1010
- Feature Information for BGP-VPN Distinguisher Attribute, on page 1011

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About BGP-VPN Distinguisher Attribute

Role and Benefit of the VPN Distinguisher Attribute

Route-target (RT) extended community attributes identify the VPN membership of routes. The RT attributes are placed onto a route at the exporting (egress) provider edge router (PE) and are transported across the iBGP cloud and across autonomous systems. Any Virtual Routing and Forwarding (VRF) instances at the remote PE that want to import such routes must have the corresponding RTs set as import RTs for that VRF.

The figure below illustrates two autonomous systems, each containing customer edge routers (CEs) that belong to different VPNs. Each PE tracks which route distinguisher (RD) corresponds to which VPN, thus controlling the traffic that belongs to each VPN.
In an Inter-AS Option B scenario like the one in the figure above, these routes are carried across an AS boundary from Autonomous System Border Router 1 (ASBR1) to ASBR2 over an MP-eBGP session, with the routes’ respective RTs as extended community attributes being received by ASBR2.

ASBR2 must maintain complex RT mapping schemes to translate RTs originated by AS1 to RTs recognized by AS2, so that the RTs can be imported by their respective VPN membership CE connections on PE2 for CE3 and CE4.

Some network administrators prefer to hide the RTs they source in AS1 from devices in AS2. In order to do that, the administrator must differentiate routes belonging to each VPN with a certain attribute so that the RTs can be removed on the outbound side of ASBR1 before sending routes to ASBR2, and ASBR2 can then map that attribute to recognizable RTs in AS2. The VPN Distinguisher (VD) extended community attribute serves that purpose.

The benefit of the BGP—VPN Distinguisher Attribute feature is that source RTs can be kept private from devices in destination autonomous systems.

**How the VPN Distinguisher Attribute Works**

The network administrator configures the egress ASBR to perform translation of RTs to a VPN distinguisher extended community attribute, and configures the ingress ASBR to perform translation of the VPN distinguisher to RTs. More specifically, the translation is achieved as follows:

**On the Egress ASBR**

- An outbound route map specifies a `match excommunity` clause that determines which VPN routes are subject to mapping, based on the route’s RT values.

- A `set extcommunity vpn-distinguisher` command sets the VPN distinguisher that replaces the RTs.

- The `set extcomm-list delete` command that references the same set of RTs is configured to remove the RTs, and then the route is sent to the neighboring ingress ASBR.

**On the Ingress ARBR**

- An inbound route map specifies a `match excommunity vpn-distinguisher` command that determines which VPN routes are subject to mapping, based on the route’s VPN distinguisher.

- The `set extcommunity rt` command specifies the RTs that replace the VPN distinguisher.

- For routes that match the clause, the VPN distinguisher is replaced with the configured RTs.
Additional Behaviors Related to the VPN Distinguisher

On the egress ASBR, if a VPN route matches a route map clause that does not have the `set extcommunity vpn-distinguisher` command configured, the RTs that the VPN route is tagged with are retained.

The VPN distinguisher is transitive across the AS boundary, but is not carried within the iBGP cloud. That is, the ingress ASBR can receive the VPN distinguisher from an eBGP peer, but the VPN distinguisher is discarded on the inbound side after it is mapped to the corresponding RTs.

On the ingress ASBR, if a VPN route carrying the VPN distinguisher matches a route map clause that does not have a `set extcommunity rt` command configured in the inbound route map, the system does not discard the attribute, nor does it propagate the attribute within the iBGP cloud. The VPN distinguisher for the route is retained so that the network administrator can configure the correct inbound policy to translate the VPN distinguisher to the RTs that the VPN route should carry. If the route is sent to eBGP peers, the VPN distinguisher is carried as is. The network administrator could configure a route-map entry to remove the VPN distinguisher from routes sent to eBGP peers.

Configuring a `set extcommunity vpn-distinguisher` command in an outbound route map or a `match extcommunity` command in an inbound route map results in an outbound or inbound route refresh request, respectively, in order to update the routes being sent or received.

How to Configure BGP-VPN Distinguisher Attribute

Replacing an RT with a VPN Distinguisher Attribute

Perform this task on an egress ASBR to replace a route target (RT) with a VPN distinguisher extended community attribute. Remember to replace the VPN distinguisher with a route target on the ingress ASBR; that task is described in the “Replacing a VPN Distinguisher Attribute with an RT” section.

SUMMARY STEPS

1. enable
2. configure terminal
3. ip extcommunity-list expanded-list {permit | deny} rt value
4. exit
5. route-map map-tag {permit | deny} [sequence-number]
6. match extcommunity extended-community-list-name
7. set extcomm-list extcommunity-name delete
8. set extcommunity vpn-distinguisher id
9. exit
10. route-map map-name {permit | deny} [sequence-number]
11. exit
12. router bgp as-number
13. neighbor ip-address remote-as autonomous-system-number
14. address-family vpnv4
15. neighbor ip-address activate
16. neighbor ip-address route-map map-name out
17. exit-address-family
<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| Step 1 | enable            | Enables privileged EXEC mode.  
  Example:  
  Device> enable  
  • Enter your password if prompted. |
| Step 2 | configure terminal | Enters global configuration mode.  
  Example:  
  Device# configure terminal |
| Step 3 | ip extcommunity-list expanded-list {permit | deny} rt value  
  Example:  
  Device(config)# ip extcommunity-list 4 permit rt 101:100 | Configures an IP extended community list to configure Virtual Private Network (VPN) route filtering, such that routes with the specified RT are in the extended community list.  
  • This example permits routes having RT 101:100 into the extended community list 4. |
| Step 4 | exit             | Exits the configuration mode and enters the next higher configuration mode.  
  Example:  
  Device(config-extcomm-list)# exit |
| Step 5 | route-map map-tag {permit | deny} [sequence-number]  
  Example:  
  Device(config)# route-map vpn-id-map1 permit 10 | Configures a route map that permits or denies the routes allowed by the subsequent match command.  
  • This example permits the routes allowed by the subsequent match command. |
| Step 6 | match extcommunity extended-community-list-name  
  Example:  
  Device(config-route-map)# match extcommunity 4 | Matches on the specified community list.  
  • For this example, routes that match the extended community list 4 (which was configured in Step 3) are subject to the subsequent set commands. |
| Step 7 | set extcomm-list extcommunity-name delete  
  Example:  
  Device(config-route-map)# set extcomm-list 4 delete | Deletes the RT from routes that are in the specified extended community list.  
  • For this example, RTs are deleted from routes that are in extended community list 4. |
| Step 8 | set extcommunity vpn-distinguisher id  
  Example:  
  Device(config-route-map)# set extcommunity vpn-distinguisher 111:100 | For the routes that are permitted by the route map, sets the specified VPN distinguisher.  
  • For this example, routes that match extended community 4 have their VPN distinguisher set to 111:100. |
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 9</strong></td>
<td>exit</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-route-map)# exit</td>
</tr>
<tr>
<td></td>
<td>Exits route-map configuration mode and enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td>route-map map-name {permit</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config)# route-map vpn-id-map1 permit 20</td>
</tr>
<tr>
<td></td>
<td>(Optional) Configures a route map entry that permits routes.</td>
</tr>
<tr>
<td></td>
<td>• This example configures a route map entry that permits other routes not subject to the RT-to-VPN distinguisher mapping. If you do not perform this step, all other routes are subject to an implicit deny.</td>
</tr>
<tr>
<td><strong>Step 11</strong></td>
<td>exit</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-route-map)# exit</td>
</tr>
<tr>
<td></td>
<td>Exits route-map configuration mode and enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Step 12</strong></td>
<td>router bgp as-number</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config)# router bgp 2000</td>
</tr>
<tr>
<td></td>
<td>Enters router configuration mode and creates a BGP routing process.</td>
</tr>
<tr>
<td><strong>Step 13</strong></td>
<td>neighbor ip-address remote-as autonomous-system-number</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-router)# neighbor 192.168.101.1 remote-as 2000</td>
</tr>
<tr>
<td></td>
<td>Specifies that the neighbor belongs to the autonomous system.</td>
</tr>
<tr>
<td><strong>Step 14</strong></td>
<td>address-family vpnv4</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-router)# address-family vpnv4</td>
</tr>
<tr>
<td></td>
<td>Enters address family configuration mode to configure BGP peers to accept address family-specific configurations.</td>
</tr>
<tr>
<td><strong>Step 15</strong></td>
<td>neighbor ip-address activate</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-router-af)# neighbor 192.168.101.1 activate</td>
</tr>
<tr>
<td></td>
<td>Activates the specified neighbor.</td>
</tr>
<tr>
<td><strong>Step 16</strong></td>
<td>neighbor ip-address route-map map-name out</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-router-af)# neighbor 192.168.101.1 route-map vpn-id-map1 out</td>
</tr>
<tr>
<td></td>
<td>Applies the specified outgoing route map to the specified neighbor.</td>
</tr>
</tbody>
</table>
Replacing a VPN Distinguisher Attribute with an RT

Perform this task on an ingress ASBR to replace a VPN distinguisher extended community attribute with a route target (RT) attribute. This task assumes you already configured the egress ASBR to replace the RT with a VPN distinguisher; that task is described in the “Replacing an RT with a VPN Distinguisher Attribute” section.

SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `ip extcommunity-list expanded-list {permit | deny} vpn-distinguisher id`
4. `exit`
5. `route-map map-tag {permit | deny} [sequence-number]`
6. `match extcommunity extended-community-list-name`
7. `set extcomm-list extcommunity-name delete`
8. `set extcommunity rt value additive`
9. `exit`
10. `route-map map-tag {permit | deny} [sequence-number]`
11. `exit`
12. `router bgp as-number`
13. `neighbor ip-address remote-as autonomous-system-number`
14. `address-family vpng`
15. `neighbor ip-address activate`
16. `neighbor ip-address route-map map-name in`
17. `exit-address-family`

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td><strong>Purpose</strong></td>
</tr>
<tr>
<td><code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><code>Example:</code></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><code>Device&gt; enable</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><code>configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><code>Example:</code></td>
<td></td>
</tr>
<tr>
<td><code>Device# configure terminal</code></td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Configures an IP extended community list to configure Virtual Private Network (VPN) route filtering, such that routes with the specified VPN distinguisher are in the extended community list.</td>
</tr>
<tr>
<td>ip extcommunity-list expanded-list {permit</td>
<td>deny} vpn-distinguisher id</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config)# ip extcommunity-list 51 permit vpn-distinguisher 111:100</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>Exits the configuration mode and enters the next higher configuration mode.</td>
</tr>
<tr>
<td>exit</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config-extcomm-list)# exit</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>Configures a route map that permits or denies the routes allowed by the subsequent match command.</td>
</tr>
<tr>
<td>route-map map-tag {permit</td>
<td>deny} [sequence-number]</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config)# route-map vpn-id-rewrite-map1 permit 10</td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>Matches on the specified community list.</td>
</tr>
<tr>
<td>match extcommunity extended-community-list-name</td>
<td>• For this example, routes that match the extended community list 51 (which was configured in Step 3) are subject to the subsequent set commands.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config-route-map)# match extcommunity 51</td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>Deletes the VPN distinguisher from routes that are in the specified extended community list.</td>
</tr>
<tr>
<td>set extcomm-list extcommunity-name delete</td>
<td>• For this example, VPN distinguishers are deleted from routes that are in extended community list 51.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config-route-map)# set extcomm-list 51 delete</td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td>Sets the routes that are permitted by the route map with the specified RT.</td>
</tr>
<tr>
<td>set extcommunity rt value additive</td>
<td>• For this example, routes that match extended community 51 have their RT set to 101:1. The additive keyword causes the RT to be added to the RT list without replacing any RTs.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config-route-map)# set extcommunity rt 101:1 additive</td>
</tr>
<tr>
<td><strong>Step 9</strong></td>
<td>Exits route-map configuration mode and enters global configuration mode.</td>
</tr>
<tr>
<td>exit</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config-route-map)# exit</td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td>(Optional) Configures a route map entry that permits routes.</td>
</tr>
<tr>
<td>route-map map-tag {permit</td>
<td>deny} [sequence-number]</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Device(config)# route-map vpn-id-rewrite-map1 permit 20</td>
<td>distinguisher-to-RT mapping. If you do not perform this step, all other routes are subject to an implicit deny.</td>
</tr>
</tbody>
</table>

**Step 11**

exit

**Example:**

Device(config-route-map)# exit

Exits route-map configuration mode and enters global configuration mode.

**Step 12**

router bgp as-number

**Example:**

Device(config)# router bgp 3000

Enters router configuration mode and creates a BGP routing process.

**Step 13**

neighbor ip-address remote-as autonomous-system-number

**Example:**

Device(config-router)# neighbor 192.168.0.81 remote-as 3000

Specified that the neighbor belongs to the autonomous system.

**Step 14**

address-family vpnv4

**Example:**

Device(config-router-af)# address-family vpnv4

Enters address family configuration mode to configure BGP peers to accept address family-specific configurations.

**Step 15**

neighbor ip-address activate

**Example:**

Device(config-router-af)# neighbor 192.168.0.81 activate

Activates the specified neighbor.

**Step 16**

neighbor ip-address route-map map-name in

**Example:**

Device(config-router-af)# neighbor 192.168.0.81 route-map vpn-id-rewrite-map1 in

Applies the specified outgoing route map to the specified neighbor.

**Step 17**

exit-address-family

**Example:**

Device(config-router-af)# exit-address-family

Exits address family configuration mode and enters privileged EXEC mode.
Example

Configuration Examples for BGP-VPN Distinguisher Attribute

Example: Translating RT to VPN Distinguisher to RT

The following example shows the egress ASBR configuration to replace a route target (RT) with a VPN distinguisher, and shows the ingress ASBR configuration to replace the VPN distinguisher with a route target.

On the egress ASBR, IP extended community list 1 is configured to filter VPN routes by permitting only routes with RT 101:100. A route map named vpn-id-map1 says that any route that matches on routes that are allowed by IP extended community list 1 are subject to two set commands. The first set command deletes the RT from the route. The second set command sets the VPN distinguisher attribute to 111:100.

The route-map vpn-id-map1 permit 20 command allows other routes, which are not part of the RT-to-VPN distinguisher mapping, to pass the route map so that they are not discarded. Without this command, the implicit deny would cause these routes to be discarded.

Finally, in autonomous system 2000, for the VPNv4 address family, the route map vpn-id-map1 is applied to routes going out to the neighbor at 192.168.101.1.

Egress ASBR

ip extcommunity-list 1 permit rt 101:100
!
route-map vpn-id-map1 permit 10
match extcommunity 1
set extcomm-list 1 delete
set extcommunity vpn-distinguisher 111:100
!
route-map vpn-id-map1 permit 20
!
router bgp 2000
neighbor 192.168.101.1 remote-as 2000
address-family vpnv4
neighbor 192.168.101.1 activate
neighbor 192.168.101.1 route-map vpn-id-map1 out
exit-address-family
!

On the ingress ASBR, IP extended community list 51 allows routes with a VPN distinguisher of 111:100. A route map named vpn-id-rewrite-map1 says that any route that matches on routes that are allowed by IP extended community list 51 are subject to two set commands. The first set command deletes the VPN distinguisher from the route. The second set command sets the RT to 101:1, and that RT is added to the RT list without replacing any RTs.

The route-map vpn-id-rewrite-map1 permit 20 command allows other routes, which are not part of the VPN distinguisher-to-RT mapping, to pass the route map so that they are not discarded. Without this command, the implicit deny would cause those routes to be discarded.
Finally, in autonomous system 3000, for the VPNv4 address family, the route map named vpn-id-rewrite-map1 is applied to incoming routes destined for the neighbor at 192.168.0.81.

**Ingress ASBR**

```
ip extcommunity-list 51 permit vpn-distinguisher 111:100
route-map vpn-id-rewrite-map1 permit 10
  match extcommunity 51
  set extcomm-list 51 delete
  set extcommunity rt 101:1 additive
route-map vpn-id-rewrite-map1 permit 20
  router bgp 3000
  neighbor 192.168.0.81 remote-as 3000
  address-family vpnv4
  neighbor 192.168.0.81 activate
  neighbor 192.168.0.81 route-map vpn-id-rewrite-map1 in
  exit-address-family
```

### Additional References

**Related Documents**

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
</tbody>
</table>

**MIBs**

<table>
<thead>
<tr>
<th>MIB</th>
<th>MIBs Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
</tr>
</tbody>
</table>

**Technical Assistance**

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>
Feature Information for BGP-VPN Distinguisher Attribute

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 88: Feature Information for BGP—VPN Distinguisher Attribute

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP—VPN Distinguisher Attribute</td>
<td>Cisco IOS XE Release 3.8S</td>
<td>The BGP—VPN Distinguisher Attribute feature allows a network administrator to keep source RTs private from an ASBR in a destination autonomous system. An RT at an egress ASBR is mapped to a VPN distinguisher, the VPN distinguisher is carried through the eBGP, and then it is mapped to an RT at the ingress ASBR. The following command was introduced:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• set extcommunity vpn-distinguisher</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The following command was modified:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• show ip bgp vpnv4</td>
</tr>
</tbody>
</table>
BGP-RT and VPN Distinguisher Attribute Rewrite Wildcard

The BGP—RT and VPN Distinguisher Attribute Rewrite Wildcard feature introduces the ability to set a range of route target (RT) community attributes or VPN distinguishing community attributes when mapping them. A network administrator might want to map one or more RTs at an egress ASBR to different RTs at an ingress ASBR. The VPN Distinguisher Attribute feature allows an administrator to map RTs to a VPN distinguisher that is carried through an eBGP and then mapped to RTs at an ingress ASBR. The mapping is achieved by configuring a route map that sets an RT range or VPN distinguisher range of extended community attributes. Specifying a range rather than individual RTs saves time and simplifies the configuration. Furthermore, a VPN distinguisher range allows more than one VPN distinguisher attribute per route-map clause, thereby removing the restriction that applied prior to this feature.

Finding Feature Information

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.
Restrictions for BGP-RT and VPN Distinguisher Attribute Rewrite Wildcard

- A range (specified in the `set extcommunity rt` command or the `set extcommunity vpn-distinguisher` command) can include a maximum of 450 extended communities.
- The VPN distinguisher range is not relayed to an iBGP peer.

Information About BGP—RT and VPN Distinguisher Attribute Rewrite Wildcard

Benefits of RT and VPN Distinguisher Attribute Mapping Range

A network administrator might want to rewrite (or map) one or more route targets (RTs) at an egress ASBR to different RTs at an ingress ASBR. One use case would be to keep the RTs at the egress ASBR private from the ingress ASBR.

The rewrite is achieved by using inbound route maps, matching prefixes to route-map clauses that match inbound RTs, and mapping those RTs to different RTs recognized by the neighbor AS. Such a rewrite configuration could be complex on inbound route maps, with potentially hundreds of RTs that would need to be specified individually (configuring `set extcommunity rt value1 value2 value3 ...`). If the RTs being attached to the prefixes are consecutive, the configuration can be simplified by specifying a range of RTs. Thus, the benefits of the RT mapping range are saving time and simplifying the configuration.

Likewise, the mapping of RTs to a VPN distinguisher attribute (and vice versa) can also be simplified by specifying a range of RTs or VPN distinguishers. The BGP—VPN Distinguisher Attribute feature allows a network administrator to keep source RTs private from an ASBR in a destination AS. An RT at an egress ASBR is mapped to a VPN distinguisher, the VPN distinguisher is carried through the eBGP, and then it is mapped to an RT at the ingress ASBR.

The RT and VPN Distinguisher Attribute Mapping Range feature introduces the ability to specify a range of either route targets (RTs) or VPN distinguishers when mapping them.

Another benefit applies to setting a VPN distinguisher. Prior to this feature, only one `set extcommunity vpn-distinguisher` value was allowed per route-map clause. With the introduction of the mapping range, a range of VPN distinguishers can be set on a route.

How to Map RTs to RTs Using a Range

Replacing an RT with a Range of RTs

Perform this task on an egress ASBR to replace a route target (RT) with an RT range. Remember to replace the range of RTs with an RT on the ingress ASBR; that task is described in the “Replacing a Range of RTs with an RT” section.
SUMMARY STEPS

1. enable
2. configure terminal
3. ip extcommunity-list expanded-list \{permit | deny\} rt value
4. exit
5. route-map map-tag \{permit | deny\} \[sequence-number\]
6. match extcommunity extended-community-list-name
7. set extcomm-list extcommunity-name delete
8. set extcommunity rt range start-value end-value
9. exit
10. route-map map-tag \{permit | deny\} \[sequence-number\]
11. exit
12. router bgp as-number
13. neighbor ip-address remote-as autonomous-system-number
14. address-family vpnv4
15. neighbor ip-address activate
16. neighbor ip-address route-map map-tag out
17. exit-address-family

DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td></td>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>ip extcommunity-list expanded-list {permit</td>
<td>deny} rt value</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>• This example permits routes having RT 101:100 into the extended community list 22.</td>
</tr>
<tr>
<td></td>
<td>Device(config)# ip extcommunity-list 22 permit rt 101:100</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>exit</td>
<td>Exits the configuration mode and enters the next higher configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config-extcomm-list)# exit</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>route-map map-tag {permit</td>
<td>deny} [sequence-number]</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td><code>Device(config)# route-map rt-mapping permit 10</code></td>
<td>- This example permits the routes allowed by the subsequent <code>match</code> command.</td>
<td></td>
</tr>
</tbody>
</table>
| **Step 6** | **match extcommunity** *extended-community-list-name*  
**Example:**  
`Device(config-route-map)# match extcommunity 22` | Matches on the specified community list.  
- For this example, routes that match the extended community list 22 (which was configured in Step 3) are subject to the subsequent `set` commands. |
| **Step 7** | **set extcomm-list** *extcommunity-name delete*  
**Example:**  
`Device(config-route-map)# set extcomm-list 22 delete` | Deletes the RT from routes that are in the specified extended community list.  
- For this example, RTs are deleted from routes that are in extended community list 22. |
| **Step 8** | **set extcommunity rt range** *start-value end-value*  
**Example:**  
`Device(config-route-map)# set extcommunity rt range 500:1 500:9` | For the routes that are permitted by the route map, sets the specified RT range of extended community attributes, inclusive.  
- For this example, routes that match extended community 22 have their RT extended community attribute values set to 500:1, 500:2, 500:3, 500:4, 500:5, 500:6, 500:7, 500:8, and 500:9. |
| **Step 9** | **exit**  
**Example:**  
`Device(config-route-map)# exit` | Exits route-map configuration mode and enters global configuration mode. |
| **Step 10** | **route-map** *map-tag* {permit | deny} [sequence-number]  
**Example:**  
`Device(config)# route-map rt-mapping permit 20` | (Optional) Configures a route map entry that permits routes.  
- This example configures a route map entry that permits other routes not subject to the RT-to-RT range mapping. If you do not perform this step, all other routes are subject to an implicit deny. |
| **Step 11** | **exit**  
**Example:**  
`Device(config-route-map)# exit` | Exits route-map configuration mode and enters global configuration mode. |
| **Step 12** | **router bgp** *as-number*  
**Example:**  
`Device(config)# router bgp 3000` | Enters router configuration mode and creates a BGP routing process. |
### Replacing a Range of RTs with an RT

Perform this task on an ingress ASBR to replace an RT range of attributes with an RT attribute. This task assumes you already configured the egress ASBR to replace the RT with an RT range; that task is described in the “Replacing an RT with a Range of RTs” section.

#### SUMMARY STEPS

1. enable
2. configure terminal
3. ip extcommunity-list expanded-list {permit | deny} rt reg-exp
4. exit
5. route-map map-tag {permit | deny} [sequence-number]
6. match extcommunity extended-community-list-name
7. set extcomm-list extcommunity-name delete
8. set extcommunity rt value additive
9. exit
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td><strong>enable</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Device&gt; enable</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td><strong>configure terminal</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Device# configure terminal</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>**ip extcommunity-list expanded-list {permit</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td><strong>exit</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Device(config-extcomm-list)# exit</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>**route-map map-tag {permit</td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td><strong>match extcommunity extended-community-list-name</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Device(config-route-map)# match extcommunity 128</td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td><strong>set extcomm-list extcommunity-name delete</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;</td>
</tr>
</tbody>
</table>

**10. route-map map-tag {permit | deny} [sequence-number]**

**11. exit**

**12. router bgp as-number**

**13. neighbor ip-address remote-as autonomous-system-number**

**14. address-family vpnv4**

**15. neighbor ip-address activate**

**16. neighbor ip-address route-map map-tag in**

**17. exit-address-family**

---

**Purpose**

Enables privileged EXEC mode.<br>• Enter your password if prompted.

Enters global configuration mode.

Configures an IP extended community list to configure Virtual Private Network (VPN) route filtering, such that routes with the specified RT range are in the extended community list.<br>• This example permits routes having RTs in the range 500:1 to 500:9 into the extended community list 128.

Exits the configuration mode and enters the next higher configuration mode.

Configures a route map that permits or denies the routes allowed by the subsequent `match` command.<br>• This example permits the routes allowed by the subsequent `match` command.

Matches on the specified community list.<br>• In this example, routes that match the extended community list 128 (which was configured in Step 3) are subject to the subsequent `set` commands.

Deletes the RTs in the range from routes that are in the specified extended community list.
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>Device(config-route-map)# set extcomm-list 128 delete</code></td>
<td>• In this example, RTs in the range are deleted from routes that are in extended community list 128.</td>
</tr>
<tr>
<td><strong>Step 8</strong> set extcommunity rt value additive</td>
<td>Sets the routes that are permitted by the route map with the specified RT.</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>Device(config-route-map)# set extcommunity rt 400:1 additive</code></td>
<td>• In this example, routes that match extended community 128 have their RT set to 400:1. The <strong>additive</strong> keyword causes the RT to be added to the RT list without replacing any RTs.</td>
</tr>
<tr>
<td><strong>Step 9</strong> exit</td>
<td>Exits route-map configuration mode and enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>Device(config-route-map)# exit</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 10</strong> route-map map-tag {permit</td>
<td>deny} [sequence-number]</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>Device(config)# route-map rtmap2 permit 20</code></td>
<td>• This example configures a route map entry that permits other routes not subject to the RT-range-to-RT mapping. If you do not perform this step, all other routes are subject to an implicit deny.</td>
</tr>
<tr>
<td><strong>Step 11</strong> exit</td>
<td>Exits route-map configuration mode and enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>Device(config-route-map)# exit</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 12</strong> router bgp as-number</td>
<td>Enters router configuration mode and creates a BGP routing process.</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>Device(config)# router bgp 4000</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 13</strong> neighbor ip-address remote-as autonomous-system-number</td>
<td>Specifies that the neighbor belongs to the autonomous system.</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>Device(config-router)# neighbor 192.168.0.50 remote-as 4000</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 14</strong> address-family vpnv4</td>
<td>Enters address family configuration mode to configure BGP peers to accept address-family-specific configurations.</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>Device(config-router-af)# address-family vpnv4</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 15</strong> neighbor ip-address activate</td>
<td>Activates the specified neighbor.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
</tbody>
</table>
Configuration Examples for BGP—RT and VPN Distinguisher Attribute Rewrite Wildcard

Example: Replacing an RT with a Range of RTs

In the following example, on the egress ASBR, routes having RT 101:100 are in the extended community list 22. A route-map named rt-mapping matches on extended community list 22 and deletes the RT from routes in the community list. Routes that match the community list have their RT set to an RT in the range from 500:1 to 500:9. The route map is applied to the neighbor 192.168.103.1.

**Egress ASBR**

```plaintext
ip extcommunity-list 22 permit rt 101:100
route-map rt-mapping permit 10
match extcommunity 22
set extcomm-list 22 delete
set extcommunity rt range 500:1 500:9
route-map rt-mapping permit 20
router bgp 3000
neighbor 192.168.103.1 remote-as 3000
address-family vpnv4
neighbor 192.168.103.1 activate
neighbor 192.168.103.1 route-map rt-mapping out
exit-address-family
```

On the ingress ASBR, RTs in the range 500:1 to 500:9 belong to extended community list 128. A route map named rtmap2 maps those RTs to RT 400:1. The route map is applied to the neighbor 192.168.0.50.
Ingress ASBR

```
ip extcommunity-list 128 permit RT:500:[1-9]
!
route-map rtmap2 permit 10
  match extcommunity 128
  set extcomm-list 128 delete
  set extcommunity rt 400:1 additive
!
route-map rtmap2 permit 20
!
router bgp 4000
  neighbor 192.168.0.50 remote-as 4000
  address-family vpnv4
    neighbor 192.168.0.50 activate
    neighbor 192.168.0.50 route-map rtmap2 in
  exit-address-family
```

**Example: Replacing an RT with a Range of VPN Distinguishers**

In the following example, on the egress ASBR, routes having RT 201:100 are in the extended community list 22. A route-map named rt-mapping matches on extended community list 22 and deletes the RT from routes in the community list. Routes that match the community list have their VPN distinguishers set to VPN distinguishers in the range from 600:1 to 600:8. The route map is applied to the neighbor 192.168.103.1.

**Egress ASBR**

```
ip extcommunity-list 22 permit rt 201:100
!
route-map rt-mapping permit 10
  match extcommunity 22
  set extcomm-list 22 delete
  set extcommunity vpn-distinguisher range 600:1 600:8
!
route-map rt-mapping permit 20
!
router bgp 3000
  neighbor 192.168.103.1 remote-as 3000
  address-family vpnv4
    neighbor 192.168.103.1 activate
    neighbor 192.168.103.1 route-map rt-mapping out
  exit-address-family
```

On the ingress ASBR, VPN distinguishers in the range 600:1 to 600:8 belong to extended community list 101. A route map named rtmr2 maps those VPN distinguishers to RT range 700:1 700:10. The route map is applied to the neighbor 192.168.0.50. The additive option adds the new range to the existing value without replacing it.

**Ingress ASBR**

```
ip extcommunity-list 101 permit VD:600:[1-8]
!
route-map rtmr2 permit 10
  match extcommunity 101
```
set extcomm-list 101 delete
set extcommunity rt 700:1 700:10 additive
!
route-map rtmap2 permit 20
!
router bgp 4000
neighbor 192.168.0.50 remote-as 4000
address-family vpnv4
  neighbor 192.168.0.50 activate
  neighbor 192.168.0.50 route-map rtmap2 in
  exit-address-family
!

Additional References for BGP-RT and VPN Distinguisher Attribute Rewrite Wildcard

Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Commands List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/support">http://www.cisco.com/support</a></td>
</tr>
</tbody>
</table>
Feature Information for BGP—RT and VPN Distinguisher Attribute Rewrite Wildcard

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
</table>
| BGP—RT and VPN Distinguisher Attribute Rewrite Wildcard | Cisco IOS XE 3.9S | The BGP—RT and VPN Distinguisher Attribute Rewrite Wildcard feature introduces the ability to set a range of route target (RT) community attributes or VPN distinguisher community attributes when mapping them. A network administrator might want to map one or more RTs at an egress ASBR to different RTs at an ingress ASBR. The VPN Distinguisher Attribute feature allows an administrator to map RTs to a VPN distinguisher that is carried through an eBGP and then mapped to RTs at an ingress ASBR. The mapping is achieved by configuring a route map that sets an RT range or VPN distinguisher range of extended community attributes. Specifying a range rather than individual RTs saves time and simplifies the configuration. Furthermore, a VPN distinguisher range allows more than one VPN distinguisher attribute per route-map clause, thereby removing the restriction that applied prior to this feature. The following commands were modified:  
• `set extcommunity rt`  
• `set extcommunity vpn-distinguisher` |
VPLS BGP Signaling

The two primary functions of the Virtual Private LAN Service (VPLS) control plane are autodiscovery and signaling. The VPLS BGP Signaling feature enables you to use BGP as both an autodiscovery and a signaling protocol for VPLS, in accordance with RFC 4761.

- Finding Feature Information, on page 1025
- Prerequisites for VPLS BGP Signaling, on page 1025
- Information About VPLS BGP Signaling, on page 1026
- How to Configure VPLS BGP Signaling, on page 1027
- Configuration Examples for VPLS BGP Signaling, on page 1029
- Additional References for VPLS BGP Signaling, on page 1030
- Feature Information for VPLS BGP Signaling, on page 1031

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for VPLS BGP Signaling

You are familiar with the concepts in the “Configuring Virtual Private LAN Services” and the “VPLS Autodiscovery BGP Based” modules of the.
Information About VPLS BGP Signaling

Overview of VPLS BGP Signaling

Prior to the VPLS BGP Signaling feature, BGP was used for autodiscovery and Label Distribution Protocol (LDP) for signaling in accordance with RFC 6074. The VPLS BGP Signaling feature enables you to use BGP as the control plane protocol for both autodiscovery and signaling in accordance with RFC 4761.

As specified in RFC 4761, internal BGP (iBGP) peers will exchange update messages of the L2VPN AFI/SAFI with L2VPN information to perform both autodiscovery and signaling. The BGP multiprotocol Network Layer Reachability Information (NLRI) consists of a Route Distinguisher (RD), VPLS Endpoint ID (VE ID), VE Block Offset (VBO), VE Block Size (VBS), and Label Base (LB).

The figure below shows the format of the NLRI for RFC 4761.

Figure 89: RFC 4761 NLRI

Additional information, such as next-hop, route target (specified for a VPLS instance), and other Layer 2 data are carried in the BGP extended community attributes. A route target-based import/export mechanism similar to L3VPN is performed by BGP to filter L2VPN NLRIs of a particular VPLS instance.

Whether you use BGP signaling (RFC 4761) or LDP signaling (RFC 6074) depends on the commands you specify. To enable the VPLS BGP Signaling feature, use the `autodiscovery bgp signaling bgp` command in L2 VFI configuration mode. This command is supported on a per VPLS instance basis.

If a BGP session receives an invalid (that is, not matching the configuration) BGP update advertisement (update or withdraw), it is ignored.

BGP’s main task in supporting VPLS is route distribution via the L2VPN address family and interactions with L2VPN. Interactions between BGP and other components remain the same. Basic BGP functionalities like best-path selection, next-hop handling, and update generation, continue to operate in the same manner with VPLS BGP signaling. BGP RT constraint works seamlessly with the BGP VPLS Signaling feature.
How to Configure VPLS BGP Signaling

Configuring VPLS BGP Signaling

SUMMARY STEPS

1. enable
2. configure terminal
3. l2vpn vfi context name
4. vpn id vpn-id
5. autodiscovery bgp signaling \{bgp | ldp\} [template template-name]
6. ve id ve-id
7. ve range ve-range
8. exit
9. exit
10. router bgp autonomous-system-number
11. bgp graceful-restart
12. neighbor ip-address remote-as autonomous-system-number
13. address-family l2vpn [vpls]
14. neighbor ip-address activate
15. neighbor ip-address send-community [both | standard | extended]
16. neighbor ip-address suppress-signaling-protocol ldp
17. end
18. show bgp l2vpn vpls \{all \textbar rd route-distinguisher\}

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** enable | Enables privileged EXEC mode.  
| **Example:** | • Enter your password if prompted.  
| Device> enable | |
| **Step 2** configure terminal | Enters global configuration mode.  
| **Example:** | |
| Device# configure terminal | |
| **Step 3** l2vpn vfi context name | Establishes a L2VPN virtual forwarding interface (VFI) between two or more separate networks and enters Layer 2 VFI configuration mode.  
<p>| <strong>Example:</strong> | |
| Device(config)# l2vpn vfi context vfi1 | |</p>
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 4</strong></td>
<td><strong>vpn id vpn-id</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Device(config-vfi)# vpn id 100</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>**autodiscovery bgp signaling {bgp</td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td><strong>ve id ve-id</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Device(config-vfi-autodiscovery)# ve id 1001</td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td><strong>ve range ve-range</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Device(config-vfi-autodiscovery)# ve range 12</td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td><strong>exit</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Device(config-vfi-autodiscovery)# exit</td>
</tr>
<tr>
<td><strong>Step 9</strong></td>
<td><strong>exit</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Device(config-vfi)# exit</td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td><strong>router bgp autonomous-system-number</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Device(config)# router bgp 100</td>
</tr>
<tr>
<td><strong>Step 11</strong></td>
<td><strong>bgp graceful-restart</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Device(config-router)# bgp graceful-restart</td>
</tr>
<tr>
<td><strong>Step 12</strong></td>
<td><strong>neighbor ip-address remote-as autonomous-system-number</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Device(config-router)# neighbor 10.10.10.1 remote-as 100</td>
</tr>
<tr>
<td>Step</td>
<td>Command or Action</td>
</tr>
<tr>
<td>------</td>
<td>-------------------------------------------------------</td>
</tr>
<tr>
<td>13</td>
<td><code>address-family l2vpn [vpls]</code></td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td></td>
<td>Device(config-router)# <code>address-family l2vpn vpls</code></td>
</tr>
<tr>
<td></td>
<td><strong>In this example, an L2VPN VPLS address family session is created.</strong></td>
</tr>
<tr>
<td>14</td>
<td><code>neighbor ip-address activate</code></td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td></td>
<td>Device(config-router-af)# <code>neighbor 10.10.10.1 activate</code></td>
</tr>
<tr>
<td>15</td>
<td>`neighbor ip-address send-community [both</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td></td>
<td>Device(config-router-af)# <code>neighbor 10.10.10.1 send-community extended</code></td>
</tr>
<tr>
<td></td>
<td><strong>In this example, an extended communities attribute is sent to the neighbor at 10.10.1.</strong></td>
</tr>
<tr>
<td>16</td>
<td><code>neighbor ip-address suppress-signaling-protocol ldp</code></td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td></td>
<td>Device(config-router-af)# <code>neighbor 10.10.10.1 suppress-signaling-protocol ldp</code></td>
</tr>
<tr>
<td></td>
<td><strong>In this example LDP signaling is suppressed (and BGP signaling enabled) for the neighbor at 10.10.1.</strong></td>
</tr>
<tr>
<td>17</td>
<td><code>end</code></td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td></td>
<td>Device(config-router-af)# <code>end</code></td>
</tr>
<tr>
<td>18</td>
<td>`show bgp l2vpn vpls {all</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td></td>
<td>Device# <code>show bgp l2vpn vpls all</code></td>
</tr>
</tbody>
</table>

## Configuration Examples for VPLS BGP Signaling

### Example: Configuring and Verifying VPLS BGP Signaling

```
12vpn vfi context vfi1
vpn id 100
```
autodiscovery bgp signaling bgp
  ve id 1001
  ve range 10
!
router bgp 100
  bgp graceful-restart
  neighbor 209.165.200.224 remote-as 100
  neighbor 209.165.200.224 update-source Loopback1
!
  address-family l2vpn vpls
  neighbor 209.165.200.224 activate
  neighbor 209.165.200.224 send-community extended
  neighbor 209.165.200.224 suppress-signaling-protocol ldp
  exit-address-family
!
  show bgp l2vpn vpls all

<table>
<thead>
<tr>
<th>Network</th>
<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>*&gt;100:100:VEID=1001:Blk=1001/136 0.0.0.0</td>
<td></td>
<td></td>
<td></td>
<td>32768</td>
<td>?</td>
</tr>
<tr>
<td>*&gt;1 100:100:VEID=1003:Blk=1000/136 209.165.200.224</td>
<td></td>
<td></td>
<td>100</td>
<td>0</td>
<td>?</td>
</tr>
</tbody>
</table>

Additional References for VPLS BGP Signaling

Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands: complete command syntax, command mode, defaults, command history, usage guidelines, and examples.</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
<tr>
<td>Configuring Virtual Private LAN Services</td>
<td></td>
</tr>
<tr>
<td>Configuring Access Port</td>
<td>Configuring Virtual Private LAN Services,</td>
</tr>
<tr>
<td>VPLS Autodiscovery BGP Based</td>
<td></td>
</tr>
</tbody>
</table>

Standards and RFCs

<table>
<thead>
<tr>
<th>Standard/RFC</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFC 4761</td>
<td>Virtual Private LAN Service (VPLS) Using BGP for Auto-Discovery and Signaling</td>
</tr>
<tr>
<td>RFC 6074</td>
<td>Provisioning, Auto-Discovery, and Signaling in Layer 2 Virtual Private Networks (L2VPNs)</td>
</tr>
</tbody>
</table>
Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

Feature Information for VPLS BGP Signaling

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to [www.cisco.com/go/cfn](http://www.cisco.com/go/cfn). An account on Cisco.com is not required.

Table 90: Feature Information for VPLS BGP Signaling

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>VPLS BGP Signaling</td>
<td>Cisco IOS XE Release 3.8S</td>
<td>The VPLS BGP Signaling feature enables you to use BGP as both an autodiscovery and signaling protocol for VPLS, in accordance with RFC 4761. The following commands were introduced or modified: <code>autodiscovery (MPLS)</code>, <code>neighbor suppress-signaling-protocol</code>, <code>show bgp l2vpn vpls</code>, and <code>ve</code>.</td>
</tr>
</tbody>
</table>
CHAPTER 71

Multicast VPN BGP Dampening

A single receiver in a specific multicast group or a group of receivers that are going up and down frequently and interested in a specific multicast group activates the Multicast VPN BGP Dampening feature to dampen type 7 routes (C-multicast route Join/Prune) within the core using BGP signaling. The feature reduces the churn caused by customer-side join/prune requests to avoid unnecessary BGP MVPN type 6/7 C-route control information.

- Finding Feature Information, on page 1033
- Prerequisites for Multicast VPN BGP Dampening, on page 1033
- Information About Multicast VPN BGP Dampening, on page 1034
- How to Configure Multicast VPN BGP Dampening, on page 1035
- Configuration Examples for Multicast VPN BGP Dampening, on page 1037
- Additional References for Multicast VPN BGP Dampening, on page 1038
- Feature Information for Multicast VPN BGP Dampening, on page 1038

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for Multicast VPN BGP Dampening

- You understand the concepts in the “BGP Route Dampening” module of the IP Routing: BGP Configuration Guide.
Information About Multicast VPN BGP Dampening

Overview of Multicast VPN BGP Dampening

BGP Route Dampening

Route dampening is a BGP feature designed to minimize the propagation of flapping routes across an internetwork. A route is considered to be flapping when its availability alternates repeatedly. Cisco devices that are running BGP contain a mechanism designed to “dampen” the destabilizing effect of flapping routes. When a Cisco device running BGP detects a flapping route, it automatically dampens that route.

The figure below shows illustrates the Multicast VPN BGP dampening mechanism.

Multicast VPN BGP Dampening

A single receiver in a multicast group or a group of receivers that are flapping frequently and interested in a specific multicast group activates multicast VPN (MVPN) BGP dampening. MVPN BGP dampening dampens the type 7 multicast routes (customer-multicast, or “C-multicast,” route join/prune) within the core using BGP signaling.

When MVPN BGP dampening is not enabled, the source sends data even though the receiver may be down. When the receiver is down, there is no periodic 60-second C-PIM join towards the provider edge (PE) device causing the PIM to timeout on the PE side after the default period (three minutes). The MVPN manager sends a prune message to BGP, which is a type 7 route (C-multicast route withdraw).

When the receiver is up, it sends a new (S,G) join request to the customer edge (CE) device. The C-PIM join is received by the PE device and a new type 7 C-multicast update is sent by BGP to the auto-discovered MVPN peers. The upstream multicast peer converts the BGP type 7 update to a PIM join to the source, and the source sends the data traffic that the receiver should receive via the downstream PE using the MDT tunnel. If the receiver goes up and down frequently, the source side PIM receives join/prune messages frequently and can cause the source to respond accordingly.
When MVPN BGP dampening is enabled, the general dampening mechanism in BGP will be applied to MVPN VRF instances. Join/Prune messages from the CE side are sent from an MVPN manager as updates/withdraw to the MVPN PE device. The MVPN manager on PE devices send join/prune messages to the customer side for Reverse Path Forwarding (RPF) and upstream multihop (UMH) next hop changes.

# How to Configure Multicast VPN BGP Dampening

## Configuring Multicast VPN BGP Dampening

Perform this task to enable and configure multicast VPN BGP dampening.

### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `router bgp as-number`
4. `address-family [ipv4 | ipv6] mvpn vrf vrf-name`
5. `bgp dampening [half-life reuse suppress max-suppress-time]`
6. `end`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Step 2</td>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td>router bgp as-number</td>
<td>Enters router configuration mode and creates a BGP routing process.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config)# router bgp 45000</td>
<td></td>
</tr>
<tr>
<td>Step 4</td>
<td>address-family [ipv4</td>
<td>ipv6] mvpn vrf vrf-name</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-router)# address-family ipv4 mvpn vrf blue</td>
<td>• Use the <code>ipv4</code> keyword to enable IPv4 multicast C-route exchange.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Use the <code>ipv6</code> keyword to enable IPv6 multicast C-route exchange.</td>
</tr>
</tbody>
</table>
Monitoring and Maintaining Multicast VPN BGP Dampening

Perform the steps in this task as required to monitor and maintain multicast VPN BGP dampening.

SUMMARY STEPS

1. **enable**

2. **show bgp {ipv4 | ipv6} mvpn {all | rd route-distinguisher | vpn vrf-name} [dampening {dampened-paths | flap-statistics [filter-list access-list-number | quote-regexp regexp | regexp regexp]}]

3. **clear ip bgp {ipv4 | ipv6} mvpn vrf vrf-name {dampening | flap-statistics}**

DETAILED STEPS

**Step 1**

**enable**

Enables privileged EXEC mode. Enter your password if prompted.

**Example:**

```
Device> enable
```

**Step 2**

**show bgp {ipv4 | ipv6} mvpn {all | rd route-distinguisher | vpn vrf-name} [dampening {dampened-paths | flap-statistics [filter-list access-list-number | quote-regexp regexp | regexp regexp]}]**

Use this command to monitor multicast VPN BGP dampening.

- The **dampened-path** keyword displays information about BGP dampened routes.
- The **parameters** keyword displays detailed BGP dampening information.
- The **flap-statistics** keyword displays information on BGP flap statistics.
Example:

Device# show bgp ipv4 mvpn vrf blue route-type 7 111.111.111.111:11111 55 202.100.0.6 232.1.1.1

BGP routing table entry for [7][111.111.111.111:11111][55][202.100.0.6/32][232.1.1.1/32]/22, version 17
Paths: (1 available, no best path)
Flag: 0x820
   Not advertised to any peer
   Refresh Epoch 1
Local, (suppressed due to dampening)
   0.0.0.0 from 0.0.0.0 (205.3.0.3)
   Origin incomplete, localpref 100, weight 32768, valid, sourced, local
   Extended Community: RT:205.1.0.1:1
   Dampinfo: penalty 3472, flapped 4 times in 00:04:42, reuse in 00:00:23
   rx pathid: 0, tx pathid: 0

Step 3 clear ip bgp {ipv4 | ipv6} mvpn vrf vrf-name {dampening | flap-statistics}

Use this command to clear the accumulated penalty for routes that are received on a router that has multicast VPN BGP dampening enabled.

- The dampening keyword clears multicast VPN BGP dampening information.
- The flap-statistic keyword clears multicast VPN BGP dampening flap statistics.

Example:

Device# clear ip bgp ipv4 mvpn vrf blue dampening

Configuration Examples for Multicast VPN BGP Dampening

Example: Configuring Multicast VPN BGP Dampening

The following example shows multicast VPN BGP dampening is applied to the VRFs named blue and red, but not to the VRF named green:

address-family ipv4 mvpn vrf blue
bgp dampening

address-family ipv4 mvpn vrf red
bgp dampening

address-family ipv4 mvpn vrf green
no bgp dampening
Additional References for Multicast VPN BGP Dampening

Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
<tr>
<td>BGP route dampening</td>
<td>“BGP Route Dampening” section of the “Configuring Internal BGP Features” module in the IP Routing: BGP Configuration Guide</td>
</tr>
</tbody>
</table>

Standards and RFCs

<table>
<thead>
<tr>
<th>Standard/RFC</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFC 2439</td>
<td>BGP Route Flap Damping</td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

Feature Information for Multicast VPN BGP Dampening

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.
### Table 91: Feature Information for Multicast VPN BGP Dampening

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multicast VPN BGP Dampening</td>
<td>Cisco IOS XE Release 3.8S</td>
<td>A single receiver in a specific multicast group or a group of receivers that are going up and down frequently and interested in a specific multicast group will cause the Multicast VPN BGP Dampening feature to dampen type 7 routes (C-multicast route join/prune) within the core using BGP signaling. The following commands were introduced or modified: <em>address-family mvpn, clear ip bgp mvpn, show bgp mvpn</em>, and <em>show ip bgp ipv4</em>.</td>
</tr>
</tbody>
</table>
CHAPTER 72

BGP—IPv6 NSR

Border Gateway Protocol (BGP) support for Nonstop Routing (NSR) enables provider edge (PE) routers to maintain BGP state with customer edge (CE) routers and ensure continuous packet forwarding during a Route Processor (RP) switchover or during a planned In-Service Software Upgrade (ISSU) for a PE router. The BGP—IPv6 NSR feature extends BGP support for NSR to Cisco IPv6 VPN Provider Edge Routers (6VPE).

- Finding Feature Information, on page 1041
- Prerequisites for BGP—IPv6 NSR, on page 1041
- Information About BGP—IPv6 NSR, on page 1042
- How to Configure BGP—IPv6 NSR, on page 1042
- Configuration Examples for BGP—IPv6 NSR, on page 1044
- Additional References for BGP—IPv6 NSR, on page 1044
- Feature Information for BGP—IPv6 NSR, on page 1045

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for BGP—IPv6 NSR

- Your network is configured to run BGP.
- Multiprotocol Layer Switching (MPLS) Layer 3 Virtual Private Networks (VPNs) are configured.
- All platforms are HA capable.
- You are familiar with the concepts in the “BGP Support for Nonstop Routing (NSR) with Stateful Switchover (SSO)” and “BGP NSR Support for iBGP Peers” modules of the IP Routing: BGP Configuration Guide.
Information About BGP—IPv6 NSR

Overview of BGP—IPv6 NSR

Nonstop routing (NSR) is beneficial for BGP peers because it reduces the likelihood of dropped packets during switchover from the active Route Processor (RP) to the standby RP. Switchover occurs when the active RP fails for some reason and the standby RP takes control of active RP operations. The BGP—IPv6 NSR feature extends BGP support for NSR to include the following IPv6-based address families:

- IPv6 unicast
- IPv6 unicast + label
- IPv6 PE-CE
- VPNv6 unicast

Figure 91: Basic 6VPE Network Configuration

The figure above depicts a basic deployment scenario. Provider edge (PE) router 1, P, and PE2 form a 6VPE cloud. The customer edge (CE) router 1 to PE1 connection is IPv6 (VRF). The PEs are HA/SSO and NSF capable. The P routers are capable of Multiprotocol Label Switching (MPLS) label preservation (NSF equivalent).

As the CE1 is customer equipment, the provider cannot determine that it must be upgraded to be NSF aware. If PE1 can perform NSR on its connection to CE1, then CE1 will not be aware or impacted when PE1 performs a switchover in SSO mode. For all other connections within the autonomous system, the operations may be NSF or graceful restart. This means the control plane will be reset, and all the immediate peers will be aware of it and will resend data to help re-establish the session, but forwarding will be uninterrupted.

Neighbors not operating under NSR are still expected to be NSF capable/aware. If the CE is already NSF aware (that is, it can handle a BGP graceful restart by its peers), then the PE-CE connection will not be NSR, and will instead follow the regular NSF processing model. This parallels NSR for VPNv4 and assists in conserving network resources.

How to Configure BGP—IPv6 NSR

Configuring BGP—IPv6 NSR

Perform this task on a PE router if you want to configure a BGP peer to support BGP—IPv6 NSR.
**SUMMARY STEPS**

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. Enter one of the following:
   - address-family ipv6 [unicast | multicast | vpnv6] [vrf vrf-name]
   - address-family vpnv6 [unicast | multicast]
5. neighbor ipv6-address% remote-as as-number
6. neighbor ipv6-address% activate
7. neighbor ipv6-address% ha-mode sso
8. end

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td></td>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>router bgp autonomous-system-number</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config)# router bgp 4000</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Enter one of the following:</td>
<td>Specifies the IPv6 address family and enters address family configuration mode.</td>
</tr>
<tr>
<td></td>
<td>• address-family ipv6 [unicast</td>
<td>multicast</td>
</tr>
<tr>
<td></td>
<td>• address-family vpnv6 [unicast</td>
<td>multicast]</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config-router)# address-family ipv6 unicast</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>neighbor ipv6-address% remote-as as-number</td>
<td>Specifies the autonomous system of the neighbor.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config-router-af)# neighbor 2001:DB8:0:CC00::1 remote-as 4000</td>
<td></td>
</tr>
</tbody>
</table>
### Configuration Examples for BGP—IPv6 NSR

**Example: Configuring BGP—IPv6 NSR**

```bash
router bgp 4000
    address-family ipv6 unicast
    neighbor 2001:DB8:0:CC00::1 remote-as 4000
    neighbor 2001:DB8:0:CC00::1 activate
    neighbor 2001:DB8:0:CC00::1 ha-mode sso
```

### Additional References for BGP—IPv6 NSR

#### Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
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<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
</tbody>
</table>
Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support website provides extensive online resources, including</td>
<td><a href="http://www.cisco.com/support">http://www.cisco.com/support</a></td>
</tr>
<tr>
<td>documentation and tools for troubleshooting and resolving technical issues</td>
<td></td>
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<tr>
<td>with Cisco products and technologies.</td>
<td></td>
</tr>
<tr>
<td>To receive security and technical information about your products, you can</td>
<td></td>
</tr>
<tr>
<td>subscribe to various services, such as the Product Alert Tool (accessed from</td>
<td></td>
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<tr>
<td>Field Notices), the Cisco Technical Services Newsletter, and Really Simple</td>
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</tr>
<tr>
<td>Syndication (RSS) Feeds.</td>
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<tr>
<td>Access to most tools on the Cisco Support website requires a Cisco.com user</td>
<td></td>
</tr>
<tr>
<td>ID and password.</td>
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</tbody>
</table>

**Feature Information for BGP—IPv6 NSR**

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

**Table 92: Feature Information for BGP—IPv6 NSR**

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP—IPv6 NSR</td>
<td>Cisco IOS XE Release 3.9S</td>
<td>BGP support for NSR enables provider edge (PE) routers to maintain BGP state with customer edge (CE) routers and ensure continuous packet forwarding during a Route Processor (RP) switchover or during a planned ISSU for a PE router. The BGP—IPv6 NSR feature extends BGP support for NSR to Cisco IPv6 VPN Provider Edge Routers (6VPE).</td>
</tr>
</tbody>
</table>
CHAPTER 73

BGP-VRF-Aware Conditional Advertisement

The Border Gateway Protocol (BGP) VRF-Aware Conditional Advertisement feature provides additional control of the advertisement of routes and extends this control to within a virtual routing and forwarding (VRF) instance.

- Finding Feature Information, on page 1047
- Information About BGP VRF-Aware Conditional Advertisement, on page 1047
- How to Configure BGP VRF-Aware Conditional Advertisement, on page 1049
- Configuration Examples for BGP VRF-Aware Conditional Advertisement, on page 1051
- Additional References for BGP VRF-Aware Conditional Advertisement, on page 1055
- Feature Information for BGP VRF-Aware Conditional Advertisement, on page 1056

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About BGP VRF-Aware Conditional Advertisement

VRF-Aware Conditional Advertisement

The Border Gateway Protocol (BGP) VRF-Aware Conditional Advertisement feature provides additional control of the advertisement of routes and extends this control within a virtual routing and forwarding (VRF) instance.

BGP Conditional Advertisement

Normally, routes are propagated regardless of the existence of a different route. The BGP conditional advertisement feature uses the exist-map, non-exist-map, and the advertise-map keywords of the neighbor
command in order to track routes by the route prefix. If a route prefix is not present in output of the
non-exist-map command, then the route specified by the advertise-map is announced. This feature is useful
for multihomed networks, in which some prefixes are advertised to one of the providers only if information
from the other provider is not present (this indicates a failure in the peering session or partial reachability).
The conditional BGP announcements are sent in addition to the normal announcements that a BGP router
sends to its peers.

VRF-Aware Conditional Advertisement

This feature extends support for BGP VRF-aware conditional advertisement to the following address families:

- IPv4 unicast
- IPv4 unicast VRF
- IPv6 unicast
- IPv6 unicast VRF

The figure above shows the IPv4 prefix 192.168.50.0/24 being advertised by a remote CE101 into VRF RED
on PE1. The prefix flows as a MP-BGP VPN prefix and is imported into the VRF RED on PE4. On the PE4
the conditions configured by the exist-map command relating to this prefix in the BGP VRF RED table
becomes the condition to advertise the prefix 203.0.113.0/24 to the CE104, that is, peer-activated under the
VRF RED on the PE4. This scenario assumes that 203.0.113.0/24 is in the VRF RED BGP table. If
203.0.113.0/24 is not in the table, this policy is ignored.

- If 192.168.50.0/24 exists in PE4’s BGP table, then the 203.0.113.0/24 network is advertised to CE104.
- If 192.168.50.0/24 does not exist in PE4’s BGP table, then the 203.0.113.0/24 network is not advertised
to CE104.
How to Configure BGP VRF-Aware Conditional Advertisement

Configuring BGP VRF-Aware Conditional Advertisement

SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. Enter one of the following:
   - address-family ipv4 [unicast] [vrf vrf-name]
   - address-family ipv6 [unicast] [vrf vrf-name]
5. neighbor {ip-address | ipv6-address} remote-as autonomous-system-number
6. neighbor {ip-address | ipv6-address} activate
7. neighbor {ip-address | ipv6-address} advertise-map map-name {exist-map map-name | non-exist-map map-name}
8. end

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# router bgp 40000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> Enter one of the following:</td>
<td>Specifies the IPv4 or IPv6 address family and enters address family configuration mode.</td>
</tr>
<tr>
<td>- address-family ipv4 [unicast] [vrf vrf-name]</td>
<td>• The <strong>unicast</strong> keyword specifies the IPv4 or IPv6 unicast address family.</td>
</tr>
<tr>
<td>- address-family ipv6 [unicast] [vrf vrf-name]</td>
<td>• The <strong>vrf</strong> keyword and <strong>vrf-name</strong> argument specify the name of the virtual routing and forwarding (VRF)</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router)# address-family ipv4 vrf VRFRED</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Step 5</strong> `neighbor {ip-address</td>
<td>ipv6-address} remote-as autonomous-system-number`</td>
</tr>
<tr>
<td>Step 5 Example: Device(config-router-af)# neighbor 192.0.2.1 remote-as 104</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> `neighbor {ip-address</td>
<td>ipv6-address} activate`</td>
</tr>
<tr>
<td>Step 6 Example: Device(config-router-af)# neighbor 192.0.2.1 activate</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong> `neighbor {ip-address</td>
<td>ipv6-address} advertise-map map-name {exist-map map-name</td>
</tr>
<tr>
<td>Step 7 Example: Device(config-router-af)# neighbor 192.0.2.1 advertise-map ADV-1 exist-map EXIST-1</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong> <code>end</code></td>
<td>Exits address family configuration mode and enters privileged EXEC mode.</td>
</tr>
<tr>
<td>Step 8 Example: Device(config-router-af)# end</td>
<td></td>
</tr>
</tbody>
</table>
What to do next
To verify the configuration of the BGP VRF-Aware Conditional Advertisement feature, use the `show bgp ip neighbors` command.

**Configuration Examples for BGP VRF-Aware Conditional Advertisement**

**Example: Configuring BGP VRF-Aware Conditional Advertisement**

The following examples use the configuration in figure 1:

**CE 101: The source of the prefixes**

```conf
router bgp 101
  bgp log-neighbor-changes
  timers bgp 0 0
  neighbor 172.16.1.2 remote-as 65000
  !
  address-family ipv4
    network 21.21.21.0 mask 255.255.255.0
    network 22.22.22.22 mask 255.255.255.255
    network 31.0.0.0
    network 33.0.0.0
    network 44.0.0.0
    network 2192.0.254 mask 255.255.255.0
    network 192.0.2.50
    neighbor 172.16.1.3 activate
  exit-address-family

PE 1

router bgp 65000
  bgp log-neighbor-changes
  no bgp default ipv4-unicast
  timers bgp 0 0
  neighbor 10.0.0.2 remote-as 65000
  neighbor 10.0.0.2 update-source Loopback0
  !
  address-family ipv4
  exit-address-family
  !
  address-family vpnv4
    neighbor 10.0.0.2 activate
    neighbor 10.0.0.2 send-community both
  exit-address-family
  !
  address-family ipv4 vrf blue
    neighbor 198.51.100.10 remote-as 201
    neighbor 198.51.100.10 activate
  exit-address-family
  !
  address-family ipv4 vrf red
    neighbor 172.16.1.2 remote-as 101
    neighbor 172.16.1.2 activate
  exit-address-family
```
PE 4

router bgp 65000
  bgp log-neighbor-changes
  no bgp default ipv4-unicast
  timers bgp 0 0
  neighbor 10.0.0.2 remote-as 65000
  neighbor 10.0.0.2 update-source Loopback0
!
  address-family ipv4
  exit-address-family
!
  address-family vpnv4
    neighbor 10.0.0.2 activate
    neighbor 10.0.0.2 send-community extended
  exit-address-family
!
  address-family ipv4 vrf blue
    neighbor 198.51.100.12 remote-as 204
    neighbor 198.51.100.12 activate
  exit-address-family
!
  address-family ipv4 vrf red
    neighbor 198.51.100.3 remote-as 104
    neighbor 198.51.100.3 activate
    neighbor 198.51.100.3 advertise-map ADV-1 exist-map EXIST-1
    neighbor 198.51.100.3 advertise-map ADV-2 exist-map EXIST-2
    neighbor 198.51.100.3 advertise-map ADV-3 exist-map EXIST-3
    neighbor 198.51.100.3 advertise-map ADV-4 exist-map EXIST-4
  exit-address-family
!
  ip prefix-list pl-adv-1 seq 5 permit 22.22.22.22/32
!
  ip prefix-list pl-adv-2 seq 5 permit 44.0.0.0/8
!
  ip prefix-list pl-adv-3 seq 5 permit 33.0.0.0/8
!
  ip prefix-list pl-adv-4 seq 5 permit 128.16.16.0/24
!
  ip prefix-list pl-exist-1 seq 5 permit 21.21.21.0/24
!
  ip prefix-list pl-exist-2 seq 5 permit 41.0.0.0/8
!
  ip prefix-list pl-exist-3 seq 5 permit 31.0.0.0/8
!
  ip prefix-list pl-exist-4 seq 5 permit 192.168.50.0/24
!
  route-map EXIST-4 permit 10
    match ip address prefix-list pl-exist-4
!
  route-map ADV-4 permit 10
    match ip address prefix-list pl-adv-4
!
  route-map EXIST-2 permit 10
    match ip address prefix-list pl-exist-2
!
  route-map ADV-2 permit 10
    match ip address prefix-list pl-adv-2
!
  route-map EXIST-3 permit 10
    match ip address prefix-list pl-exist-3
!
  route-map ADV-3 permit 10
    match ip address prefix-list pl-adv-3
! route-map EXIST-1 permit 10
   match ip address prefix-list pl-exist-1
!
! route-map ADV-1 permit 10
   match ip address prefix-list pl-adv-1

Example: Verifying BGP VRF-Aware Conditional Advertisement

The following examples use the configuration in figure 1:

CE 101

CE101# show ip bgp all

For address family: IPv4 Unicast
BGP table version is 28, local router ID is 203.0.113.11

<table>
<thead>
<tr>
<th>Network</th>
<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>* 21.21.21.0/24</td>
<td>0.0.0.0</td>
<td>0</td>
<td>32768</td>
<td>i</td>
<td></td>
</tr>
<tr>
<td>* 22.22.22.22/32</td>
<td>0.0.0.0</td>
<td>0</td>
<td>32768</td>
<td>i</td>
<td></td>
</tr>
<tr>
<td>* 31.0.0.0</td>
<td>0.0.0.0</td>
<td>0</td>
<td>32768</td>
<td>i</td>
<td></td>
</tr>
<tr>
<td>* 33.0.0.0</td>
<td>0.0.0.0</td>
<td>0</td>
<td>32768</td>
<td>i</td>
<td></td>
</tr>
<tr>
<td>* 44.0.0.0</td>
<td>0.0.0.0</td>
<td>0</td>
<td>32768</td>
<td>i</td>
<td></td>
</tr>
<tr>
<td>* 192.0.2.254/24</td>
<td>0.0.0.0</td>
<td>0</td>
<td>32768</td>
<td>i</td>
<td></td>
</tr>
<tr>
<td>* 192.0.2.50</td>
<td>0.0.0.0</td>
<td>0</td>
<td>32768</td>
<td>i</td>
<td></td>
</tr>
</tbody>
</table>

PE 1

PE1# show ip bgp all

For address family: IPv4 Unicast

For address family: VPNv4 Unicast

BGP table version is 46, local router ID is 10.0.0.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal, r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter, x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

<table>
<thead>
<tr>
<th>Network</th>
<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route Distinguisher: 1:1 (default for vrf red)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* 21.21.21.0/24</td>
<td>172.16.1.2</td>
<td>0</td>
<td>101</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>* 22.22.22.22/32</td>
<td>172.16.1.2</td>
<td>0</td>
<td>101</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>* 31.0.0.0</td>
<td>172.16.1.2</td>
<td>0</td>
<td>101</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>* 33.0.0.0</td>
<td>172.16.1.2</td>
<td>0</td>
<td>101</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>* 44.0.0.0</td>
<td>172.16.1.2</td>
<td>0</td>
<td>101</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>* 192.0.2.254/24</td>
<td>172.16.1.2</td>
<td>0</td>
<td>101</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>* 192.0.2.50</td>
<td>172.16.1.2</td>
<td>0</td>
<td>101</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

PE 4

The status is Withdraw for the exist-map EXIST-2 because the condition for advertisement has not been met.
PE4# show ip bgp all

For address family: VPNv4 Unicast

BGP table version is 82, local router ID is 10.0.0.4

<table>
<thead>
<tr>
<th>Network</th>
<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>21.21.21.0/24</td>
<td>10.0.0.1</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>101</td>
</tr>
<tr>
<td>22.22.22.22/32</td>
<td>10.0.0.1</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>101</td>
</tr>
<tr>
<td>31.0.0.0</td>
<td>10.0.0.1</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>101</td>
</tr>
<tr>
<td>33.0.0.0</td>
<td>10.0.0.1</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>101</td>
</tr>
<tr>
<td>44.0.0.0</td>
<td>10.0.0.1</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>101</td>
</tr>
<tr>
<td>192.0.2.254/24</td>
<td>10.0.0.1</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>101</td>
</tr>
<tr>
<td>192.0.2.50</td>
<td>10.0.0.1</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>101</td>
</tr>
</tbody>
</table>

PE4# show ip bgp vpnv4 all neighbors 198.51.100.3

...<snip>...

For address family: VPNv4 Unicast
Translates address family IPv4 Unicast for VRF red
Session: 198.51.100.3
BGP table version 48, neighbor version 48/0
Output queue size : 0
Index 3, Advertise bit 0
3 update-group member
Condition-map EXIST-1, Advertise-map ADV-1, status: Advertise
Condition-map EXIST-2, Advertise-map ADV-2, status: Withdraw
Condition-map EXIST-3, Advertise-map ADV-3, status: Advertise
Condition-map EXIST-4, Advertise-map ADV-4, status: Advertise
Slow-peer detection is disabled
...

PE4#

PE4# show ip bgp vpnv4 all update-group

...<snip>...

BGP version 4 update-group 3, external, Address Family: VPNv4 Unicast
BGP Update version : 48/0, messages 0
Condition-map EXIST-1, Advertise-map ADV-1, status: Advertise
Condition-map EXIST-2, Advertise-map ADV-2, status: Withdraw
Condition-map EXIST-3, Advertise-map ADV-3, status: Advertise
Condition-map EXIST-4, Advertise-map ADV-4, status: Advertise
Topology: red, highest version: 47, tail marker: 47
Format state: Current working (OK, last not in list)
Refresh blocked (not in list, last not in list)
Update messages formatted 4, replicated 4, current 0, refresh 0, limit 1000
Number of NLRIs in the update sent: max 3, min 0
Minimum time between advertisement runs is 0 seconds
Has 1 member:
198.51.100.3
Prefix 44.0.0.0 is missing as 41.0.0.0/8 does not appear in PE 4 to trigger the advertisement to CE 104. The state is Withdraw.

CE104# show ip bgp all

For address family: IPv4 Unicast

BGP table version is 45, local router ID is 198.51.100.3
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal, r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter, x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

<table>
<thead>
<tr>
<th>Network</th>
<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>*&gt; 21.21.0.0/24</td>
<td>104.0.0.1</td>
<td>0</td>
<td>65000 101</td>
<td>i</td>
<td></td>
</tr>
<tr>
<td>*&gt; 22.22.22.32</td>
<td>104.0.0.1</td>
<td>0</td>
<td>65000 101</td>
<td>i</td>
<td></td>
</tr>
<tr>
<td>*&gt; 31.0.0.0</td>
<td>104.0.0.1</td>
<td>0</td>
<td>65000 101</td>
<td>i</td>
<td></td>
</tr>
<tr>
<td>*&gt; 33.0.0.0</td>
<td>104.0.0.1</td>
<td>0</td>
<td>65000 101</td>
<td>i</td>
<td></td>
</tr>
<tr>
<td>*&gt; 192.0.2.254/24</td>
<td>104.0.0.1</td>
<td>0</td>
<td>65000 101</td>
<td>i</td>
<td></td>
</tr>
<tr>
<td>*&gt; 192.0.2.50</td>
<td>104.0.0.1</td>
<td>0</td>
<td>65000 101</td>
<td>i</td>
<td></td>
</tr>
</tbody>
</table>

---

**Additional References for BGP VRF-Aware Conditional Advertisement**

**Related Documents**

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
</tbody>
</table>

**Technical Assistance**

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</td>
<td><a href="http://www.cisco.com/support">http://www.cisco.com/support</a></td>
</tr>
<tr>
<td>To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds.</td>
<td></td>
</tr>
<tr>
<td>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</td>
<td></td>
</tr>
</tbody>
</table>
Feature Information for BGP VRF-Aware Conditional Advertisement

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 93: Feature Information for BGP VRF-Aware Conditional Advertisement

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP VRF-Aware Conditional Advertisement</td>
<td>Cisco IOS XE Release 3.9S</td>
<td>The Border Gateway Protocol (BGP) VRF-Aware Conditional Advertisement feature provides additional control of the advertisement of routes and extends this control to within a virtual routing and forwarding (VRF) instance.</td>
</tr>
</tbody>
</table>
BGP—Selective Route Download

The BGP—Selective Route Download feature allows a network administrator to selectively download some or none of the BGP routes into the Routing Information Base (RIB). The primary application for this feature is to suppress the unnecessary downloading of certain BGP routes to the RIB or Forwarding Information Base (FIB) on a dedicated route reflector, which propagates BGP updates without carrying transit traffic. The feature thereby helps to maximize resources available and to improve routing scalability and convergence on the dedicated route reflector.

- Finding Feature Information, on page 1057
- Information About BGP—Selective Route Download, on page 1057
- How to Selectively Download BGP Routes, on page 1058
- Configuration Examples for BGP—Selective Route Download, on page 1062
- Additional References for Selective Route Download, on page 1063
- Feature Information for Selective Route Download, on page 1064

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About BGP—Selective Route Download

Dedicated Route Reflector Does Not Need All Routes

The role of a dedicated route reflector (RR) is to propagate BGP updates without participating in the actual forwarding of transit traffic. That means the RR does not need to have all BGP routes downloaded into its RIB or FIB. It is beneficial for the RR to preserve its resources by not processing and storing those routes.

By default, BGP routes are downloaded to the RIB. To save resources on a dedicated route reflector, such downloading can be reduced or prevented by configuring a table map. A table map is so named because it controls what is put into the BGP routing table.
A table map references a route map, in this context to control the downloading of routes. A table map can be used in other features, such as the BGP Policy Accounting Output Interface Accounting feature.

It is important to understand the use of the `filter` keyword in the `table-map` command.

- When the `table-map` command is used *without* the `filter` keyword, the route map referenced in the `table-map` command is used to set certain properties (such as the traffic index) of the routes for installation into the RIB. The route is always downloaded, regardless of whether it is permitted or denied by the route map.

- When the `table-map` command is used *with* the `filter` keyword, the route map referenced is also used to control whether a BGP route is to be downloaded to the RIB (hence the filter). A BGP route is not downloaded to the RIB if it is denied by the route map.

Note that the Selective Route Download feature is not applicable to Multiprotocol Label Switching (MPLS) Layer 3 VPN because the route download is already automatically suppressed on a route reflector.

**Benefits of Selective Route Download**

The BGP—Selective Route Download feature allows a network administrator to selectively download some or none of the BGP routes into the Routing Information Base (RIB). The primary application for this feature is to suppress the unnecessary downloading of certain BGP routes to the RIB or Forwarding Information Base (FIB) on a dedicated route reflector, which propagates BGP updates without carrying transit traffic. The feature thereby helps to maximize resources available and to improve routing scalability and convergence on the dedicated route reflector.

**How to Selectively Download BGP Routes**

**Suppressing the Downloading of All BGP Routes on a Dedicated RR**

Perform this task on a dedicated route reflector (RR) to prevent all BGP routes from being downloaded to the RIB, and thereby save resources.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `route-map route-map-name deny [sequence-number]`
4. `exit`
5. `router bgp as-number`
6. `address-family ipv4 unicast`
7. `table-map route-map-name filter`
8. `end`
9. `clear ip bgp ipv4 unicast table-map`
**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
</tr>
<tr>
<td><code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Router&gt; enable</code></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td></td>
</tr>
<tr>
<td><code>configure terminal</code></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Router# configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td></td>
</tr>
<tr>
<td><code>route-map route-map-name deny</code></td>
<td>Enters route map configuration mode to configure a route map.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Router(config)# route-map bgp-to-rib deny 10</code></td>
<td>• In this example, the route map named bgp-to-rib denies all routes.</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td></td>
</tr>
<tr>
<td><code>exit</code></td>
<td>Exits route-map configuration mode and enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Router(config-route-map)# exit</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td></td>
</tr>
<tr>
<td><code>router bgp as-number</code></td>
<td>Enters router configuration mode and creates a BGP routing process.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Router(config)# router bgp 100</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td></td>
</tr>
<tr>
<td><code>address-family ipv4 unicast</code></td>
<td>Enters address family configuration mode to configure BGP peers to accept address-family-specific configurations.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Router(config-router)# address-family ipv4 unicast</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td></td>
</tr>
<tr>
<td><code>table-map route-map-name filter</code></td>
<td>Specifies a route map that filters what goes into the BGP routing table (the Routing Information Base [RIB]).</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Router(config-router-af)# table-map bgp-to-rib filter</code></td>
<td>• The routes that are permitted by the route map are downloaded into the RIB.</td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td></td>
</tr>
<tr>
<td><code>end</code></td>
<td>Exits address family configuration mode and enters privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Router(config-router-af)# end</code></td>
<td></td>
</tr>
</tbody>
</table>
### Selectively Downloading BGP Routes on a Dedicated RR

Perform this task on a dedicated route reflector (RR) to selectively download BGP routes to the RIB. When the externally connected routes are carried in BGP, it is necessary to download these routes to the RIB for next hop resolution on the RR. One scalable approach to accomplish the selective route download is to use a BGP community to identify the externally connected routes. That is, attach a designated BGP community during the redistribution of the externally connected routes on the ASBRs, and then on the RR, filter the route download based on the BGP community. This task illustrates the configuration of the RR using a route map that matches on a community list to control which routes are downloaded.

### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `ip community-list standard-list-number permit AA:NN`
4. `route-map route-map-name permit [sequence-number]`
5. `match community standard-list-number`
6. `exit`
7. `router bgp as-number`
8. `address-family ipv4 unicast`
9. `table-map route-map-name filter`
10. `end`
11. `clear ip bgp ipv4 unicast table-map`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** | Enables privileged EXEC mode.  
- Enter your password if prompted. |
<p>| <code>enable</code> |  |
| <code>configure terminal</code> | Enters global configuration mode.  |
| <code>ip community-list standard-list-number permit AA:NN</code> |  |
| <code>route-map route-map-name permit [sequence-number]</code> |  |
| <code>match community standard-list-number</code> |  |
| <code>exit</code> |  |
| <code>router bgp as-number</code> |  |
| <code>address-family ipv4 unicast</code> |  |
| <code>table-map route-map-name filter</code> |  |
| <code>end</code> |  |
| <code>clear ip bgp ipv4 unicast table-map</code> |  |</p>
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 3** ip community-list standard-list-number permit AA:NN  
Example: Router(config)# ip community-list 100 permit 65510:100 | Creates a standard community list and specifies an autonomous system and network number allowed in the community list. |
| **Step 4** route-map route-map-name permit [sequence-number]  
Example: Router(config)# route-map bgp-to-rib permit 10 | Enters route-map configuration mode to configure a route map.  
• The route map named bgp-to-rib permits routes that match the community list identified in the next step. |
| **Step 5** match community standard-list-number  
Example: Router(config-route-map)# match community 100 | Matches on routes that are permitted by community list 100. |
| **Step 6** exit  
Example: Router(config-route-map)# exit | Exits route-map configuration mode and enters global configuration mode. |
| **Step 7** router bgp as-number  
Example: Router(config)# router bgp 65510 | Enters router configuration mode and creates a BGP routing process. |
| **Step 8** address-family ipv4 unicast  
Example: Router(config-router)# address-family ipv4 unicast | Enters address family configuration mode to configure BGP peers to accept address family-specific configurations. |
| **Step 9** table-map route-map-name filter  
Example: Router(config-router-af)# table-map bgp-to-rib filter | Specifies a route map that filters what goes into the BGP routing table (the Routing Information Base [RIB]). |
| **Step 10** end  
Example: Router(config-router-af)# end | Exits address family configuration mode and enters privileged EXEC mode. |
| **Step 11** clear ip bgp ipv4 unicast table-map  
Example: Router# clear ip bgp ipv4 unicast table-map | Reloads the BGP RIB after the table map or the route map is configured or changed in order to put the changes into effect. |
Configuration Examples for BGP—Selective Route Download

Examples: Selective Route Download

The role of a dedicated route reflector (RR) is to propagate BGP updates without participating in the actual forwarding of transit traffic. In some cases, the dedicated RR may need only selected routes downloaded; in some cases it may not need any routes downloaded.

It is likely that the dedicated RR would have the overload bit set if the IS-IS routing protocol is being used, or an OSPF stub router would be configured if OSPF is being used.

**Example: Next Hop is Loopback Address—Filter All Routes From Being Downloaded**

In this example, the ASBRs are configured with the `next-hop-self` command for iBGP sessions. (That configuration is not shown). The next hops of the BGP routes advertised to iBGP sessions are the loopback addresses carried in the IGP (either OSPF or IS-IS). There is no need to download any BGP routes to the RIB. The following configuration on the dedicated RR suppresses the downloading of all BGP routes because the `table map` command includes the `filter` keyword, and the route map that the table map references denies all routes.

```
route-map bgp-to-rib deny 10
!
router bgp 65000
    address-family ipv6 unicast
    table-map bgp-to-rib filter
```

**Example: Redistribution of Connected Routes in IGP—Filter All Routes From Being Downloaded**

In this example, the next hops of the BGP routes are resolved on the externally connected routes, which are carried in an IGP, such as OSPF or IS-IS, via a prefix-list-based selective redistribution of the connected routes. The routes are received from iBGP.

Although the scenario is different from the preceding example, the configuration is the same. The following configuration on the dedicated RR suppresses the downloading of all BGP routes because the `table map` command includes the `filter` keyword, and the route map that the table map references denies all routes.

```
route-map bgp-to-rib deny 10
!
router bgp 65000
    address-family ipv6 unicast
    table-map bgp-to-rib filter
```

**Example: Redistribution of Connected Routes in BGP—Selectively Filter Routes From Being Downloaded**

When the externally connected routes are carried in BGP, it is necessary to download these routes to the RIB, where the next-hop resolution on the RR can be calculated. One scalable way to achieve the selective route download is to use a BGP community on the ASBR to identify these externally connected routes. That is, on the border routers, attach a designated BGP community during the redistribution of the externally connected routes.
routes, and then on the RR, filter the route download based on the BGP community. The following shows the configuration on the ASBR and the configuration on the RR.

**ASBR Configuration**

```plaintext
router bgp 65510
  address-family ipv4 unicast
  redistribute connected route-map connected-to-bgp

route-map connected-to-bgp permit 10
  match ip address prefix-list extend-connected
  set community 65510:100

ip prefix-list extend-connected permit 192.168.1.1/30
```

**RR Configuration**

```plaintext
ip community-list 100 permit 65510:100

route-map bgp-to-rib permit 10
  match community 100

router bgp 65510
  address-family ipv4 unicast
  table-map bgp-to-rib filter
```

---

**Additional References for Selective Route Download**

### Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
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<tbody>
<tr>
<td>Cisco IOS Commands</td>
<td>Cisco IOS Master Commands List, All Releases</td>
</tr>
<tr>
<td>BGP Commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
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</table>

### Technical Assistance

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<thead>
<tr>
<th>Description</th>
<th>Link</th>
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<tbody>
<tr>
<td>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/support">http://www.cisco.com/support</a></td>
</tr>
</tbody>
</table>
Feature Information for Selective Route Download

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 94: Feature Information for Selective Route Download

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
</table>
| Selective Route Download | Cisco IOS XE Release 2.3S | The BGP—Selective Route Download feature allows a network administrator to selectively download some or none of the BGP routes into the Routing Information Base (RIB). The primary application for this feature is to suppress the unnecessary downloading of certain BGP routes to the RIB or Forwarding Information Base (FIB) on a dedicated route reflector, which propagates BGP updates without carrying transit traffic. The feature thereby helps to maximize resources available and to improve routing scalability and convergence on the dedicated route reflector. The following command was modified:  
  • table-map |
CHAPTER 75

BGP—Support for iBGP Local-AS

Prior to the BGP—Support for iBGP Local-AS feature, the `neighbor local-as` command was used on a BGP speaker to change the AS negotiated for an eBGP neighbor and to modify the AS_PATH sent and/or received. The `neighbor local-as` command can now be used to do the same on an iBGP session. AS negotiation creates an iBGP session and we enable sending iBGP attributes (LOCAL_PREF, ORIGINATOR_ID, and CLUSTER_LIST) over it, and accept this attributes when received from this session. This functionality is useful when merging two autonomous systems into one.

- Finding Feature Information, on page 1065
- Restrictions for Support for iBGP Local-AS, on page 1065
- Information About Support for iBGP Local-AS, on page 1066
- Support for iBGP Local-AS, on page 1066
- Benefits of iBGP Local-AS, on page 1067
- How to Configure iBGP Local-AS, on page 1067
- Configuring iBGP Local-AS, on page 1067
- Configuration Examples for iBGP Local-AS, on page 1070
- Example: Configuring iBGP Local-AS, on page 1070
- Additional References for Support for iBGP Local-AS, on page 1070
- Feature Information for BGP—Support for iBGP Local-AS, on page 1071

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Restrictions for Support for iBGP Local-AS

- This feature is not supported for a peer that belongs to a confederation.

- Nonlocal-AS iBGP neighbors that are in a single AS are put into a separate update group from iBGP neighbors that are configured with the iBGP Local-AS feature.
Two iBGP neighbors that are in two different autonomous systems and that are configured as iBGP Local-AS neighbors are put into separate update groups.

**Information About Support for iBGP Local-AS**

**Support for iBGP Local-AS**

Prior to the Support for iBGP Local-AS feature, when a peer (or peer group) was configured with the `neighbor local-as` command and the `neighbor remote-as` command that specified the same AS number, the session would be negotiated as an iBGP session (this happens when the advertised ASes in both OPEN messages are the same). However, updates were propagated as in an eBGP session (LOCAL_PREF, ORIGINATOR_ID and CLUSTER_LIST were not propagated), and could cause errors if they were received via this session. Thus, iBGP local-AS was not fully supported.

The Support for iBGP Local-AS feature means all those iBGP attributes are propagated. Additionally, as in any iBGP session, the AS is not prepended in AS_PATH attribute when advertising routes to an iBGP local-as session.

The figure below illustrates a scenario where this feature is being used to facilitate the merging of two autonomous systems. The route reflector R3 and R4 belong to AS 1000; R1 and R6 belong to AS 3000. The RR is configured with `neighbor local-as 3000` and `neighbor remote-as 3000` commands. Even though the routers belong to two different autonomous systems, attributes like the LOCAL_PREF are preserved in the updates from R6 to R4 and R6 to R1 (as show in the figure), and also in the updates from R4 to R1 and R4 to R6 (not shown in the figure).

*Figure 93: Support for iBGP Local-AS to Preserve iBGP Policies Between Two Autonomous Systems*
Benefits of iBGP Local-AS

This feature is used when merging two ISPs that have different autonomous system numbers. It is desirable to preserve attributes that are considered internal (LOCAL_PREF, ORIGINATOR_ID, and CLUSTER_LIST) in the routes that are being propagated to other autonomous system.

How to Configure iBGP Local-AS

Configuring iBGP Local-AS

Configure the iBGP Local-AS feature on a BGP speaker for a given neighbor when you want that session to behave as a full iBGP session. This configuration is typically performed on a route reflector, but not exclusively on it. In a route reflector you can optionally configure changing iBGP attributes sent to a neighbor via the command allow-policy (this command is not exclusive for this feature and can be used on any RR).

SUMMARY STEPS

1. enable
2. configure terminal
3. ipv6 unicast-routing
4. router bgp autonomous-system-number
5. neighbor peer-group-name peer-group
6. neighbor {ip-address | ipv6-address} peer-group peer-group-name
7. neighbor {ip-address | ipv6-address | peer-group} remote-as as-number
8. neighbor {ip-address | ipv6-address | peer-group} local-as as-number
9. neighbor {ip-address | ipv6-address | peer-group} route-reflector-client
10. address-family vpnv4
11. neighbor {ip-address | ipv6-address | peer-group} allow-policy
12. exit
13. address-family vpnv6
14. neighbor {ip-address | ipv6-address | peer-group} allow-policy
15. end
16. show ip bgp vpnv4 all neighbors {ip-address | ipv6-address} policy
17. show ip bgp vpnv4 all update-group update-group
18. show ip bgp vpnv4 all neighbors {ip-address | ipv6-address}

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
</tbody>
</table>

IP Routing: BGP Configuration Guide, Cisco IOS XE 17
<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>configure terminal Example: Device# configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>3</td>
<td>ipv6 unicast-routing Example: Device(config)# ipv6 unicast-routing</td>
<td>Enables the forwarding of IPv6 unicast datagrams.</td>
</tr>
<tr>
<td>4</td>
<td>router bgp autonomous-system-number Example: Device(config)# router bgp 1000</td>
<td>Enters router configuration mode to create or configure a BGP routing process.</td>
</tr>
<tr>
<td>5</td>
<td>neighbor peer-group-name peer-group Example: Device(config-router)# neighbor rr-client-ab peer-group</td>
<td>(Optional) Identifies a peer group.</td>
</tr>
<tr>
<td>6</td>
<td>neighbor {ip-address</td>
<td>ipv6-address} peer-group peer-group-name Example: Device(config-router)# neighbor 192.168.3.3 peer-group rr-client-ab</td>
</tr>
<tr>
<td>7</td>
<td>neighbor {ip-address</td>
<td>ipv6-address</td>
</tr>
<tr>
<td>8</td>
<td>neighbor {ip-address</td>
<td>ipv6-address</td>
</tr>
<tr>
<td>9</td>
<td>neighbor {ip-address</td>
<td>ipv6-address</td>
</tr>
<tr>
<td>10</td>
<td>address-family vpnv4 Example: Device(config-router)# address-family vpnv4</td>
<td>(Optional) Places the router in VPNv4 address family configuration mode.</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
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<td></td>
</tr>
<tr>
<td><strong>Step 11</strong></td>
<td>**neighbor {ip-address</td>
<td>ipv6-address</td>
</tr>
<tr>
<td><strong>Step 12</strong></td>
<td><code>exit</code>&lt;br&gt;Example:&lt;br&gt;Device(config-router-af)# exit</td>
<td>Exits address family configuration mode and enters router configuration mode.</td>
</tr>
<tr>
<td><strong>Step 13</strong></td>
<td><code>address-family vpnv6</code>&lt;br&gt;Example:&lt;br&gt;Device(config-router)# address-family vpnv6</td>
<td>(Optional) Places the router in VPNv6 address family configuration mode.</td>
</tr>
<tr>
<td><strong>Step 14</strong></td>
<td>**neighbor {ip-address</td>
<td>ipv6-address</td>
</tr>
<tr>
<td><strong>Step 15</strong></td>
<td><code>end</code>&lt;br&gt;Example:&lt;br&gt;Device(config-router-af)# end</td>
<td>Exits address family configuration mode, and enters privileged EXEC mode.</td>
</tr>
</tbody>
</table>
| **Step 16** | `show ip bgp vpnv4 all neighbors {ip-address | ipv6-address} policy`<br>Example:<br>Device# show ip bgp vpnv4 all neighbors 192.168.3.3 policy | (Optional) Displays the locally configured policies of the neighbor.  
• The output includes the phrase “allow-policy” if the `neighbor allow-policy` command was configured for that neighbor. |
| **Step 17** | `show ip bgp vpnv4 all update-group update-group`<br>Example:<br>Device# show ip bgp vpnv4 all update-group 2 | (Optional) Displays the information for the update group.  
• The output includes the phrase “Allow-policy” if the `neighbor allow-policy` command was configured for neighbors in the update group. |
| **Step 18** | `show ip bgp vpnv4 all neighbors {ip-address | ipv6-address}`<br>Example:<br>Device# show ip bgp vpnv4 all neighbors 192.168.3.3 | (Optional) Displays information about the neighbor.  
• The output includes the remote AS and local AS, which will indicate the same AS number when the Support for iBGP Local-AS feature is configured. |
Configuration Examples for iBGP Local-AS

Example: Configuring iBGP Local-AS

The example configures a route reflector (RR) in AS 4000 to treat BGP sessions with the peer group rr-client-2 in AS 2500 as iBGP sessions. That is, iBGP attributes (LOCAL_PREF, ORIGINATOR_ID, and CLUSTER_LIST) will not be dropped from routes in advertisements to and from the neighbors belonging to the peer group; the attributes will be passed unmodified. AS 2500 will not be prepended to the AS_PATH attribute in routes to or from the peer group.

Additionally, the neighbor allow-policy command configures that the network administrator can configure iBGP policies on the RR. That is, an outbound route map can be configured to change attributes that are sent to the downstream peers. In this example, the command is applied to VPNv4 and VPNv6 address families.

```conf
router bgp 4000
neighbor rr-client-2 peer-group
neighbor 192.168.1.1 peer-group rr-client-2
neighbor 192.168.4.1 peer-group rr-client-2
neighbor rr-client-2 remote-as 2500
neighbor rr-client-2 local-as 2500
neighbor rr-client-2 route-reflector-client
address-family vpnv4
  neighbor rr-client-2 allow-policy
!
address-family vpnv6
  neighbor rr-client-2 allow-policy
```

Additional References for Support for iBGP Local-AS

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
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<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Commands List, All Releases</td>
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<td>BGP commands</td>
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<th>Description</th>
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<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

Feature Information for BGP—Support for iBGP Local-AS

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to [www.cisco.com/go/cfn](http://www.cisco.com/go/cfn). An account on Cisco.com is not required.

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP—Support for iBGP Local-AS</td>
<td>Cisco IOS XE Release 3.9S</td>
<td>Prior to the BGP—Support for Local-AS feature, the <strong>neighbor local-as</strong> command was used on a route reflector to customize AS_PATH attributes for routes received from an eBGP neighbor. The <strong>neighbor local-as</strong> command can now be used to enable the sending of the iBGP attributes (LOCAL_PREF, ORIGINATOR_ID, CLUSTER_ID, and CLUSTER_LIST) over an iBGP local-AS session. This functionality is useful when merging two autonomous systems, when it is advantageous to keep the iBGP attributes in routes. Prior to the BGP—Support for iBGP Local-AS feature, the RR should not have been configured to change iBGP attributes. With the introduction of this feature, the RR can be configured to change iBGP attributes, providing more flexibility. The following command was introduced: • <strong>neighbor allow-policy</strong> The following commands were modified: • <strong>neighbor local-as</strong> • <strong>show ip bgp vpnv4</strong></td>
</tr>
</tbody>
</table>
eiBGP Multipath for Non-VRF Interfaces (IPv4/IPv6)

The eiBGP Multipath for Non-VRF Interfaces (IPv4/IPv6) feature allows you to configure multipath load sharing among native IPv4 and IPv6 external Border Gateway Protocol (eBGP) and internal BGP (iBGP) paths for improved load balancing in deployments. This module explains the feature and how to configure it.

• Finding Feature Information, on page 1073
• Information About eiBGP Multipath for Non-VRF Interfaces (IPv4/IPv6), on page 1073
• How to Configure eiBGP Multipath for Non-VRF Interfaces (IPv4/IPv6), on page 1074
• Configuration Examples for eiBGP Multipath for Non-VRF Interfaces (IPv4/IPv6), on page 1075
• Feature Information for eiBGP Multipath for Non-VRF Interfaces (IPv4/IPv6), on page 1075

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About eiBGP Multipath for Non-VRF Interfaces (IPv4/IPv6)

eiBGP Multipath for Non-VRF Interfaces Overview

The Border Gateway Protocol (BGP) path-selection algorithm prefers external BGP (eBGP) paths over internal BGP (iBGP) paths. With the eiBGP Multipath for Non-VRF Interfaces (IPv4/IPv6) feature, this algorithm is modified to allow multipath load sharing among native IPv4 and IPv6 eBGP and iBGP paths. Prior to the eiBGP Multipath for Non-VRF Interfaces (IPv4/IPv6) feature, this functionality was only available on VPN routing and forwarding (VRF) instances. With this feature, the functionality is extended to non-VRF interfaces. The maximum-paths command allows you to configure BGP to install multiple paths in the Routing...
Information Base (RIB) for multipath load sharing. The BGP best path algorithm selects a single multipath as the best path and advertises the path to BGP peers. Other multipaths are inserted into both the BGP table and the RIB, and these multipaths are used by Cisco Express Forwarding to perform load balancing, which is performed either on a per-packet basis or on a per-source or per-destination basis.

This feature can be configured on a customer provider edge (PE) device. However, the feature should be configured only on one PE device at the customer site. If this feature is configured on more than one PE device, some parts of the traffic may loop between the PE devices at the customer site. Therefore, it is important to set up the feature appropriately to avoid traffic loops. This feature is enabled by default.

How to Configure eBGP Multipath for Non-VRF Interfaces (IPv4/IPv6)

Enabling IPv4/IPv6 Multipaths for Non-VRF Interfaces

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example: Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode to create or configure a Border Gateway Protocol (BGP) routing process.</td>
</tr>
<tr>
<td>Example: Device(config)# router bgp 64496</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> Enter one of the following: • address-family ipv4 unicast</td>
<td>Enters IPv4 or IPv6 address family configuration mode.</td>
</tr>
</tbody>
</table>
### Purpose

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>• address-family ipv6 unicast</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config-router)# address-family ipv4 unicast</td>
<td></td>
</tr>
<tr>
<td>Device(config-router)# address-family ipv6 unicast</td>
<td></td>
</tr>
<tr>
<td>Step 5</td>
<td>maximum-paths eibgp number</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config-router-af)# maximum-paths eibgp 3</td>
<td>Forwards packets over multiple external BGP (eBGP) and internal BGP (iBGP) paths.</td>
</tr>
<tr>
<td>Step 6</td>
<td>end</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device(config-router-af)# end</td>
<td>Exits address family configuration mode and returns to privileged EXEC mode.</td>
</tr>
</tbody>
</table>

### Configuration Examples for eiBGP Multipath for Non-VRF Interfaces (IPv4/IPv6)

#### Example: Enabling IPv4/IPv6 Multipaths in Non-VRF Interfaces

The following example shows how to enable IPv4 multipaths on non-VRF interfaces.

```
Device> enable
Device# configure terminal
Device(config)# router bgp 64496
Device(config-router)# address-family ipv4 unicast
Device(config-router-af)# maximum-paths eibgp 4
Device(config-router-af)# end
```

The following example shows how to enable IPv6 multipaths on non-VRF interfaces.

```
Device> enable
Device# configure terminal
Device(config)# router bgp 64497
Device(config-router)# address-family ipv6 unicast
Device(config-router-af)# maximum-paths eibgp 4
Device(config-router-af)# end
```

### Feature Information for eiBGP Multipath for Non-VRF Interfaces (IPv4/IPv6)

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.
Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to [www.cisco.com/go/cfn](http://www.cisco.com/go/cfn). An account on Cisco.com is not required.

**Table 96: Feature Information for eiBGP Multipath for Non-VRF Interfaces (IPv4/IPv6)**

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>eiBGP Multipath for Non-VRF Interfaces (IPv4/IPv6)</td>
<td></td>
<td>The eiBGP Multipath for Non-VRF Interfaces (IPv4/IPv6) feature allows you to configure multipath load sharing among native IPv4 and IPv6 external Border Gateway Protocol (eBGP) and internal BGP (iBGP) paths for improved load balancing in deployments. The following command was modified: <code>maximum-paths eibgp</code>.</td>
</tr>
</tbody>
</table>
L3VPN iBGP PE-CE

The L3VPN iBGP PE-CE feature enables the provider edge (PE) and customer edge (CE) devices to exchange Border Gateway Protocol (BGP) routing information by peering as iBGP instead of as external BGP peering between the PE and CE.

- Finding Feature Information, on page 1077
- Restrictions for L3VPN iBGP PE-CE, on page 1077
- Information About L3VPN iBGP PE-CE, on page 1078
- How to Configure L3VPN iBGP PE-CE, on page 1078
- Configuration Examples for L3VPN iBGP PE-CE, on page 1079
- Additional References for L3VPN iBGP PE-CE, on page 1079
- Feature Information for L3VPN iBGP PE-CE, on page 1080

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Restrictions for L3VPN iBGP PE-CE

We recommend not using the soft-reconfiguration inbound or BGP soft-reconfig-backup feature with the iBGP PE CE.
Information About L3VPN iBGP PE-CE

L3VPN iBGP PE-CE

When BGP is used as the provider edge (PE) or customer edge (CE) routing protocol, the peering sessions are configured as an external peering between the VPN provider autonomous system (AS) and the customer network autonomous system. The L3VPN iBGP PE-CE feature enables the PE and CE devices to exchange Border Gateway Protocol (BGP) routing information by peering as internal Border Gateway Protocol (iBGP) instead of the widely used external BGP peering between the PE and the CE. This mechanism applies at each PE device where a VRF-based CE is configured as iBGP. This eliminates the need for service providers (SPs) to configure autonomous system override for the CE. With this feature enabled, there is no need to configure the virtual private network (VPN) sites using different autonomous systems.

The introduction of the **neighbor internal-vpn-client** command enables PE devices to make an entire VPN cloud act like an internal VPN client to the CE devices. These CE devices are connected internally to the VPN cloud through the iBGP PE-CE connection inside the VRF. After this connection is established, the PE device encapsulates the CE-learned path into an attribute called ATTR_SET and carries it in the iBGP-sourced path throughout the VPN core to the remote PE device. At the remote PE device, this attribute is assigned with individual attributes and the source CE path is extracted and sent to the remote CE devices. ATTR_SET is an optional transitive attribute that carries a set of BGP path attributes. It can include any BGP attribute that can occur in a BGP update message as received from the source CE device.

How to Configure L3VPN iBGP PE-CE

Configuring L3VPN iBGP PE-CE

**SUMMARY STEPS**

1. enable
2. configure terminal
3. router bgp as-number
4. address-family ipv4 vrf name
5. neighbor ip-address internal-vpn-client

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td>Step 2 configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config)# configure terminal</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp as-number</td>
<td>Enters router configuration mode and creates a BGP routing process.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# router bgp 100</td>
<td></td>
</tr>
</tbody>
</table>

| **Step 4** address-family ipv4 vrf name | Enters address family configuration mode and configures VPN routing and forwarding. |
| **Example:** Device(config-router)# address-family ipv4 vrf blue |

| **Step 5** neighbor ip-address internal-vpn-client | Defines a neighboring device with which to exchange routing information. The neighbor internal-vpn-client command stacks the iBGP-CE neighbor path in the VPN attribute set. |
| **Example:** Device(config-router-af)# neighbor 10.0.0.1 internal-vpn-client |

### Configuration Examples for L3VPN iBGP PE-CE

#### Example: Configuring L3VPN iBGP PE-CE

The following example shows how to configure L3VPN iBGP PE-CE:

```
Device# enable
Device(config)# configure terminal
Device(config)# router bgp 100
Device(config-router)# address-family ipv4 vrf blue
Device(config-router-af)# neighbor 10.0.0.1 internal-vpn-client
```

### Additional References for L3VPN iBGP PE-CE

#### Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
</tbody>
</table>
Technical Assistance

**Description**

The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.

To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds.

Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.

**Link**

http://www.cisco.com/support

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### Feature Information for L3VPN iBGP PE-CE

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

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#### Table 97: Feature Information for L3VPN iBGP PE-CE

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>L3VPN iBGP PE-CE</td>
<td>Cisco IOS XE Release 3.10S</td>
<td>The L3VPN iBGP PE-CE feature enables the provider edge (PE) and customer edge (CE) devices to exchange Border Gateway Protocol (BGP) routing information by peering as iBGP instead of as external BGP between the PE and CE. The <code>neighbor internal-vpn-client</code> command was introduced.</td>
</tr>
</tbody>
</table>
CHAPTER 78

BGP NSR Support for MPLS VPNv4 and VPNv6 Inter-AS Option B

Border Gateway Protocol (BGP) nonstop routing (NSR) provides support for NSR and nonstop forwarding (NSF) in the event of a switchover from an active to a standby Route Processor (RP). BGP NSR supports provider-edge-to-customer-edge (PE-CE) connections for IPv4 and IPv6 address families and also for Internal BGP (IBGP) peers at the PE device for IPv4, IPv6, VPN version 4 (VPNv4), and VPN version 6 (VPNv6) address families. The BGP NSR Support for MPLS VPNv4 and VPNv6 Inter-AS Option B feature provides support for NSR at the autonomous system boundary routers (ASBRs) in Multiprotocol Label Switching (MPLS) Inter-Autonomous System (Inter-AS) Option B deployments for both VPNv4 and VPNv6 address families.

This module describes how to enable BGP NSR support at ASBRs in Inter-AS Option B for VPNv4 and VPNv6 address families.

- Restrictions for BGP NSR Support for MPLS VPNv4 and VPNv6 Inter-AS Option B, on page 1081
- Information About BGP NSR Support for MPLS VPNv4 and VPNv6 Inter-AS Option B, on page 1082
- How to Configure BGP NSR Support for MPLS VPNv4 and VPNv6 Inter-AS Option B, on page 1084
- Configuration Examples for BGP NSR Support for MPLS VPNv4 and VPNv6 Inter-AS Option B, on page 1085
- Additional References for BGP NSR Support for MPLS VPNv4 and VPNv6 Inter-AS Option B, on page 1086
- Feature Information for BGP NSR Support for MPLS VPNv4 and VPNv6 Inter-AS Option B, on page 1087

Restrictions for BGP NSR Support for MPLS VPNv4 and VPNv6 Inter-AS Option B

- If a peer is activated under an address family for which nonstop routing (NSR) is not supported (for example, multicast distribution tree [MDT]), and if the address family topology is tied to the same session as other address family topologies for which NSR is supported (for example, VPN version 4 [VPNv4]), then NSR will not be supported for that peer-established session. NSR cannot be supported for a session if the session establishment involves activating the peer in an address family for which NSR is not supported. As a workaround, you can create a multisession and activate the nonsupported topology as part of a new session.
- NSR can be configured only on a per-neighbor basis.
There can be some performance and memory impact as a result of enabling BGP NSR support at autonomous system boundary routers (ASBRs) in Inter-AS Option B.

## Information About BGP NSR Support for MPLS VPNv4 and VPNv6 Inter-AS Option B

### Overview of BGP NSR

Border Gateway Protocol (BGP) nonstop routing (NSR) with stateful switchover (SSO) provides a high availability (HA) solution to service providers whose provider edge (PE) routers engage in External BGP (EBGP) peering relationships with customer edge (CE) routers that do not support BGP graceful restart (GR). BGP NSR works with SSO to synchronize BGP state information between the active and standby Route Processors (RPs). SSO minimizes the amount of time for which a network is unavailable to users following a switchover.

BGP NSR with SSO is supported in BGP peer, BGP peer group, and BGP session template configurations. To configure support for BGP NSR with SSO in BGP peer and BGP peer group configurations, use the `neighbor ha-mode sso` command in address family configuration mode for IPv4 virtual routing and forwarding (VRF) address family BGP peers sessions. To include support for Cisco BGP NSR with SSO in a BGP session template, use the `ha-mode sso` command in session-template configuration mode.

### Inter-Autonomous Systems

BGP autonomous systems (ASs) are used to divide global external networks into individual routing domains where local routing policies are applied. Separate BGP ASs dynamically exchange routing information through External BGP (EBGP) peering sessions. BGP peers within the same AS exchange routing information through Internal BGP (IBGP) peering sessions.

When multiple sites of a VPN are connected to different ASs, Inter-Autonomous System (Inter-AS) deployments are useful for providing VPN services between different ASs. In this scenario, provider edge (PE) routers attached to the VPN cannot maintain IBGP connections with each other or with a common route reflector (RR). EBGP is used to distribute VPN-IPv4/IPv6 addresses. RFC 2547bis presents the following Inter-AS VPN solutions:

- Virtual routing and forwarding (VRF)-to-VRF connections at autonomous system boundary routers (ASBRs)—PEs act as ASBRs of their ASs. The ASBRs are directly connected and manage VPN routes between them through multiple subinterfaces. The ASBRs associate each such subinterface with a VRF and use EBGP to distribute unlabeled IPv4 addresses to each other. This solution is also called "Inter-AS Option A." Inter-AS Option A provides IP-based forwarding between the ASBRs connecting the different ASs; however, it also requires a single BGP session for each VPN connection. Inter-AS Option A is easy to implement, but it has limited scalability.

- EBGP redistribution of labeled VPN-IPv4 routes—Neighboring ASBRs use Multiprotocol External BGP (MP-EBGP) to exchange labeled VPN-IPv4 routes that the ASBRs obtain from PEs in their respective ASs. PE routers use IBGP to redistribute labeled VPN-IPv4 routes either to an ASBR or to an RR of which an ASBR is a client. This solution is also called "Inter-AS Option B." Inter-AS Option B provides Multiprotocol Label Switching (MPLS)-based forwarding between the ASBRs connecting different ASs. Inter-AS Option B provides better scalability than Inter-AS Option A because Option B requires only one BGP session to exchange all VPN prefixes between the ASBRs.
Overview of MPLS VPNv4 and VPNv6 Inter-AS Option B

In the Inter-Autonomous System (Inter-AS) Option B solution, two autonomous system border routers (ASBRs) use Multiprotocol External BGP (MP-EBGP) to exchange labeled VPN-IPv4 routes that they obtain from the provider edge (PEs) devices in their respective ASs. Multiprotocol Label Switching (MPLS)-based forwarding is used between the ASBRs. If a failure is encountered at an ASBR, routing and forwarding is impacted in the absence of nonstop routing (NSR) or graceful restart (GR). NSR provides the ability to preserve the routing state to a redundant Route Processor (RP), which can take over the functionality of the active RP in the event of a failover. In conjunction with nonstop forwarding (NSF), the routing and forwarding states can remain unimpacted during a failover.

The figure below illustrates two ASs, AS1 and AS2, each containing customer edge (CE) routers that belong to different VPNs. Each PE tracks which route distinguisher (RD) corresponds to which VPN, thus controlling the traffic that belongs to each VPN.

- Customer edge 1 (CE1) and CE3 belong to VPN 1.
- CE2 and CE4 belong to VPN 2.
- Provider edge 1 (PE1) uses route distinguisher 1 (RD 1) for VPN 1 (VRF 1) and RD 2 for VPN 2 (VRF 2).
- PE2 uses RD 3 for VPN 1 (VRF 1) and RD 4 for VPN 2 (VRF 2).

Figure 94: Flow of Routes in Inter-AS Option B

In an Inter-AS Option B scenario like the one in the figure above, the routes are carried across an AS boundary from ASBR1 to ASBR2 over an MP-EBGP session.

In Inter-AS Option B, the routes are advertised as follows:

1. PEs in AS1 advertise labeled VPN-IPv4 routes to either the ASBR of AS1 or the route reflector (RR) of the ASBR through Multiprotocol Internal BGP (MP-IBGP).
2. The ASBR of AS1 advertises labeled VPN-IPv4 routes to the ASBR of AS2 through MP-EBGP.
3. The ASBR of AS2 advertises labeled VPN-IPv4 routes to either the PEs in AS2 or the RR of the PEs through MP-IBGP.

The ASBRs must perform special processing on the labeled VPN-IPv4 routes, which is also called the ASBR extension method.
How to Configure BGP NSR Support for MPLS VPNv4 and VPNv6 Inter-AS Option B

Configuring an ASBR to Enable BGP NSR Support in Inter-AS Option B

Border Gateway Protocol (BGP) nonstop routing (NSR) support at autonomous system boundary router (ASBR) in Inter-Autonomous System (Inter-AS) Option B can be configured in the same way that BGP NSR is configured for Multiprotocol Internal BGP (MP-IBGP) peers at the provider edge (PE). The configuration is performed in global router mode, on a per-neighbor basis. The NSR support is applied to all address families under which the neighbor has been activated (provided the neighbor is not activated under a non-supported address family). If a neighbor is activated under an unsupported address family, that topology must be made to be part of a different session using multisession.

**SUMMARY STEPS**

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. neighbor ip-address remote-as autonomous-system-number
5. neighbor ip-address ha-mode sso
6. address-family {vpnv4 | vvpn6} [multicast | unicast]
7. neighbor ip-address activate
8. end
9. show ip bgp vpnv4 all sso summary
10. show ip bgp vpnv4 neighbors ip-address

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enable privileged EXEC mode.</td>
</tr>
<tr>
<td>enable</td>
<td>Enters privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Enter your password if prompted.</td>
</tr>
<tr>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>configure terminal</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td>router bgp autonomous-system-number</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config)# router bgp 400</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>Specifies the AS of the neighbor.</td>
</tr>
<tr>
<td>neighbor ip-address remote-as autonomous-system-number</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
</tbody>
</table>
### Configuration Examples for BGP NSR Support for MPLS VPNv4 and VPNv6 Inter-AS Option B

#### Example: Configuring an ASBR to Enable BGP NSR Support in Inter-AS Option B

**Configuring an ASBR to Be NSR-Capable at the VPNv4 Address Family Level**

```plaintext
router bgp 200
    neighbor 192.168.1.1 remote-as 200
    neighbor 192.168.1.1 ha-mode sso
    address-family vpnv4 unicast
        neighbor 192.168.1.1 activate
```

---

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>Device(config-router)# neighbor 192.168.1.1 remote-as 4000</code></td>
<td>Configures a BGP neighbor to support BGP NSR with stateful switchover (SSO).</td>
</tr>
<tr>
<td><strong>Step 5</strong> <code>neighbor ip-address ha-mode sso</code> <strong>Example:</strong> <code>Device(config-router)# neighbor 192.168.1.1 ha-mode sso</code></td>
<td>Enters address family configuration mode for configuring routing sessions that use standard VPNv4 or VPNv6 address prefixes.</td>
</tr>
<tr>
<td><strong>Step 6</strong> `address-family {vpnv4</td>
<td>vpnv6} [multicast</td>
</tr>
<tr>
<td><strong>Step 7</strong> <code>neighbor ip-address activate</code> <strong>Example:</strong> <code>Device(config-router-af)# neighbor 192.168.1.1 activate</code></td>
<td>Exits address family configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Step 8</strong> <code>end</code> <strong>Example:</strong> <code>Device(config-router-af)# end</code></td>
<td>Displays information about BGP peers that support BGP NSR with SSO.</td>
</tr>
<tr>
<td><strong>Step 9</strong> <code>show ip bgp vpnv4 all sso summary</code> <strong>Example:</strong> <code>Device# show ip bgp vpnv4 all sso summary</code></td>
<td>Displays information about BGP and TCP connections to neighbors.</td>
</tr>
<tr>
<td><strong>Step 10</strong> <code>show ip bgp vpnv4 neighbors ip-address</code> <strong>Example:</strong> <code>Device# show ip bgp vpnv4 neighbors 192.168.1.1</code></td>
<td></td>
</tr>
</tbody>
</table>
Configuring an ASBR to Be NSR-Capable at the VPNv6 Address Family Level

```
router bgp 300
    neighbor 192.168.1.10 remote-as 300
    neighbor 192.168.1.10 ha-mode sso
    address-family vpnv6 multicast
    neighbor 192.168.1.10 activate
```

To verify that an ASBR is NSR-capable, check the `show ip bgp vpnv4 neighbors` command output for the Stateful switchovers support enabled field.

```
ASBR# show ip bgp vpnv4 neighbors 192.168.1.10
```

```
BGP neighbor is 192.168.1.10, vrf A, remote AS 200, external link
BGP version 4, remote router ID 192.168.1.10
BGP state = Established, up for 00:16:01
Last read 00:00:04, last write 00:00:35, hold time is 180, keepalive interval is 60 seconds

Neighbor sessions:
  1 active, is not multisession capable (disabled)
Neighbor capabilities:
  Route refresh: advertised and received(new)
  Four-octets ASN Capability: advertised and received
  Address family IPv4 Unicast: advertised and received
  Enhanced Refresh Capability: advertised and received
  Multisession Capability:
  Stateful switchover support enabled: YES for session 1
```

Additional References for BGP NSR Support for MPLS VPNv4 and VPNv6 Inter-AS Option B

### Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
</tbody>
</table>
Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/support">http://www.cisco.com/support</a></td>
</tr>
</tbody>
</table>

Feature Information for BGP NSR Support for MPLS VPNv4 and VPNv6 Inter-AS Option B

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 98: Feature Information for BGP NSR Support for Inter-AS Option B

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP NSR Support for MPLS VPNv4 and VPNv6 Inter-AS Option B</td>
<td>Cisco IOS XE Release 3.10S</td>
<td>The BGP NSR Support for MPLS VPNv4 and VPNv6 Inter-AS Option B feature provides support for nonstop routing (NSR) at the autonomous system boundary routers (ASBR) in Inter-Autonomous System (Inter-AS) Option B deployments for both VPNv4 and VPNv6 address families. No commands were introduced or modified.</td>
</tr>
</tbody>
</table>
BGP-RTC for Legacy PE

The BGP-Route Target Constrain (RTC) for Legacy PE feature helps to prevent the propagation of VPN Network Layer Reachability Information (NLRI) to a provider edge (PE) device that is not interested in the VPN. This feature builds an outbound filter used by a Boarder Gateway Protocol (BGP) speaker to decide which routes to pass to its peer and propagates route target (RT) reachability information between internal BGP (iBGP) meshes.

Finding Feature Information, on page 1089
• Prerequisites for BGP-RTC for Legacy PE, on page 1089
• Information About BGP-RTC for Legacy PE, on page 1090
• How to Configure BGP-RTC for Legacy PE, on page 1090
• Configuration Examples for BGP-RTC for Legacy PE, on page 1092
• Additional References for BGP-RTC for Legacy PE, on page 1093
• Feature Information for BGP-RTC for Legacy PE, on page 1094

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for BGP-RTC for Legacy PE

Before you configure the BGP-RTC for Legacy PE feature, you must configure the RT filter unicast address family type. For more information, see "Configuring BGP: RT Constrained Route Distribution" module in the IP Routing: BGP Configuration Guide.
Information About BGP-RTC for Legacy PE

Overview of BGP-RTC for Legacy PE

The BGP—RTC for Legacy PE feature makes use of VPN unicast route exchange from the legacy provider edge (PE) devices to a new Boarder Gateway Protocol (BGP) speaker (route reflector [RR]) to signal route target (RT) membership. The legacy PEs announce a set of special routes with mapped RTs to the RR along with a standard community. The presence of the community triggers the RR to extract the RTs and build RT membership information.

In scenarios where VPN membership is normal, this functionality helps reduce the scaling requirements on the PE devices and the RRs. The PE devices need not to spend resources for filtering out unwanted routes. The BGP peers that have common outbound policies are grouped under a single format group. Separate replication groups are used within a format group to separate BGP peers with its own peer-based policies. The Route Target Constrain (RTC)-capable peers are placed in separate format groups. Each RTC peers have a separate replication group. When legacy RT is configured for a peer, then it must be treated the same way as the RTC peer except that there is no capability negotiation.

Legacy PE Support-PE Behavior

Each legacy Route Target Constrain (RTC) speaking neighbor is assigned a separate replication group. BGP checks the VPN table for any route with a reserved community value and uses it to create RTC network from the VPN prefix received from a legacy RTC peer with community values. The PE device uses the existing VPN advertisement mechanism to convey route target (RT) membership from the legacy provider edge (PE) devices. The route reflector (RR) processes advertisement mechanisms of RT membership information from legacy PE devices. RRs translate the legacy PE RT membership information to equivalent RTC Network Layer Reachability Information (NLRIs) to propagate to other RRs.

Legacy PE Support-RR Behavior

Route reflectors (RR) identify routes from legacy provider edge (PE) devices for retrieving route target (RT) membership information by the community value and filter VPN routes to legacy PE devices. RRs use the existing VPN advertisement mechanism to convey and process RT membership from the legacy PEs. The legacy PE RT membership information is translated into equivalent RT membership Network Layer Reachability Information (NLRIs) from the client to propagate to other RRs. The RR then creates the route target filter list for each legacy client by collecting the entire set of route targets.

How to Configure BGP-RTC for Legacy PE

Configuring BGP-RTC for Legacy PE

SUMMARY STEPS

1. enable
2. configure terminal
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| 1    | enable            | Enables privileged EXEC mode.  
|      | Example:          | • Enter your password if prompted. |
|      | Device> enable    |         |
| 2    | configure terminal | Enters global configuration mode. |
|      | Example:          |         |
|      | Device# configure terminal |         |
| 3    | router bgp as-number | Configures a Border Gateway Protocol (BGP) routing process and enters router configuration mode. |
|      | Example:          |         |
|      | Device(config)# router bgp 1 |         |
| 4    | address-family {vpnv4 | vpng6 } unicast | Specifies the VVPNv4 or VVPNv6 address family and enters address family configuration mode. |
|      | Example:          |         |
|      | Device(config-router)# address-family vpng4 unicast |         |
| 5    | neighbor {ip-address | peer-group-name | ipv6-address} accept-route-legacy-rt | Configures the neighbor on the route reflector (RR) to treat the provider edge (PE) device as a legacy PE for the route target (RT) and accepts VPN routes tagged with the special community. |
|      | Example:          |         |
|      | Device(config-router-af)# neighbor 10.0.0.1 accept-route-legacy-rt |         |
| 6    | address-family rtfilter | Specifies the RT filter address family type. |
|      | Example:          |         |
|      | Device(config-router-af)# address-family rtfilter |         |
| 7    | end               | Exits address family configuration mode and returns to privileged EXEC mode. |
|      | Example:          |         |
|      | Device(config-router-af)# end |         |
| 8    | show ip bgp vpng4 all update-group | (Optional) Displays the information about neighbors in the update group. |
|      | update-group      |         |
|      | Example:          |         |
### Command or Action

Device# show ip bgp vpnv4 all update-group 2

### Purpose

(Optional) Displays information about the BGP VPNv4 neighbor.

### Step 9

**show ip bgp vpnv4 all neighbors**  
(ip-address | ipv6-address)

**Example:**
Device# show ip bgp vpnv4 all neighbors 192.168.3.3

### Step 10

**show ip bgp vpnv4 all peer-group**

**Example:**
Device# show ip bgp vpnv4 all peer-group

### Step 11

**debug ip bgp all updates in**

**Example:**
Device# debug ip bgp all updates in

### Configuration Examples for BGP-RTC for Legacy PE

#### Example: BGP-RTC for Legacy PE

**Configuration on the Route Reflector**

The following example shows how to configure the neighbor on the route reflector (RR) to treat the provider edge (PE) device as a legacy PE for the route target (RT) and accept VPN routes tagged with the special community:

```
Device# configure terminal
Device(config)# router bgp 1
Device(config-router)# address-family vpnv4 unicast
Device(config-router-af)# neighbor 10.1.1.1 accept-route-legacy-rt
Device(config-router-af)# address-family rtfilter
Device(config-router-af)# exit address-family
```

**Configuration on the Legacy PE**

The following example shows how to create a route filter VRF and attach an export map that collects and carries all RTs locally configured on Layer 3 VPN virtual routing and forwarding (VRF):

```
ip vrf route-filter
rd 55:1111
export map SET_RT
route-map SET_RT permit 10
match ip address prefix-list RT_NET1
set community 4294901762 (0xFFFF0002)
set extcommunity rt 255.220.0.0:12241 255.220.0.0:12242 additive
set extcommunity rt 255.220.0.0:12243 255.220.0.0:12244 additive
set extcommunity rt 255.220.0.0:12245 255.220.0.0:12246 additive
set extcommunity rt 255.220.0.0:12247 255.220.0.0:12248 additive
set extcommunity rt 255.220.0.0:12249 255.220.0.0:12250 additive
```
route-map SET_RT permit 20  
match ip address prefix-list RT_NET2  
set community 4294901762 (0xFFFF0002)  
set extcommunity rt 255.220.0.0:12251 255.220.0.0:12252 additive  
set extcommunity rt 255.220.0.0:12253 255.220.0.0:12254 additive  
set extcommunity rt 255.220.0.0:12255 additive

ip route vrf route-filter 5.5.5.5 255.255.255.255 Null0 – (matching prefix-set RT_NET1)  
ip route vrf route-filter 6.6.6.6 255.255.255.255 Null0 – (matching prefix-set RT_NET2)

route-map LEG_PE permit 10  
match ip address prefix-list RT_NET1 RT_NET2  
set community no-advertise additive

The following example shows how to apply the route map to a VPNv4 neighbor:

router bgp 55  
address-family vpnv4 unicast  
neighbor x.x.x.x route-map LEG_PE out

The following example shows how to source a static route into a Border Gateway Protocol (BGP) network using a network statement:

router bgp 55  
address-family ipv4 vrf route-filter  
network 5.5.5.5 mask 255.255.255.255  
network 6.6.6.6 mask 255.255.255.255

Additional References for BGP-RTC for Legacy PE

Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
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<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
<tr>
<td>Configuring BGP: RT Constrained Route Distribution</td>
<td>&quot;Configuring BGP: RT Constrained Route Distribution&quot; module in the IP Routing: BGP Configuration Guide</td>
</tr>
</tbody>
</table>

Standards and RFCs

<table>
<thead>
<tr>
<th>Standard/RFC</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFC 4684</td>
<td>Constrained Route Distribution for Border Gateway Protocol/MultiProtocol Label Switching (BGP/MPLS) Internet Protocol (IP) Virtual Private Networks (VPNs)</td>
</tr>
</tbody>
</table>
Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/support">http://www.cisco.com/support</a></td>
</tr>
</tbody>
</table>

Feature Information for BGP-RTC for Legacy PE

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 99: Feature Information for BGP-RTC for Legacy PE

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP-RTC for Legacy PE</td>
<td>Cisco IOS XE Release 3.11S</td>
<td>The BGP-RTC for Legacy PE feature helps to prevent the propagation of VPN Network Layer Reachability Information (NLRI) to a provider edge (PE) device that is not interested in the VPN. This feature builds an outbound filter used by a Border Gateway Protocol (BGP) speaker to decide which routes to pass to its peer and propagates route target (RT) reachability information between internal BGP (iBGP) meshes. <strong>The neighbor accept-route-legacy-rt</strong> command was introduced.</td>
</tr>
</tbody>
</table>
CHAPTER 80

BGP PBB EVPN Route Reflector Support

The BGP PBB EVPN Route Reflector Support feature provides Boarder Gateway Protocol (BGP) route reflector functionality for Ethernet VPN (EVPN) and provider backbone bridging (PBB) EVPN of Layer 2 VPN address family. EVPN enables customer MAC addresses as routable addresses and distributes them in BGP to avoid any data plane MAC address learning over the Multiprotocol Label Switching (MPLS) core network. The route reflector is enhanced to store the received EVPN updates without configuring EVPN explicitly on the route reflector and then advertises these updates to other provider edge (PE) devices so that the PEs do not need to have a full mesh of BGP sessions.

- Finding Feature Information, on page 1095
- Prerequisites for BGP PBB EVPN Route Reflector Support, on page 1095
- Information About BGP PBB EVPN Route Reflector Support, on page 1096
- How to Configure BGP PBB EVPN Route Reflector Support, on page 1097
- Configuration Examples for BGP PBB EVPN Route Reflector Support, on page 1098
- Additional References for BGP PBB EVPN Route Reflector Support, on page 1099
- Feature Information for BGP PBB EVPN Route Reflector Support, on page 1099

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for BGP PBB EVPN Route Reflector Support

- Before you configure the BGP PBB EVPN Route Reflector Support feature, you must configure the RT filter unicast address family type to support for EVPN address family. For more information, see the "Configuring BGP: RT Constrained Route Distribution" module in the IP Routing: BGP Configuration Guide.

- The EVPN Subsequent Address Family Identifier (SAFI) needs to be enabled globally before you enable it under the BGP neighbor.
Information About BGP PBB EVPN Route Reflector Support

EVPN Overview

Ethernet VPN (EVPN) allows Multiprotocol Label Switching (MPLS) networks to provide multipoint Layer 2 VPN (L2VPN) services.

In EVPN, the customer MAC addresses are learned in the data plane over links connecting customer devices (CE) to the provider edge (PE) devices. The MAC addresses are then distributed over the Multiprotocol Label Switching (MPLS) core network using Boarder Gateway Protocol (BGP) with an MPLS label identifying the service instance. A single MPLS label per EVPN instance is sufficient as long as the receiving PE device performs a MAC lookup in the disposition path. Receiving PE devices inject these routable MAC addresses into their Layer 2 routing information base (RIB) and forwarding information base (FIB) along with their associated adjacencies.

EVPN defines a BGP Network Layer Reachability Information (NLRI) that advertises different route types and route attributes. The EVPN NLRI is carried in BGP using BGP multiprotocol extensions with an Address Family Identifier (AFI) and a Subsequent Address Family Identifier (SAFI). BGP drops unsupported route types and does not propagate them to neighbors.

BGP EVPN Autodiscovery Support on Route Reflector

By default, routes received from an internal BGP (iBGP) peer are not sent to another iBGP peer unless a full mesh configuration is formed between all Boarder Gateway Protocol (BGP) devices within an autonomous system (AS). Configuring a route reflector allows a device to advertise or reflect the iBGP learned routes to other iBGP speakers.

Ethernet VPN (EVPN) Autodiscovery supports BGP route reflectors. A BGP route reflector can be used to reflect BGP EVPN prefixes without EVPN being explicitly configured on the route reflector. The route reflector does not participate in autodiscovery; that is, no pseudowires are set up between the route reflector and the provider edge (PE) devices. A route reflector reflects EVPN prefixes to other PE devices so that these PE devices do not need to have a full mesh of BGP sessions. The network administrator configures only the BGP EVPN address family on a route reflector.

BGP uses the Layer 2 VPN (L2VPN) routing information base (RIB) to store endpoint provisioning information, which is updated each time any Layer 2 virtual forwarding instance (VFI) is configured. The prefix and path information is stored in the L2VPN database, which allows BGP to make decisions about the best path. When BGP distributes the endpoint provisioning information in an update message to all its BGP neighbors, this endpoint information is used to configure a pseudowire mesh to support L2VPN-based services.

EVPN Address Family

BGP supports Layer 2 VPN (L2VPN) EVPN address family under router configuration mode to carry L2VPN EVPN autodiscovery and signaling Network Layer Reachability Information (NLRI) to Boarder Gateway Protocol (BGP) neighbors. This address family is allowed on both internal BGP (iBGP) and external BGP (eBGP) neighbors under default virtual routing and forwarding (VRF) for both IPv4 and IPv6 neighbors. The EVPNI SAFI is not supported under VRF and VRF neighbors.
How to Configure BGP PBB EVPN Route Reflector Support

Configuring BGP PBB EVPN Route Reflector

Perform this task on the Border Gateway Protocol (BGP) route reflector to configure the device as a BGP route reflector and configure the specified neighbor as its client and to display the information from the BGP routing table.

SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp as-number
4. address-family l2vpn [vpls | evpn]
5. neighbor {ip-address | peer-group-name} activate
6. neighbor {ip-address | ipv6-address | peer-group-name} route-reflector-client
7. end
8. show bgp l2vpn evpn all
9. debug bgp l2vpn evpn updates
10. clear bgp l2vpn evpn

DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td></td>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>router bgp as-number</td>
<td>Configures a BGP routing process and enters router configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config)# router bgp 1</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>address-family l2vpn [vpls</td>
<td>evpn]</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config-router)# address-family l2vpn evpn</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>neighbor {ip-address</td>
<td>peer-group-name} activate</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config-router-af)# neighbor 10.0.0.2 activate</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>Configures the local device as the BGP route reflector and the specified neighbor as one of its clients.</td>
<td></td>
</tr>
<tr>
<td>`neighbor {ip-address</td>
<td>ipv6-address</td>
<td>peer-group-name}`</td>
</tr>
<tr>
<td><code>route-reflector-client</code></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><code>Device(config-router-af)# neighbor 10.0.0.2 route-reflector-client</code></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>Exits address family configuration mode and returns to privileged EXEC mode.</td>
<td></td>
</tr>
<tr>
<td><code>end</code></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><code>Device(config-router-af)# end</code></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td>(Optional) Displays the complete L2VPN EVVPN database.</td>
<td></td>
</tr>
<tr>
<td><code>show bgp l2vpn evpn all</code></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><code>Device# show bgp l2vpn evpn all</code></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 9</strong></td>
<td>(Optional) Specifies debugging messages for BGP update.</td>
<td></td>
</tr>
<tr>
<td><code>debug bgp l2vpn evpn updates</code></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><code>Device# debug bgp l2vpn evpn updates events</code></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td>(Optional) Specifies that all current BGP sessions will be reset.</td>
<td></td>
</tr>
<tr>
<td><code>clear bgp l2vpn evpn</code></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><code>Device# clear bgp l2vpn evpn *</code></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Configuration Examples for BGP PBB EVVPN Route Reflector Support

**Example: Configuring BGP PBB EVVPN Route Reflector**

In the following example, the local device is a route reflector. It passes learned iBGP routes to the neighbor at 10.0.0.2:

```
Device# configure terminal
Device(config)# router bgp 1
Device(config-router)# address-family l2vpn evpn
Device(config-router-af)# neighbor 10.0.0.2 activate
Device(config-router-af)# neighbor 10.0.0.2 route-reflector-client
Device(config-router-af)# exit address-family
```

In the following example, the `show bgp l2vpn evpn all route-type 1` command displays the Ethernet autodiscovery route information:

```
show bgp l2vpn evpn all route-type 1
```

BGP routing table entry for

```
[1][100.100.100.100:1111][AAAAABBBCCCDDEEEE][23456789][101234]/25, version 2
Paths: (1 available, best #1, table EVPN-BGP-Table)
    Advertised to update-groups:
      1  2  3
```
Additional References for BGP PBB EVPN Route Reflector Support

Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
</tbody>
</table>

Standards and RFCs

<table>
<thead>
<tr>
<th>Standard/RFC</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFC 4456</td>
<td>BGP Route Reflection: An Alternative to Full Mesh Internal BGP (IBGP)</td>
</tr>
<tr>
<td>RFC 4684</td>
<td>Constrained Route Distribution for Border Gateway Protocol/MultiProtocol Label Switching (BGP/MPLS) Internet Protocol (IP) Virtual Private Networks (VPNs)</td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/support">http://www.cisco.com/support</a></td>
</tr>
</tbody>
</table>

Feature Information for BGP PBB EVPN Route Reflector Support

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.
Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

### Table 100: Feature Information for BGP PBB EVPN Route Reflector Support

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP PBB EVPN Route Reflector Support</td>
<td>Cisco IOS XE</td>
<td>The BGP PBB EVPN Route Reflector Support feature provides Border Gateway Protocol (BGP) route reflector functionality for Ethernet VPN (EVPN) and provider backbone bridging (PBB) EVPN of Layer 2 VPN address family. EVPN enables customer MAC addresses as routable addresses and distributes them in BGP to avoid any data plane MAC address learning over the Multiprotocol Label Switching (MPLS) core network. The route reflector is enhanced to store the received EVPN updates without configuring EVPN explicitly on the route reflector and then advertises these updates to other provider edge (PE) devices so that the PEs do not need to have a full mesh of BGP sessions. The following command was modified: <code>address-family l2vpn</code>.</td>
</tr>
<tr>
<td></td>
<td>Release 3.11S</td>
<td></td>
</tr>
</tbody>
</table>
BGP Monitoring Protocol

The BGP Monitoring Protocol (BMP) feature supports the following functionality to monitor Border Gateway Protocol (BGP) neighbors, also called BMP clients:

- Configure devices to function as BMP servers, and set up parameters on the servers, that are required for monitoring of the BGP neighbors.
- Establish connectivity of the BMP servers with BGP neighbors for monitoring.
- Generate statistics report from monitoring the BGP neighbors.
- Perform appropriate error handling on the BGP neighbors.
- Graceful scale up and degradation to the point of closing connectivity between the BMP servers and BGP neighbors.

- Finding Feature Information, on page 1101
- Prerequisites for BGP Monitoring Protocol, on page 1102
- Information About BGP Monitoring Protocol, on page 1102
- How to Configure BGP Monitoring Protocol, on page 1103
- Verifying BGP Monitoring Protocol, on page 1107
- Monitoring BGP Monitoring Protocol, on page 1108
- Configuration Examples for BGP Monitoring Protocol, on page 1109
- Additional References for BGP Monitoring Protocol, on page 1113
- Feature Information for BGP Monitoring Protocol, on page 1114

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.
Prerequisites for BGP Monitoring Protocol

Before you configure BGP Monitoring Protocol (BMP) servers, you must configure Border Gateway Protocol (BGP) neighbors, which function as BMP clients, and establish a session with its peers using either IPv4/IPv6 or VPNv4/VPNv6 address-family identifiers.

Information About BGP Monitoring Protocol

BGP Monitoring Protocol Overview

The BGP Monitoring Protocol (BMP) feature enables monitoring of BGP neighbors (called BMP clients). You can configure a device to function as a BMP server, which monitors either one or several BMP clients, which in turn, has several active peer sessions configured. You can also configure a BMP client to connect to one or more BMP servers. The BMP feature enables configuration of multiple BMP servers (configured as primary servers) to function actively and independent of each other, simultaneously to monitor BMP clients.

Each BMP server is specified by a number and you can use command-line interface (CLI) to configure parameters such as IP address, port number, and so on. Upon activation of a BMP server, it attempts to connect to BMP clients by sending an initiation message. The CLI enables multiple—independent and asynchronous—BMP server connections.

BGP neighbors, called BMP clients, are configured to send data to specific BMP servers for monitoring purposes. These clients are configured in a queue. When a request for a connection arrives from BMP clients to BMP servers, the connection is established based on the order in which the requests arrived. Once the BMP server connects with the first BMP neighbor, it sends out refresh requests to monitor the BMP clients and starts monitoring those BMP clients with whom the connection is already established.

The session connection requests from the other BMP clients in queue to the BMP servers initiates after an initial delay that you can configure using the `initial-delay` command. If a connection establishes but fails later, due to some reason, the connection request is retried after a delay, which you can configure using `failure-retry-delay` command. If there is repeated failure in connection establishment, the connection retries are delayed based on the delay configured using the `flapping-delay` command. Configuring the delay for such requests becomes significant because the route refresh requests that are sent to all connected BMP clients causes considerable network traffic and load on the device.

To avoid excessive load on the device, the BMP servers sends route refresh requests to individual BMP clients at a time, in the order in which connections are established in the queue. Once a BMP client that is already connected is in the “reporting” state, it sends a “peer-up” message to the BMP server. After the client receives a route-refresh request, route monitoring begins for that neighbor. Once the route refresh request ends, the next neighbor in the queue is processed. This cycle continues until all “reporting” BMP neighbors are reported and all routes sent by these “reporting” BMP neighbors are continuously monitored. If a neighbor establishes after BMP monitoring has begun, it does not require a route-refresh request. All received routes from that client is sent to BMP servers.

It is advantageous to batch up refresh requests from BMP clients, if several BMP servers are activated in quick succession. Use the `bmp initial-refresh delay` command to configure a delay in triggering the refresh mechanism when the first BMP server comes up. If other BMP servers come online within this time-frame, only one set of refresh requests is sent to the BMP clients. You can also configure the `bmp initial-refresh skip` command to skip all refresh requests from BMP servers and just monitor all incoming messages from the peers.
In a client-server configuration, it is recommended that the resource load of the devices be kept minimal and adding excessive network traffic must be avoided. In the BMP configuration, you can configure various delay timers on the BMP server to avoid flapping during connection between the server and client. To avoid excessive message throughput or high usage of system resources, you can configure the maximum buffer limit for the BMP session.

# How to Configure BGP Monitoring Protocol

## Configuring a BGP Monitoring Protocol Session

Perform this task to configure BGP Monitoring Protocol (BMP) session parameters for the BMP servers to establish connectivity with BMP clients.

### SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp as-number
4. bmp {buffer-size buffer-bytes | initial-refresh {delay refresh-delay | skip} | server server-number-n
5. end

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| 1.   | enable            | Enables privileged EXEC mode.  
      | Example:          | • Enter your password if prompted.  
      | Device> enable    |         |
| 2.   | configure terminal| Enters global configuration mode.  
      | Example:          |         
      | Device# configure terminal |         |
| 3.   | router bgp as-number | Enters router configuration mode and creates a BGP routing process.  
      | Example:          |         
      | Device(config)# router bgp 65000 |         |
| 4.   | bmp {buffer-size buffer-bytes | initial-refresh {delay refresh-delay | skip} | server server-number-n | Configures BMP parameters for BGP neighbors and enters BMP server configuration mode to configure BMP servers.  
      | Example:          |         
      | Device(config-router)# bmp initial-refresh delay 30 |         |
### Configuring BGP Monitoring Protocol on BGP Neighbors

Perform this task to activate BGP Monitoring Protocol (BMP) on BGP neighbors (also called BMP clients) so that the client activity is monitored by the BMP server configured on the neighbor.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp as-number`
4. `neighbor {ipv4-addr | neighbor-tag | ipv6-addr} bmp-activate {all | server server-number-1 [server server-number-2 . . . [server server-number-n]]}

   - Repeat Steps 1 to 4 to configure other BMP clients in the session.
5. `end`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>configure terminal</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Enters router configuration mode and creates a BGP routing process.</td>
</tr>
<tr>
<td>router bgp as-number</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config)# router bgp 65000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>Activates BMP monitoring on a BGP neighbor.</td>
</tr>
<tr>
<td>neighbor {ipv4-addr</td>
<td>neighbor-tag</td>
</tr>
<tr>
<td>Example:</td>
<td>• Repeat Steps 1 to 4 to configure other BMP clients in the session.</td>
</tr>
</tbody>
</table>
### Purpose

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device(config-router)# neighbor 30.1.1.1 bmp-activate server 1 server 2</td>
<td></td>
</tr>
</tbody>
</table>
### Command or Action

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
</tr>
</thead>
</table>
| **Step 3** | router bgp as-number  
Example: Device(config)# router bgp 65000 |
| **Step 4** | bmp {buffer-size buffer-bytes | initial-refresh {delay refresh-delay | skip} | server server-number-n  
Example: Device(config-router)# bmp server 1 |
| **Step 5** | activate  
Example: Device(config-router-bmpsrvr)# activate |
| **Step 6** | address {ipv4-addr | ipv6-addr} port-number  
Example: Device(config-router-bmpsrvr)# address 10.1.1.1 port-number 8000 |
| **Step 7** | description LINE server-description  
Example: Device(config-router-bmpsrvr)# description LINE SERVER1 |
| **Step 8** | failure-retry-delay failure-retry-delay  
Example: Device(config-router-bmpsrvr)# failure-retry-delay 40 |
| **Step 9** | flapping-delay flap-delay  
Example: Device(config-router-bmpsrvr)# flapping-delay 120 |
| **Step 10** | initial-delay initial-delay-time  
Example: Device(config-router-bmpsrvr)# initial-delay 20 |
| **Step 11** | set ip dscp dscp-value  
Example: |

### Purpose

<table>
<thead>
<tr>
<th>Step</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 3</strong></td>
<td>Enters router configuration mode and creates a BGP routing process.</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>Enters BMP server configuration mode to configure BMP servers.</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>Initiates a connection between BMP server and BGP neighbors.</td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>Configures IP address and port number to a specific BMP server.</td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>Configures a textual description of a BMP server.</td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td>Configures delay in the retry requests during failures when sending BMP server updates.</td>
</tr>
<tr>
<td><strong>Step 9</strong></td>
<td>Configures delays in flapping when sending BMP server updates.</td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td>Configures delays in sending initial requests for updates from the BMP servers.</td>
</tr>
<tr>
<td><strong>Step 11</strong></td>
<td>Configures the IP Differentiated Services Code Point (DSCP) values for BMP servers.</td>
</tr>
</tbody>
</table>
### Purpose Command or Action

Device(config-router-bmpsrvr)# set ip dscp 5

<table>
<thead>
<tr>
<th>Step 12</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
|         | stats-reporting-period  
Example: | Configures the time interval in which the BMP server receives the statistics report from BGP neighbors. |
|         | Device(config-router-bmpsrvr)# stats-reporting-period 30 |         |

<table>
<thead>
<tr>
<th>Step 13</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
|         | update-source  
Example: | Configures the interface source for routing updates on the BMP servers. |
|         | Device(config-router-bmpsrvr)# update-source ethernet 0/0 |         |

<table>
<thead>
<tr>
<th>Step 14</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
|         | exit-bmp-server-mode  
Example: | Exits from BMP server configuration mode and returns to router configuration mode. |
|         | Device(config-router-bmpsrvr)# exit-bmp-server-mode |         |

<table>
<thead>
<tr>
<th>Step 15</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
|         | end  
Example: | Returns to privileged EXEC mode. |
|         | Device(config-router)# end |         |

### Verifying BGP Monitoring Protocol

Perform the following steps to verify the configuration for the BGP Monitoring Protocol (BMP) servers and BMP clients:

#### SUMMARY STEPS

1. enable
2. show ip bgp bmp
3. show running-config

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| 1    | enable  
Example: | Enables privileged EXEC mode. |
|      | Device> enable   | • Enter your password if prompted. |
### Command or Action

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| Step 2 | `show ip bgp bmp`  
  **Example:**  
  `Device# show ip bgp bmp neighbors`  | Displays information about BMP servers and neighbors. |
| Step 3 | `show running-config`  
  **Example:**  
  `Device# show running-config | section bmp`  | Displays information about BMP servers and neighbors. |

### Monitoring BGP Monitoring Protocol

Perform the following steps to enable debugging and monitor the BGP Monitoring Protocol (BMP) servers.

**SUMMARY STEPS**

1. `enable`
2. `debug ip bgp bmp`
3. `show debugging`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1**  
  **enable**  
  **Example:**  
  `Device> enable`  | Enables privileged EXEC mode.  
  - Enter your password if prompted. |
| **Step 2**  
  **debug ip bgp bmp**  
  **Example:**  
  `Device# debug ip bgp bmp server`  | Enables debugging of the BMP attributes. |
| **Step 3**  
  **show debugging**  
  **Example:**  
  `Device# show debugging`  | Displays information about the types of debugging that are enabled on a device. |
Configuration Examples for BGP Monitoring Protocol

Examples for Configuring, Verifying, and Monitoring BGP Monitoring Protocol

Examples: Configuring BGP Monitoring Protocol

There are two levels of configuration required for the BGP Monitoring Protocol (BMP) to function as designed. You must enable BMP monitoring on each BGP neighbor (also called BMP client) to which several peers are connected in a network, and establish connectivity between the BMP servers and clients. Then, configure each BMP server in BMP server configuration mode for a specific server with the parameters required for monitoring the associated BMP clients.

The following example shows how to activate BMP on a neighbor with IP address 30.1.1.1, which is monitored by BMP servers (in this case, server 1 and 2):

Device> enable
Device# configure terminal
Device(config)# router bgp 65000
Device(config-router)# neighbor 30.1.1.1 bmp-activate server 1 server 2
Device(config-router)# end

The following example shows how to configure initial refresh delay of 30 seconds for BGP neighbors on which BMP is activated using the `neighbor bmp-activate` command:

Device> enable
Device# configure terminal
Device(config)# router bgp 65000
Device(config-router)# bmp initial-refresh delay 30
Device(config-router)# bmp buffer-size 2048
Device(config-router)# end

The following example shows how to enter BMP server configuration mode and initiate connection between a specific BMP server with the BGP BMP neighbors. In this example, connection to clients is initiated from BMP servers 1 and 2 along with configuration of the monitoring parameters:

Device> enable
Device# configure terminal
Device(config)# router bgp 65000
Device(config-router)# bmp server 1
Device(config-router-bmpsrvr)# activate
Device(config-router-bmpsrvr)# address 10.1.1.1 port-number 8000
Device(config-router-bmpsrvr)# description LINE SERVER1
Device(config-router-bmpsrvr)# failure-retry-delay 40
Device(config-router-bmpsrvr)# flapping-delay 120
Device(config-router-bmpsrvr)# initial-delay 20
Device(config-router-bmpsrvr)# set ip dscp 5
Device(config-router-bmpsrvr)# stats-reporting-period 30
Device(config-router-bmpsrvr)# update-source ethernet 0/0
Device(config-router-bmpsrvr)# exit-bmp-server-mode
Device(config-router)# bmp server 2
Examples for Configuring, Verifying, and Monitoring BGP Monitoring Protocol

Examples: Verifying BGP Monitoring Protocol

The following is sample output from the `show ip bgp bmp server` command for server number 1. The attributes displayed are configured in the BMP server configuration mode:

```
Device# show ip bgp bmp server 1
Print detailed info for 1 server number 1.

bmp server 1
  address: 10.1.1.1  port 8000
  description SERVER1
  up time 00:06:22
  session-startup route-refresh
  initial-delay 20
  failure-retry-delay 40
  flapping-delay 120
  activated
```

The following is sample output from the `show ip bgp bmp server` command for server number 2. The attributes displayed are configured in the BMP server configuration mode:

```
Device# show ip bgp bmp server 2
Print detailed info for 1 server number 2.

bmp server 2
  address: 20.1.1.1  port 9000
  description SERVER2
  up time 00:06:23
  session-startup route-refresh
  initial-delay 20
  failure-retry-delay 40
  flapping-delay 120
  activated
```

The following is sample output from the `show ip bgp bmp server summary` command after deactivating the BMP server 1 and 2 connections:

```
Device# show ip bgp bmp server summary

Number of BMP servers configured: 2
Number of BMP neighbors configured: 10
Number of neighbors on TransitionQ: 0, MonitoringQ: 0, ConfigQ: 0
Number of BMP servers on StatsQ: 0
BMP Refresh not in progress, refresh not scheduled
Initial Refresh Delay configured, refresh value 30s
BMP buffer size configured, buffer size 2048 MB, buffer size bytes used 0 MB
```
The following is sample output from the `show ip bgp bmp neighbors` command, which shows the status of the BGP BMP neighbors after reactivating the BMP server 1 and 2 connections:

Device# `show ip bgp bmp neighbors`

Number of BMP neighbors configured: 10
BMP Refresh not in progress, refresh not scheduled
Initial Refresh Delay configured, refresh value 30s
BMP buffer size configured, buffer size 2048 MB, buffer size bytes used 0 MB

The following is sample output from the `show ip bgp bmp server` command for BMP server number 1 and 2. The statistics reporting interval on BMP server 1 and 2 has been set to 30 seconds, therefore each server receives statistics messages from its connected BGP BMP neighbor in each cycle of 30 seconds:

Device# `show ip bgp bmp server summary`

Number of BMP servers configured: 2
Number of BMP neighbors configured: 10
Number of neighbors on TransitionQ: 0, MonitoringQ: 0, ConfigQ: 0
Number of BMP servers on StatsQ: 0
BMP Refresh not in progress, refresh not scheduled
Initial Refresh Delay configured, refresh value 30s
BMP buffer size configured, buffer size 2048 MB, buffer size bytes used 0 MB

Device# `show ip bgp bmp server summary`

Number of BMP servers configured: 2
Number of BMP neighbors configured: 10
Number of neighbors on TransitionQ: 0, MonitoringQ: 0, ConfigQ: 0
Number of BMP servers on StatsQ: 0
BMP Refresh not in progress, refresh not scheduled
Initial Refresh Delay configured, refresh value 30s
BMP buffer size configured, buffer size 2048 MB, buffer size bytes used 0 MB

ID Host/Net  Port  TCB  Status  Uptime  MsgSent  LastStat
1 10.1.1.1  8000  0x0  Down  0
2 20.1.1.1  9000  0x0  Down  0
If we configure several BGP BMP neighbors to be monitored by the BMP servers, for example 10, then 10 statistics messages are received by both servers in each periodic cycle that is configured.

The following is sample output from the `show running-config` command, which shows the running configuration on the device:

```
Device# show running-config | section bmp

bmp server 1
address 10.1.1.1 port-number 8000
description SERVER1
initial-delay 20
failure-retry-delay 40
flapping-delay 120
update-source Ethernet0/0
set ip dscp 3
activate
exit-bmp-server-mode
bmp server 2
address 20.1.1.1 port-number 9000
description SERVER2
initial-delay 20
failure-retry-delay 40
flapping-delay 120
update-source Ethernet2/0
set ip dscp 5
activate
exit-bmp-server-mode
bmp initial-refresh delay 30
bmp-activate all
```

**Examples: Monitoring BGP Monitoring Protocol**

The following example shows how to enable debugging of the various BMP attributes:

```
Device# debug ip bgp bmp event
BGP BMP events debugging is on
Device# debug ip bgp bmp neighbor
BGP BMP neighbor debugging is on
Device# debug ip bgp bmp server
BGP BMP server debugging is on
```

The following is sample output from the `show debugging` command after you enable the BGP BMP server debugging:

```
Device# show debugging
IP routing:
BGP BMP server debugging is on
Device#
```
Additional References for BGP Monitoring Protocol

Related Documents

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<tr>
<th>Related Topic</th>
<th>Document Title</th>
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<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
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<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support website provides extensive online resources, including</td>
<td><a href="http://www.cisco.com/support">http://www.cisco.com/support</a></td>
</tr>
<tr>
<td>documentation and tools for troubleshooting and resolving technical issues</td>
<td></td>
</tr>
<tr>
<td>with Cisco products and technologies.</td>
<td></td>
</tr>
<tr>
<td>To receive security and technical information about your products, you can</td>
<td></td>
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<tr>
<td>subscribe to various services, such as the Product Alert Tool (accessed from</td>
<td></td>
</tr>
<tr>
<td>Field Notices), the Cisco Technical Services Newsletter, and Really Simple</td>
<td></td>
</tr>
<tr>
<td>Syndication (RSS) Feeds.</td>
<td></td>
</tr>
<tr>
<td>Access to most tools on the Cisco Support website requires a Cisco.com user</td>
<td></td>
</tr>
<tr>
<td>ID and password.</td>
<td></td>
</tr>
</tbody>
</table>
Feature Information for BGP Monitoring Protocol

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.
Table 101: Feature Information for BGP Monitoring Protocol

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP Monitoring Protocol</td>
<td>Cisco IOS XE Release 3.11S</td>
<td></td>
</tr>
<tr>
<td>Feature Name</td>
<td>Releases</td>
<td>Feature Description</td>
</tr>
<tr>
<td>--------------</td>
<td>----------</td>
<td>---------------------</td>
</tr>
<tr>
<td>The BMP feature supports the following functionality to enable monitoring of the Border Gateway Protocol (BGP) neighbors, which become BMP clients:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Configure devices to function as BMP servers, and set up parameters on the servers, that are required for monitoring of the BGP neighbors.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Establish connectivity of the BMP servers with BGP neighbors for monitoring.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Generate statistics report from monitoring the BGP neighbors.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Perform appropriate error handling on the BGP neighbors.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Graceful scale up and degradation to the point of closing connectivity between the BMP servers and BGP neighbors.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The following commands were introduced or modified:</td>
<td></td>
<td></td>
</tr>
<tr>
<td><code>bmp</code></td>
<td></td>
<td></td>
</tr>
<tr>
<td><code>debug ip bgp bmp</code></td>
<td></td>
<td></td>
</tr>
<tr>
<td><code>neighbor bmp-activate</code></td>
<td></td>
<td></td>
</tr>
<tr>
<td><code>show ip bgp bmp</code></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The following commands were introduced in BMP server configuration mode, to configure specific BMP servers:</td>
<td></td>
<td></td>
</tr>
<tr>
<td><code>activate</code></td>
<td></td>
<td></td>
</tr>
<tr>
<td><code>address</code></td>
<td></td>
<td></td>
</tr>
<tr>
<td><code>default</code></td>
<td></td>
<td></td>
</tr>
<tr>
<td><code>description</code></td>
<td></td>
<td></td>
</tr>
<tr>
<td><code>exit-bmp-server-mode</code></td>
<td></td>
<td></td>
</tr>
<tr>
<td><code>failure-retry-delay</code></td>
<td></td>
<td></td>
</tr>
<tr>
<td><code>flapping-delay</code></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feature Name</td>
<td>Releases</td>
<td>Feature Description</td>
</tr>
<tr>
<td>-------------------</td>
<td>----------</td>
<td>--------------------------------------</td>
</tr>
<tr>
<td>initial-delay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>set ip dscp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>stats-reporting-period</td>
<td></td>
<td></td>
</tr>
<tr>
<td>update-source</td>
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</tr>
</tbody>
</table>
VRF Aware BGP Translate-Update

The VRF aware BGP translate-update feature enables multicast forwarding on those customer-edge (CE) devices, which have an older version of Cisco software that does not support multicast BGP (mBGP) routing.

The provider-edge (PE) devices establish a virtual routing and forwarding (VRF) session with the neighbor CE devices, and configure the translate-update feature under an IPv4/IPv6 VRF address family. The PE devices translate the updates from unicast to multicast on CE devices and put them as multicast updates in the Border Gateway Protocol (BGP) VRF routing table of the PE devices for processing.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

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Prerequisites for VRF Aware BGP Translate-Update

- The VRF aware translate-update feature applies only to IPv4/IPv6 virtual routing and forwarding (VRF) address-families.
- You must use peer-group for the configuration of the neighbor under IPv4/IPv6 VRF address families.
- BGP neighbors that are only capable of unicast routing, must be activated under both unicast and multicast address families.
BGP neighbors must also be enabled under the compatible multicast address family for the VRF aware translate-update feature to function as designed.

The provider-edge (PE) devices must have multicast VRF enabled and must have a session established with the customer-edge (CE) devices.

**Restrictions for VRF Aware BGP Translate-Update**

- You must not configure (nonVRF) IPv4/IPv6 address families for the VRF aware BGP translate-update feature. The IPv4/IPv6 address family must be configured for multicast routing using the Subsequent Address Family Identifier (SAFI) feature.

- The VRF aware BGP translate-update feature does not support configuration of BGP neighbor using peer-template.

**Information About VRF Aware BGP Translate-Update**

**VRF Aware BGP Translate-Update Overview**

The VRF aware BGP translate-update feature enables multicast forwarding on those customer-edge (CE) devices, which have an older version of Cisco software that does not support multicast BGP (mBGP) routing.

This feature is analogous to the Subsequent Address Family Identifier (SAFI), which provides the capability to support multicast routing in the service provider's core IPv4 network, but is limited in support to IPv4/IPv6 address families. In the case of the virtual routing and forwarding (VRF) aware BGP translate-update feature, provider-edge (PE) devices establish a VRF session with the neighbor CE devices, and have the translate-update feature configured under an IPv4/IPv6 VRF address family.

When the `neighbor translate-update` command is configured on a PE device under the (IPv4 VRF) address-family configuration mode or the (IPv6 VRF) address-family configuration mode, the PE devices translate the updates from unicast to multicast on CE devices and put them in the Border Gateway Protocol (BGP) VRF routing table of the PE devices, as multicast updates, for processing. If you also configure the optional keyword `unicast`, the updates that are not translated, are placed in the PE device's unicast queue and populates the unicast VRF BGP table. The translation from unicast to multicast routes occurs from CE devices to PE devices only, and the multicast and unicast prefixes are only advertised from the CE device to the PE device's multicast neighbors.

For example, when you configure the VRF aware BGP translate-update feature under a VRF (v1) for a neighbor CE device (CE1), a neighbor topology under the IPv4-multicast-VRF or IPv6-multicast-VRF address-family is added to CE1's session with a PE device (PE1). The multicast-VRF neighbor topology does not actively participate in these multicast sessions and only forwards announcements that arrive from CE1. Once such announcements arrive, they are translated into multicast and placed in the nonactive multicast VRF neighbor's routing table. The Cisco software ensures that the routes advertised by CE1 configured under the IPv4/IPv6 VRF address-family are available on PE1's IPv4/IPv6 multicast VRF v1 address-family BGP table. These routes, along with PE1's IPv4/IPv6 multicast VRF v1 address-family BGP table, are advertised to PE1's multicast peers if you have configured the `neighbor translate-update` command. The routes are also advertised to PE1's unicast peers if you have also configured the optional keyword `unicast`.
The `unicast` keyword is optional, yet significant, as it enables the PE devices to place unicast advertisements from the CE devices in the unicast BGP table of the PE devices. Therefore, route advertisements from CE devices populates both unicast and multicast BGP tables, else CE device's routes only populate the PE device's multicast BGP table.

---

**Note**

You must also enable address-family under the compatible multicast address-family for VRF aware BGP translate-update feature to function as designed.

---

## How To Configure VRF Aware BGP Translate-Update

### Configuring VRF Aware BGP Translate-Update

Perform this task to configure VRF aware BGP translate-update feature:

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp as-number`
4. `address-family ipv4 [mdt | tunnel | {multicast | unicast} [vrf vrf-name] | vrf vrf-name]`
5. `neighbor peer-group-name peer-group`
6. `neighbor {ipv4-addr | ipv6-addr} remote-as autonomous-system-number`
7. `neighbor {ipv4-addr | ipv6-addr} peer-group peer-group-name`
8. `neighbor {ipv4-addr | ipv6-addr} peer-group-name activate`
9. `neighbor {ipv4-address | ipv6-address} translate-update multicast [unicast]`
10. `end`
11. `show bgp vpnv4 multicast {all | vrf vrf-name | rd route-distinguisher}`
12. `show ip route multicast vrf vrf-name`
13. `show running-config`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1**
  
  **enable**
  
  **Example:**
  
  `Device> enable`
  
  Enables privileged EXEC mode.

  • Enter your password if prompted.

| **Step 2**
  
  **configure terminal**
  
  **Example:**
  
  `Device# configure terminal`
  
  Enters global configuration mode. |
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 3**
router bgp as-number  
Example:
Device(config)# router bgp 65000 | Enters router configuration mode and creates a BGP routing process. |
| **Step 4**
address-family ipv4 [mdt | tunnel | {multicast | unicast} [vrf vrf-name] | vrf vrf-name]  
Example:
Device(config)# address-family ipv4 vrf v1 | Enters address family configuration mode to configure a routing session using standard IP Version 4 (IPv4) address prefixes. |
| **Step 5**
neighbor peer-group-name peer-group  
Example:
Device(config-af)# neighbor n2 peer-group | Creates a BGP or multiprotocol BGP peer group. |
| **Step 6**
neighbor {ipv4-addr | ipv6-addr | peer-group-name} remote-as autonomous-system-number  
Example:
Device(config-af)# neighbor n2 remote-as 4 | Adds an entry to the BGP or multiprotocol BGP neighbor table. |
| **Step 7**
neighbor {ipv4-addr | ipv6-addr} peer-group peer-group-name  
Example:
Device(config-af)# neighbor 10.1.1.1 peer-group n2 | Configures a BGP neighbor to be a member of a peer group. |
| **Step 8**
neighbor {ipv4-addr | ipv6-addr | peer-group-name} activate  
Example:
Device(config-af)# neighbor 10.1.1.1 activate | Enables exchange of information with a BGP neighbor. |
| **Step 9**
neighbor {ipv4-address | ipv6-address} translate-update multicast [unicast]  
Example:
Device(config-af)# neighbor 10.1.1.1 translate-update multicast unicast | Enables multicast routing on devices, which are not capable of multicast BGP (mBGP) routing. |
| **Step 10**
end  
Example:
Device(config-af)# end | Returns to privileged EXEC mode. |
### Removing the VRF Aware BGP Translate-Update Configuration

Perform this task to disable the VRF aware BGP translate-update feature:

**SUMMARY STEPS**

1. enable
2. configure terminal
3. router bgp as-number
4. address-family ipv4 [mdt | tunnel | {multicast | unicast} [vrf vrf-name] | vrf vrf-name]
5. no neighbor {ipv4-address | ipv6-address} translate-update multicast [unicast]
6. end
7. show running-config

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td></td>
<td>Device&gt; enable</td>
</tr>
<tr>
<td>Step 2 configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device# configure terminal</td>
</tr>
<tr>
<td>Step 3 router bgp as-number</td>
<td>Enters router configuration mode and creates a BGP routing process.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
</tbody>
</table>
### Configuration Examples for VRF Aware BGP Translate-Update

#### Example: Configuring VRF aware BGP Translate-Update

The following example shows how to configure the translate-update feature for an IPv4 VRF address-family named v1 and BGP neighbor n2 peer-group for VRF configuration:

```
Device> enable
Device# configure terminal
Device(config)# router bgp 65000
Device(config-router)# address-family ipv4 vrf v1
Device(config-router-af)# neighbor n2 peer-group
Device(config-router-af)# neighbor n2 remote-as 4
Device(config-router-af)# neighbor 10.1.1.1 peer-group n2
Device(config-router-af)# neighbor 10.1.1.1 activate
```

---

**Note**

Peer-template configuration for BGP neighbor is not supported for this feature due to conflicts with the earlier versions of Cisco software.
Device(config-router-af)# neighbor 10.1.1.1 translate-update multicast unicast
Device(config-router-af)# end

The following is sample output from the `show bgp vpnv4 multicast vrf` command. As the VRF aware BGP translate-update feature is configured, the state of the neighbor displays “NoNeg”:

```
Device# show bgp vpnv4 multicast vrf v1 summary
BGP router identifier 10.1.3.1, local AS number 65000
BGP table version is 8, main routing table version 8
7 network entries using 1792 bytes of memory
8 path entries using 960 bytes of memory
3 BGP AS-PATH entries using 88 bytes of memory
2 BGP extended community entries using 48 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
BGP using 4168 total bytes of memory
BGP activity 23/2 prefixes, 33/9 paths, scan interval 60 secs
```

<table>
<thead>
<tr>
<th>Neighbor</th>
<th>V</th>
<th>AS MagRcvd</th>
<th>MagSent</th>
<th>TblVer</th>
<th>InQ OutQ</th>
<th>Up/Down</th>
<th>State/PfxRcd</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1.1.1</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>10</td>
<td>1</td>
<td>0</td>
<td>00:01:10 (NoNeg)</td>
</tr>
<tr>
<td>10.1.3.2</td>
<td>4</td>
<td>2</td>
<td>12</td>
<td>10</td>
<td>8</td>
<td>0</td>
<td>00:01:33</td>
</tr>
</tbody>
</table>

The following is sample output from the `show ip route multicast vrf` command:

```
The routes configured using the translate-update feature does not have the “+” symbol against the prefixes in the Routing Information Base (RIB) table. Appearance of the symbol in the first entry indicates that the unicast route has leaked into the multicast table. However, the second entry is a translate-update route, which appears to be a multicast route.

Device# show ip route multicast vrf v1
B + 10.1.1.0/24 [20/0] via 10.1.1.1 (v1), 00:00:08
B 10.1.1.0/24 [20/0] via 10.1.1.1 (v1), 00:00:42
```

The following is sample output from the `show running-config` command:

```
The provider-edge (PE) device must activate its BGP neighbor under the multicast address-family even though the neighbor is not capable of multicast routing. If the unicast address-family identifier has the route-map configured and multicast address-family identifier has no route-map configured, the unicast route-map controls the route under the unicast table but not the route under multicast table.

Device# show running-config
address-family ipv4 vrf v1
redistribute connected
redistribute static
neighbor 10.1.1.1 remote-as 4
neighbor 10.1.1.1 activate
```
Example: Configuring VRF aware BGP Translate-Update

neighbor 10.1.1.1 translate-update multicast unicast
neighbor 10.1.1.1 remote-as 4
neighbor 10.1.1.1 activate
exit-address-family

! address-family ipv4 multicast vrf v1
redistribute connected
redistribute static
neighbor 10.1.1.1 remote-as 4
neighbor 10.1.1.1 activate
neighbor 10.1.1.1 soft-reconfiguration inbound
neighbor 10.1.1.1 route-map x in
exit-address-family

Note The “neighbor 10.1.1.1 soft-reconfiguration inbound” and the “neighbor 10.1.1.1 route-map x in” field in the output indicate that only the routes in the BGP multicast table are affected.

The following is sample output from the show running-config command when you configure a neighbor under different address-families:

Note Configuring the BGP neighbor under different address-families manipulates the unicast routes and multicast routes advertised to the neighbor.

Configuration for IPv4/IPv6 unicast address-family:

Device# show running-config

address-family ipv4
neighbor 20.2.2.1 activate
neighbor 20.2.2.1 translate-update multicast unicast
exit-address-family
!
address-family ipv4 multicast
neighbor 20.2.2.1 activate
exit-address-family
!

Configuration for IPv4/IPv6 VRF unicast address-family:

Device# show running-config

address-family ipv4 vrf v1
neighbor 20.2.2.1 remote-as 4
neighbor 20.2.2.1 activate
neighbor 20.2.2.1 translate-update multicast unicast
exit-address-family
!
address-family ipv4 multicast vrf v1
neighbor 20.2.2.1 remote-as 4
neighbor 20.2.2.1 activate
exit-address-family
!
The following is sample configuration of the translate-update feature from a device with the old version of Cisco Software. The neighbor, in this case, is configured for IPv4/IPv6 unicast address-family, without running the `address-family` command:

Configuration in the old format, without an address-family configured:

```plaintext
Device> enable
Device# configure terminal
Device(config)# router bgp 65000
Device(config-router)# neighbor 20.2.2.1 remote-as 4
Device(config-router)# neighbor 20.2.2.1 translate-update nlri ipv4 multicast unicast
Device(config-router-af)# end
```

Configuration in the new format, without an address-family configured:

```plaintext
Device> enable
Device# configure terminal
Device(config)# router bgp 65000
Device(config-router)# neighbor 20.2.2.1 remote-as 4
Device(config-router)# neighbor 20.2.2.1 translate-update nlri multicast unicast
Device(config-router-af)# end
```

**Example: Removing VRF aware BGP Translate-Update Configuration**

The following example shows how to disable the VRF aware BGP translate-update feature for an IPv4 VRF address-family named v1 and BGP neighbor n2 peer-group for VRF:

Disabling the translate-update configuration for a neighbor deletes the pseudo multicast neighbor and flaps the session, similar to removing the neighbor from a multicast session:

```plaintext
Device> enable
Device# configure terminal
Device(config)# router bgp 65000
Device(config-router)# address-family ipv4 vrf v1
Device(config-router-af)# no neighbor 10.1.1.1 translate-update multicast unicast
Device(config-router-af)# end
```

The following output displays the debug logs after you disable the translate-update feature on the neighbor:

```
*Nov 20 07:09:15.902: %BGP_SESSION-5-ADJCHANGE: neighbor 2.2.2.1 IPv4 Multicast vpn vrf v1 topology base removed from session  Neighbor deleted
*Nov 20 07:09:15.902: %BGP-5-ADJCHANGE: neighbor 2.2.2.1 vpn vrf v1 Down Neighbor deleted
*Nov 20 07:09:15.902: %BGP_SESSION-5-ADJCHANGE: neighbor 2.2.2.1 IPv4 Unicast vpn vrf v1 topology base removed from session Neighbor deleted
*Nov 20 07:09:16.877: %BGP-5-ADJCHANGE: neighbor 2.2.2.1 vpn vrf v1 Up
```

The following is sample output from the `show running-config` command:
The associated neighbor 10.1.1.1 is removed even from the nonvolatile generation (NVGEN) after translate-update is disabled on that neighbor.

Device# show running-config

address-family ipv4 vrf v1
redistribute connected
redistribute static
neighbor 10.1.1.1 remote-as 4
neighbor 10.1.1.1 activate
exit-address-family
!
address-family ipv4 multicast vrf v1
redistribute connected
redistribute static
exit-address-family

Additional References for VRF Aware BGP Translate-Update

Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
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### Table 102: Feature Information for VRF Aware BGP Translate-Update

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>VRF aware BGP Translate-Update</td>
<td>Cisco IOS XE Release 3.11S</td>
<td>The VRF aware BGP translate-update feature enables multicast forwarding on those customer-edge (CE) devices, which have an older version of Cisco software that does not support multicast BGP (mBGP) routing. The following command was introduced: <code>neighbor translate-update</code></td>
</tr>
</tbody>
</table>
CHAPTER 83

BGP Support for MTR

The BGP Support for MTR feature provides Border Gateway Protocol (BGP) support for multiple logical topologies over a single physical network. This module describes how to configure BGP for Multitopology Routing (MTR).

• Finding Feature Information, on page 1131
• Prerequisites for BGP Support for MTR, on page 1131
• Restrictions for BGP Support for MTR, on page 1132
• Information About BGP Support for MTR, on page 1132
• How to Configure BGP Support for MTR, on page 1134
• Configuration Examples for BGP Support for MTR, on page 1140
• Additional References, on page 1143
• Feature Information for BGP Support for MTR, on page 1143

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for BGP Support for MTR

• Be familiar with all the concepts in the “Information About BGP Support for MTR” section.
• Configure and activate a global Multitopology Routing (MTR) topology configuration.
Restrictions for BGP Support for MTR

- Redistribution within a topology is permitted. Redistribution from one topology to another is not permitted. This restriction is designed to prevent routing loops. You can use topology translation or topology import functionality to move routes from one topology to another.

- Only a single multicast topology can be configured, and only the base topology can be specified if a multicast topology is created.

Information About BGP Support for MTR

Routing Protocol Support for MTR

You must enable IP routing on the device for Multitopology Routing (MTR) to operate. MTR supports static and dynamic routing in Cisco software. You can enable dynamic routing per topology to support interdomain and intradomain routing. Route calculation and forwarding are independent for each topology. MTR support is integrated into Cisco software for the following protocols:

- Border Gateway Protocol (BGP)
- Integrated Intermediate System-to-Intermediate System (IS-IS)

You apply the per-topology configuration in router address family configuration mode of the global routing process (router configuration mode). The address family and subaddress family are specified when the device enters address family configuration mode. You specify the topology name and topology ID by entering the **topology** command in address family configuration mode.

You configure each topology with a unique topology ID under the routing protocol. The topology ID is used to identify and group Network Layer Reachability Information (NLRI) for each topology in updates for a given protocol. In OSPF, EIGRP, and IS-IS, you enter the topology ID during the first configuration of the **topology** command for a class-specific topology. In BGP, you configure the topology ID by entering the **bgp tid** command under the topology configuration.

You can configure class-specific topologies with different metrics than the base topology. Interface metrics configured on the base topology can be inherited by the class-specific topology. Inheritance occurs if no explicit inheritance metric is configured in the class-specific topology.

You configure BGP support only in router configuration mode. You configure Interior Gateway Protocol (IGP) support in router configuration mode and in interface configuration mode.

By default, interfaces are not included in nonbase topologies. For routing protocol support for EIGRP, IS-IS, and OSPF, you must explicitly configure a nonbase topology on an interface. You can override the default behavior by using the **all-interfaces** command in address family topology configuration mode. The **all-interfaces** command causes the nonbase topology to be configured on all interfaces of the device that are part of the default address space or the virtual routing and forwarding (VRF) instance in which the topology is configured.
**BGP Network Scope**

To implement Border Gateway Protocol (BGP) support for Multitopology Routing (MTR), the scope hierarchy is required, but the scope hierarchy is not limited to MTR use. The scope hierarchy introduces new configuration modes such as router scope configuration mode. The device enters router scope configuration mode when you configure the `scope` command in router configuration mode. When this command is entered, a collection of routing tables is created.

You configure BGP commands under the scope hierarchy for a single network (globally), or on a per-virtual routing and forwarding (VRF) basis; these configurations are referred to as scoped commands. The scope hierarchy can contain one or more address families.

**MTR CLI Hierarchy Under BGP**

The Border Gateway Protocol (BGP) CLI provides backward compatibility for pre-Multitopology Routing (MTR) BGP configuration and provides a hierarchical implementation of MTR. Router configuration mode is backward compatible with the pre-address family and pre-MTR configuration CLI. Global commands that affect all networks are configured in this configuration mode. For address family and topology configuration, you configure general session commands and peer templates to be used in address family configuration mode or in topology configuration mode.

After configuring any global commands, you define the scope either globally or for a specific virtual routing and forwarding (VRF) instance. The device enters address family configuration mode when you configure the `address-family` command in router scope configuration mode or in router configuration mode. Unicast is the default address family if no subaddress family identifier (SAFI) is specified. MTR supports only the IPv4 address family with a SAFI of unicast or multicast.

When the device enters address family configuration mode from router configuration mode, the software configures BGP to use pre-MTR-based CLI. This configuration mode is backward compatible with pre-existing address family configurations. Entering address family configuration mode from router scope configuration mode configures the device to use the hierarchical CLI that supports MTR. Address family configuration parameters that are not specific to a topology are entered in this address family configuration mode.

The device enters BGP topology configuration mode when you configure the `topology` command in address family configuration mode. You can configure up to 32 topologies (including the base topology) on a device. You configure the topology ID by entering the `bgp tid` command. All address family and subaddress family configuration parameters for the topology are configured here.

---

**Note**

Configuring a scope for a BGP routing process removes CLI support for pre-MTR-based configuration.

The following example shows the hierarchy levels that are used when you configure BGP for MTR implementation:

```
routing bgp <autonomous-system-number>
  ! Global commands
  scope {global | vrf <vrf-name>}
    ! Scoped commands
      address-family {<afi>} [<safi>]
        ! Address family specific commands
```

---
BGP Sessions for Class-Specific Topologies

Multitopology Routing (MTR) is configured under the Border Gateway Protocol (BGP) on a per-session basis. The base unicast and multicast topologies are carried in the global (default) session. A separate session is created for each class-specific topology that is configured under a BGP routing process. Each session is identified by its topology ID. BGP performs a best-path calculation individually for each class-specific topology. A separate Routing Information Base (RIB) and Forwarding Information Base (FIB) are maintained for each session.

Topology Translation Using BGP

Depending on the design and policy requirements for your network, you might need to install routes from a class-specific topology on one device in a class-specific topology on a neighboring device. Topology translation functionality using the Border Gateway Protocol (BGP) provides support for this operation. Topology translation is BGP neighbor-session based. You configure the `neighbor translate-topology` command by using the IP address and topology ID from the neighbor.

The topology ID identifies the class-specific topology of the neighbor. The routes in the class-specific topology of the neighbor are installed in the local class-specific Routing Information Base (RIB). BGP performs a best-path calculation on all installed routes and installs these routes into the local class-specific RIB. If a duplicate route is translated, BGP selects and installs only one instance of the route per standard BGP best-path calculation behavior.

Topology Import Using BGP

Importing topologies using the Border Gateway Protocol (BGP) is similar to topology translation. The difference is that routes are moved between class-specific topologies on the same device. You configure this function by entering the `import topology` command and specify the name of the class-specific topology or base topology. Best-path calculations are run on the imported routes before they are installed into the topology Routing Information Base (RIB). This `import topology` command also includes a `route-map` keyword to allow you to filter routes that are moved between class-specific topologies.

How to Configure BGP Support for MTR

Activating an MTR Topology by Using BGP

Perform this task to activate a Multitopology Routing (MTR) topology inside an address family by using the Border Gateway Protocol (BGP). This task is configured on Device B in the figure below and must also be configured on Device D and Device E. In this task, a scope hierarchy is configured to apply globally, and a neighbor is configured in router scope configuration mode. Under the IPv4 unicast address family, an MTR topology that applies to video traffic is activated for the specified neighbor. There is no interface configuration mode for BGP topologies.
SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. scope {global | vrf vrf-name}
5. neighbor {ip-address | peer-group-name} remote-as autonomous-system-number
6. neighbor {ip-address | peer-group-name} transport {connection-mode {active | passive} | path-mtu-discovery | multi-session | single-session}
7. address-family ipv4 [ndt | multicast | unicast]
8. topology {base | topology-name}
9. bgp tid number
10. neighbor ip-address activate
11. neighbor {ip-address | peer-group-name} translate-topology number
12. end
14. show ip bgp topology {* | topology} summary

DETAILED STEPS

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
</tbody>
</table>

Figure 95: BGP Network Diagram
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device&gt; enable</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters router configuration mode to create or configure a BGP routing process.</td>
</tr>
<tr>
<td>Example: Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td></td>
</tr>
<tr>
<td>Example: Device(config)# router bgp 45000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> scope {global</td>
<td>vrf vrf-name}</td>
</tr>
<tr>
<td>Example: Device(config-router)# scope global</td>
<td>• BGP general session commands that apply to a single network, or a specified virtual and routing forwarding (VRF) instance, are entered in this configuration mode.</td>
</tr>
<tr>
<td></td>
<td>• Use the <strong>global</strong> keyword to specify that BGP uses the global routing table.</td>
</tr>
<tr>
<td></td>
<td>• Use the <strong>vrf vrf-name</strong> keyword and argument to specify that BGP uses a specific VRF routing table. The VRF must already exist.</td>
</tr>
<tr>
<td><strong>Step 5</strong> neighbor {ip-address</td>
<td>peer-group-name} remote-as autonomous-system-number</td>
</tr>
<tr>
<td>Example: Device(config-router-scope)# neighbor 172.16.1.2 remote-as 45000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> neighbor {ip-address</td>
<td>peer-group-name} transport {connection-mode {active</td>
</tr>
<tr>
<td>Example: Device(config-router-scope)# neighbor 172.16.1.2 transport multi-session</td>
<td>• Use the <strong>connection-mode</strong> keyword to specify the type of connection, either active or passive.</td>
</tr>
<tr>
<td></td>
<td>• Use the <strong>path-mtu-discovery</strong> keyword to enable the TCP transport path maximum transmission unit (MTU) discovery.</td>
</tr>
<tr>
<td></td>
<td>• Use the <strong>multi-session</strong> keyword to specify a separate TCP transport session for each address family.</td>
</tr>
<tr>
<td></td>
<td>• Use the <strong>single-session</strong> keyword to specify that all address families use a single TCP transport session.</td>
</tr>
<tr>
<td><strong>Step 7</strong> address-family ipv4 {mdt</td>
<td>multicast</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>------------------</td>
<td>---------</td>
</tr>
<tr>
<td><code>Device(config-router-scope)# address-family ipv4</code></td>
<td>Use the <code>mdt</code> keyword to specify IPv4 multicast distribution tree (MDT) address prefixes. Use the <code>multicast</code> keyword to specify IPv4 multicast address prefixes. Use the <code>unicast</code> keyword to specify the IPv4 unicast address family. By default, the device is placed in address family configuration mode for the IPv4 unicast address family if the <code>unicast</code> keyword is not specified with the <code>address-family ipv4</code> command. Non-topology-specific configuration parameters are configured in this configuration mode.</td>
</tr>
</tbody>
</table>

**Step 8**

**topology {base | topology-name}**  
**Example:**  
`Device(config-router-scope-af)# topology VIDEO`  

Configures the topology instance in which BGP routes class-specific or base topology traffic, and enters router scope address family topology configuration mode.

**Step 9**

**bgp tid number**  
**Example:**  
`Device(config-router-scope-af-topo)# bgp tid 100`  

Associates a BGP routing process with the specified topology ID. Each topology must be configured with a unique topology ID.

**Step 10**

**neighbor ip-address activate**  
**Example:**  
`Device(config-router-scope-af-topo)# neighbor 172.16.1.2 activate`  

Enables the BGP neighbor to exchange prefixes for the network service access point (NSAP) address family with the local device.  
**Note** If you have configured a peer group as a BGP neighbor, do not use this command because peer groups are automatically activated when any peer group parameter is configured.

**Step 11**

**neighbor {ip-address | peer-group-name} translate-topology number**  
**Example:**  
`Device(config-router-scope-af-topo)# neighbor 172.16.1.2 translate-topology 200`  

(Optional) Configures BGP to install routes from a topology on another device to a topology on the local device.  
**Note** The topology ID is entered for the `number` argument to identify the topology on the device.

**Step 12**

**end**  
**Example:**  
`Device(config-router-scope-af-topo)# end`  

(Optional) Exits router scope address family topology configuration mode and returns to privileged EXEC mode.

**Step 13**

**clear ip bgp topology {* | topology-name} {as-number | dampening [network-address [network-mask]] | flap-statistics [network-address [network-mask]]}**  

Resets BGP neighbor sessions under a specified topology or all topologies.
### What to Do Next

Repeat this task for every topology that you want to enable, and repeat this configuration on all neighbor devices that are to use the topologies.

If you want to import routes from one Multitopology Routing (MTR) topology to another on the same device, see the “Importing Routes from an MTR Topology by Using BGP” section.

### Importing Routes from an MTR Topology by Using BGP

Perform this task to import routes from one Multitopology Routing (MTR) topology to another on the same device, when multiple topologies are configured on the same device. In this task, a prefix list is defined to permit prefixes from the 10.2.2.0 network, and this prefix list is used with a route map to filter routes moved from the imported topology. A global scope is configured, address family IPv4 is entered, the VIDEO topology is specified, the VOICE topology is imported, and the routes are filtered using the route map named 10NET.

### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `ip prefix-list list-name [seq number] {deny | permit} network[length [ge ge-length] [le le-length]`
4. `route-map map-name [permit | deny] [sequence-number]`
5. `match ip address {access-list-number [access-list-number ... | access-list-name...] | access-list-name [access-list-number ... | access-list-name] | prefix-list prefix-list-name [prefix-list-name...]}`
6. `exit`
7. `router bgp autonomous-system-number`
8. `scope {global | vrf vrf-name}`
9. `address-family ipv4 [mdt | multicast | unicast]`
10. `topology {base | topology-name}`
11. `import topology {base | topology-name} [route-map map-name]`
12. `end`
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** | `enable` | Enables privileged EXEC mode.  
  - Enter your password if prompted. |
| **Example:** | Device> enable |
| **Step 2** | `configure terminal` | Enters global configuration mode. |
| **Example:** | Device# configure terminal |
| **Step 3** | `ip prefix-list list-name [seq number] [deny | permit] network/length [ge ge-length] [le le-length]` | Configures an IP prefix list.  
  - In this example, prefix list TEN permits advertising of the 10.2.2.0/24 prefix depending on a match set by the `match ip address` command. |
| **Example:** | Device(config)# ip prefix-list TEN permit 10.2.2.0/24 |
| **Step 4** | `route-map map-name [permit | deny] [sequence-number]` | Creates a route map and enters route-map configuration mode.  
  - In this example, the route map named 10NET is created. |
| **Example:** | Device(config)# route-map 10NET |
| **Step 5** | `match ip address {access-list-number [access-list-number ... | access-list-name...] | access-list-name [access-list-number ... | access-list-name] | prefix-list prefix-list-name [prefix-list-name...]}` | Configures the route map to match a prefix that is permitted by a standard access list, an extended access list, or a prefix list.  
  - In this example, the route map is configured to match prefixes permitted by prefix list TEN. |
| **Example:** | Device(config-route-map)# match ip address prefix-list TEN |
| **Step 6** | `exit` | Exits route-map configuration mode and returns to global configuration mode. |
| **Example:** | Device(config-router)# exit |
| **Step 7** | `router bgp autonomous-system-number` | Enters router configuration mode to create or configure a Border Gateway Protocol (BGP) routing process. |
| **Example:** | Device(config)# router bgp 50000 |
| **Step 8** | `scope {global | vrf vrf-name}` | Defines the scope to the BGP routing process and enters router scope configuration mode.  
  - BGP general session commands that apply to a single network, or a specified virtual routing and forwarding |
<p>| <strong>Example:</strong> | Device(config-router)# scope global |</p>
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 9</strong></td>
<td>Enters router scope address family configuration mode to configure an address family session under BGP. Nontopology-specific configuration parameters are configured in this configuration mode.</td>
</tr>
<tr>
<td>address-family ipv4 [mdt</td>
<td>multicast</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-router-scope)# address-family ipv4</td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td>Configures the topology instance in which BGP routes class-specific or base topology traffic, and enters router scope address family topology configuration mode.</td>
</tr>
<tr>
<td>topology {base</td>
<td>topology-name}</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-router-scope-af)# topology VIDEO</td>
</tr>
<tr>
<td><strong>Step 11</strong></td>
<td>(Optional) Configures BGP to move routes from one topology to another on the same device. • The <strong>route-map</strong> keyword can be used to filter routes that moved between topologies.</td>
</tr>
<tr>
<td>import topology {base</td>
<td>topology-name} [route-map map-name]</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config-router-scope-af-topo)# import topology VOICE route-map 10NET</td>
</tr>
<tr>
<td><strong>Step 12</strong></td>
<td>(Optional) Exits router scope address family topology configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td>end</td>
<td>Device(config-router-scope-af-topo)# end</td>
</tr>
</tbody>
</table>

**Configuration Examples for BGP Support for MTR**

**Example: BGP Topology Translation Configuration**

The following example shows how to configure the Border Gateway Protocol (BGP) in the VIDEO topology and how to configure topology translation with the 192.168.2.2 neighbor:

```plaintext
router bgp 45000
  scope global
  neighbor 172.16.1.1 remote-as 50000
  neighbor 192.168.2.2 remote-as 55000
  neighbor 172.16.1.1 transport multi-session
  neighbor 192.168.2.2 transport multi-session
  address-family ipv4
  topology VIDEO
```
Example: BGP Global Scope and VRF Configuration

The following example shows how to configure a global scope for a unicast topology and also for a multicast topology. After the device exits the router scope configuration mode, a scope is configured for the virtual routing and forwarding (VRF) instance named DATA.

```
router bgp 45000
  scope global
    bgp default ipv4-unicast
    neighbor 172.16.1.2 remote-as 45000
    neighbor 192.168.3.2 remote-as 50000
    address-family ipv4 unicast
      topology VOICE
        bgp tid 100
        neighbor 172.16.1.2 activate
        exit
        address-family ipv4 multicast
          topology base
            neighbor 192.168.3.2 activate
            exit
            exit
          exit
          exit
    scope vrf DATA
      neighbor 192.168.1.2 remote-as 40000
      address-family ipv4
        neighbor 192.168.1.2 activate
        end
```

Examples: BGP Topology Verification

The following example shows summary output for the `show ip bgp topology` command. Information is displayed about Border Gateway Protocol (BGP) neighbors configured to use the Multitopology Routing (MTR) topology named VIDEO.

```
Device# show ip bgp topology VIDEO summary

BGP router identifier 192.168.3.1, local AS number 45000
BGP table version is 1, main routing table version 1
Neighbor   V  AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd
172.16.1.2 4  45000   289    289      1   0   0   04:48:44    0
192.168.3.2 4  50000    3    3       1   0  00:00:27    0
```

The following partial output displays BGP neighbor information under the VIDEO topology:

```
Device# show ip bgp topology VIDEO neighbors 172.16.1.2

BGP neighbor is 172.16.1.2, remote AS 45000, internal link
BGP version 4, remote router ID 192.168.2.1
BGP state = Established, up for 04:56:30
Last read 00:00:23, last write 00:00:21, hold time is 180, keepalive interval is 60 seconds
```
Neighbor sessions:
  1 active, is multisession capable
Neighbor capabilities:
  Route refresh: advertised and received (new)
Message statistics, state Established:
  InQ depth is 0
  OutQ depth is 0

  Sent   Rcvd
  Opens: 1   1
  Notifications: 0   0
  Updates: 0   0
  Keepalives: 296  296
  Route Refresh: 0  0
  Total: 297  297
Default minimum time between advertisement runs is 0 seconds
For address family: IPv4 Unicast topology VIDEO
Session: 172.16.1.2 session 1
BGP table version 1, neighbor version 1/0
Output queue size: 0
Index 1, Offset 0, Mask 0x2
1 update-group member
  Topology identifier: 100
  ...
Address tracking is enabled, the RIB does have a route to 172.16.1.2
Address tracking requires at least a /24 route to the peer
Connections established: 1; dropped 0
Last reset never
Transport(tcp) path-mtu-discovery is enabled
Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Minimum incoming TTL 0, Outgoing TTL 255
Local host: 172.16.1.1, Local port: 11113
Foreign host: 172.16.1.2, Foreign port: 179
  ...

Example: Importing Routes from an MTR Topology by Using BGP

The following example shows how to configure an access list to be used by a route map named VOICE to filter routes imported from the Multitopology Routing (MTR) topology named VOICE. Only routes with the prefix 192.168.1.0 are imported.

access-list 1 permit 192.168.1.0 0.0.0.255
route-map BLUE
  match ip address 1
  exit
router bgp 50000
  scope global
    neighbor 10.1.1.2 remote-as 50000
    neighbor 172.16.1.1 remote-as 60000
    address-family ipv4
      topology VIDEO
        bgp tid 100
        neighbor 10.1.1.2 activate
        neighbor 172.16.1.1 activate
        import topology VOICE route-map VOICE
      end
    clear ip bgp topology VIDEO 50000
Additional References

Related Documents

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<tr>
<th>Related Topic</th>
<th>Document Title</th>
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</thead>
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<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>Multitopology Routing (MTR) commands</td>
<td>Cisco IOS Multitopology Routing Command Reference</td>
</tr>
<tr>
<td>Border Gateway Protocol (BGP) commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
<tr>
<td>BGP concepts and tasks</td>
<td>IP Routing: BGP Configuration Guide</td>
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Technical Assistance

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<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

Feature Information for BGP Support for MTR

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.
Table 103: Feature Information for BGP Support for MTR

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP Support for MTR</td>
<td>12.2(33)SRB 15.0(1)S</td>
<td>This feature provides Border Gateway Protocol (BGP) support for multiple logical topologies over a single physical network.</td>
</tr>
<tr>
<td></td>
<td>Cisco IOS XE Release 2.5</td>
<td>In Cisco IOS XE Release 2.5, support was added for the Cisco ASR 1000 Series Routers.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The following commands were introduced or modified: address-family ipv4, bgp tid, clear ip bgp topology, import topology, neighbor translate-topology, neighbor transport, scope, show ip bgp topology, topology.</td>
</tr>
</tbody>
</table>
CHAPTER 84

BGP Accumulated IGP

The BGP Accumulated IGP feature is an optional nontransitive Border Gateway Protocol (BGP) path attribute. The attribute type code for the accumulated interior gateway protocol (AIGP) attribute is assigned by the Internet Assigned Numbers Authority (IANA). The value field of the AIGP attribute is defined as a set of type, length, value (TLV) elements. The AIGP TLV contains the AIGP metric.

- Finding Feature Information, on page 1145
- Information About BGP Accumulated IGP, on page 1145
- How to Configure BGP Accumulated IGP, on page 1147
- Configuration Examples for BGP Accumulated IGP, on page 1150
- Additional References for BGP Accumulated IGP, on page 1151
- Feature Information for BGP Accumulated IGP, on page 1152

Finding Feature Information

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Information About BGP Accumulated IGP

Overview of BGP Accumulated IGP

The BGP Accumulated IGP feature is required to simulate the current Open Shortest Path First (OSPF) behavior of computing the distance associated with a path. OSPF or Label Distribution Protocol (LDP) carries the prefix or label information only in the local area. Then, Border Gateway Protocol (BGP) carries the prefix or label to all the remote areas by redistributing the routes into BGP at area boundaries. The routes or labels are then advertised using label-switched paths (LSP). The next-hop for the route is changed at each Area Border Router (ABR) to a local device, which removes the need to leak OSPF routes across area boundaries. The bandwidth available on each of the core links is mapped to the OSPF cost; therefore, it is imperative that
BGP carries this cost correctly between each of the provider edge (PE) devices. This functionality is achieved by using the BGP Accumulated IGP feature.

You need to enable accumulated interior gateway protocol (AIGP) processing for internal Border Gateway Protocol (iBGP) and external Border Gateway Protocol (eBGP) neighbors to carry the AIGP attribute. Neighbors configured with the AIGP attribute are put in a separate update group from other iBGP neighbors. A separate update group is required for neighbors that are enabled to send the AIGP value to cost community. BGP needs to translate the AIGP attribute to the cost community or multi-exit discriminator (MED) and attach it to the route before advertising to legacy.

When BGP installs AIGP attribute routes into the routing information base (RIB), it adds the AIGP cost with the next-hop cost. If the next-hop is a nonrecursive IGP route, BGP sets the AIGP metric to the received AIGP value and the first hop IGP metric to the next-hop. If the next-hop is a recursive route with the AIGP metric, BGP adds the received AIGP metric to the next-hop AIGP metric.

**Sending and Receiving BGP Accumulated IGP**

When a session receives a prefix with the accumulated interior gateway protocol (AIGP) attribute and is not configured to receive AIGP information, the session discards the AIGP attribute and processes the remainder of the update message, and then it passes the AIGP attribute to other BGP peers. The route is then installed into the routing information base (RIB) and the prefix is sent with the AIGP attribute to all the AIGP-enabled neighbors. The AIGP attribute value is not updated if the next-hop of the route is not changed by the device before advertising it to the neighbor. If the device changes the next-hop of the route, it recalculates the AIGP attribute value by adding the next-hop metric to the received AIGP attribute value.

**Originating Prefixes with Accumulated IGP**

Origination of routes with the accumulated interior gateway protocol (AIGP) metric is controlled by configuration. AIGP attributes are attached to redistributed routes that satisfy the following conditions:

- The protocol redistributing the route is enabled for AIGP.
- The route is an interior gateway protocol (IGP) route redistributed into Border Gateway Protocol (BGP). The value assigned to the AIGP attribute is the value of the IGP next-hop to the route or as set by a route policy.
- The route is a static route redistributed into BGP. The value assigned is the value of the next-hop to the route or as set by a route policy.
- The route is imported into BGP through a network statement. The value assigned is the value of the next-hop to the route or as set by a route policy.
- The inbound or outbound route map also creates an AIGP attribute route map using the `set aigp-metric` command.
How to Configure BGP Accumulated IGP

Configuring AIGP Metric Value

SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp as-number
4. address-family ipv4 [unicast | multicast | vrf vrf-name]
5. redistribute protocol autonomous-system-number route-map map-tag
6. network network-id route-map map-tag
7. exit
8. route-map rtmap
9. set aigp-metric [igp-metric | value]
10. end

DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| Step 1 | enable | Enables privileged EXEC mode.  
Example:  
Device> enable |
| Step 2 | configure terminal | Enters global configuration mode.  
Example:  
Device# configure terminal |
| Step 3 | router bgp as-number | Enters router configuration mode for the specified routing process.  
Example:  
Device(config)# router bgp 40000 |
| Step 4 | address-family ipv4 [unicast | multicast | vrf vrf-name] | Specifies the IPv4 address family and enters address family configuration mode.  
Example:  
Device(config-router)# address-family ipv4 unicast |
| Step 5 | redistribute protocol autonomous-system-number route-map map-tag | Redistributes routes from one routing domain to another routing domain.  
Example: |
### Enabling Send and Receive for an AIGP Attribute

#### SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp [as-number]
4. address-family [ipv4 | ipv6] [unicast]
5. neighbor ip-address aigp
6. end

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
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</tr>
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<tbody>
<tr>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>device(config-router-af)# redistribute bgp 100 route-map rtmap</td>
<td>Specifies the networks to be advertised by the Border Gateway Protocol (BGP) routing process.</td>
</tr>
<tr>
<td>device(config-router-af)# network network-id route-map map-tag</td>
<td>Exits address family configuration mode and returns to global configuration mode.</td>
</tr>
<tr>
<td>device(config-router-af)# exit</td>
<td>Enters route map configuration mode.</td>
</tr>
<tr>
<td>device(config-router-af)# exit</td>
<td>Specifies a metric value for the accumulated interior gateway protocol (AIGP) attribute. The manual metric value range is from 0 to 4294967295.</td>
</tr>
<tr>
<td>device(config-router-af)# exit</td>
<td>Exits route map configuration mode and enters privileged EXEC mode.</td>
</tr>
</tbody>
</table>

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Table: Command or Action

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<th>Purpose</th>
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<tr>
<td>device(config-router-af)# redistribute bgp 100 route-map rtmap</td>
<td>Specifies the networks to be advertised by the Border Gateway Protocol (BGP) routing process.</td>
</tr>
<tr>
<td>device(config-router-af)# network network-id route-map map-tag</td>
<td>Exits address family configuration mode and returns to global configuration mode.</td>
</tr>
<tr>
<td>device(config-router-af)# exit</td>
<td>Enters route map configuration mode.</td>
</tr>
<tr>
<td>device(config-router-af)# exit</td>
<td>Specifies a metric value for the accumulated interior gateway protocol (AIGP) attribute. The manual metric value range is from 0 to 4294967295.</td>
</tr>
<tr>
<td>device(config-router-af)# exit</td>
<td>Exits route map configuration mode and enters privileged EXEC mode.</td>
</tr>
</tbody>
</table>
Configuring BGP Accumulated IGP

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp as-number`
4. `address-family {ipv4 | ipv6} [unicast]`
5. `neighbor ip-address aigp [send {cost-community community-id poi {igp-cost | pre-bestpath} [transitive]} | med]`
6. `end`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
</tbody>
</table>

---

**Example:**

- **Step 1**
  
  ```
  Device> enable
  ```

- **Step 2**
  
  ```
  Device# configure terminal
  ```

- **Step 3**
  
  ```
  Device(config)# router bgp 40000
  ```

- **Step 4**
  
  ```
  Device(config-router)# address-family ipv4 unicast
  ```

- **Step 5**
  
  ```
  Device(config-router-af)# neighbor 192.168.1.1 aigp
  ```

- **Step 6**
  
  ```
  Device(config-router-af)# end
  ```
### Command or Action

**Step 2**

**Example:**

Device> enable

- Enters global configuration mode.

**Step 3**

**Example:**

Device(config)# configure terminal

**Step 4**

**Example:**

Device(config-router)# router bgp 40000

- Enters router configuration mode for the specified routing process.

**Step 5**

**Example:**

Device(config-router)# address-family ipv4 unicast

- Specifies the IPv4 or IPv6 address family and enters address family configuration mode.

**Step 6**

**Example:**

Device(config-router-af)# end

- Exits address family configuration mode and returns to privileged EXEC mode.

### Configuration Examples for BGP Accumulated IGP

### Example: Configuring AIGP Metric Value

The following is a sample configuration for originating prefixes with the accumulated internal gateway protocol (AIGP) metric attribute:

Device# configure terminal
Device(config)# router bgp 40000
Device(config-router)# address-family ipv4 unicast
Device(config-router-af)# redistribute bgp 100 route-map rtmap
Device(config-router-af)# network 10.1.1.1 route-map rtmap
Device(config-router-af)# exit
Device(config)# route-map rtmap

---

**IP Routing: BGP Configuration Guide, Cisco IOS XE 17**
Example: Enabling Send and Receive for an AIGP Attribute

The following example shows how to enable AIGP send and receive capability in address family configuration mode:

```
Device# configure terminal
Device(config)# router bgp 40000
Device(config-router)# address-family ipv4 unicast
Device(config-router-af)# neighbor 192.168.1.1 aigp
Device(config-router-af)# exit
```

Example: Configuring BGP Accumulated IGP

In the following example, the device belongs to autonomous system 65000 and is configured to send the cost-community attribute to its neighbor at IP address 172.16.70.23:

```
Device# configure terminal
Device(config)# router bgp 65000
Device(config-router)# address-family ipv4 multicast
Device(config-router-af)# neighbor 172.16.70.23 aigp send cost-community 100 poi igp-cost transitive
Device(config-router-af)# exit
```

In the following example, the device belongs to autonomous system 65000 and is configured to send the MED attribute to its neighbor at IP address 172.16.70.23:

```
Device# configure terminal
Device(config)# router bgp 65000
Device(config-router)# address-family ipv4 multicast
Device(config-router-af)# neighbor 172.16.70.23 aigp send med
Device(config-router-af)# exit
```

Additional References for BGP Accumulated IGP

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
</tbody>
</table>
Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support website provides extensive online resources, including</td>
<td><a href="http://www.cisco.com/support">http://www.cisco.com/support</a></td>
</tr>
<tr>
<td>documentation and tools for troubleshooting and resolving technical issues</td>
<td></td>
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<td>with Cisco products and technologies.</td>
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<td>To receive security and technical information about your products, you can</td>
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<tr>
<td>subscribe to various services, such as the Product Alert Tool (accessed from</td>
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<tr>
<td>Field Notices), the Cisco Technical Services Newsletter, and Really Simple</td>
<td></td>
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<tr>
<td>Syndication (RSS) Feeds.</td>
<td></td>
</tr>
<tr>
<td>Access to most tools on the Cisco Support website requires a Cisco.com user</td>
<td></td>
</tr>
<tr>
<td>ID and password.</td>
<td></td>
</tr>
</tbody>
</table>

Feature Information for BGP Accumulated IGP

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 104: Feature Information for BGP Accumulated IGP

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP Accumulated IGP</td>
<td>Cisco IOS XE Release 3.12S</td>
<td>The BGP Accumulated IGP feature is an optional nontransitive Border Gateway Protocol (BGP) path attribute. The attribute type code for the accumulated interior gateway protocol (AIGP) attribute is assigned by the IANA. The value field of the AIGP attribute is defined as a set of type, length, value (TLV) elements. The AIGP TLV contains the AIGP metric. The following commands were introduced: <code>aigp</code>, <code>aigp send cost-community</code>, <code>aigp send med</code>, <code>bgp bestpath aigp ignore</code>, <code>set aigp-metric</code></td>
</tr>
</tbody>
</table>
BGP MVPN Source-AS Extended Community Filtering

The BGP MVPN Source-AS Extended Community Filtering feature enables the provider edge (PE) device to suppress attaching the multicast VPN (MVPN)-related extended communities to routes learned from a customer edge (CE) device or redistributed in a virtual routing and forwarding (VRF) instance for a specified neighbor.

- Finding Feature Information, on page 1153
- Information About BGP MVPN Source-AS Extended Community Filtering, on page 1153
- How to Configure BGP MVPN Source-AS Extended Community Filtering, on page 1154
- Configuration Examples for BGP MVPN Source-AS Extended Community Filtering, on page 1155
- Additional References for BGP MVPN Source-AS Extended Community Filtering, on page 1156
- Feature Information for BGP MVPN Source-AS Extended Community Filtering, on page 1156

Finding Feature Information

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Information About BGP MVPN Source-AS Extended Community Filtering

Overview of BGP MVPN Source-AS Extended Community Filtering

VPN routes carry special extended communities (source autonomous system [AS] extended community and virtual routing and forwarding [VRF] route import extended community) to support multicast VPN (MVPN). Legacy provider edge (PE) devices interpret the source AS extended community as old style multicast distribution tree (MDT). You can attach the extended communities when the prefix is created. After the BGP
MVPN Source-AS Extended Community Filtering feature is enabled, this allows the PE device to suppress these extended communities. You can use this functionality to suppress extended communities from being sent for Subsequent Address Family Identifier (SAFI) 128 routes and instead use SAFI 129. Devices with SAFI 129 must be able to identify the source AS extended community correctly.

### How to Configure BGP MVPN Source-AS Extended Community Filtering

#### Configuring BGP MVPN Source-AS Extended Community Filtering

**SUMMARY STEPS**

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. address-family ipv4 vrf vrf-name
5. unicast-reachability [source-as | vrf-route-import] [disable]
6. end

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Enters router configuration mode for the specified routing process.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# router bgp 45000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> address-family ipv4 vrf vrf-name</td>
<td>Specifies the IPv4 address family and enters address family configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router)# address-family ipv4 vrf vpn1</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>Disables advertising extended communities for non-MVPN profiles.</td>
</tr>
<tr>
<td><strong>unicast-reachability</strong></td>
<td>`[source-as</td>
</tr>
<tr>
<td>[disable]</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config-router-af)# unicast-reachability source-as disable</td>
</tr>
</tbody>
</table>

| **Step 6** | Exits address family configuration mode and enters privileged EXEC mode. |
| **end** | |
| **Example:** | Device(config-router-af)# end |

## Configuration Examples for BGP MVPN Source-AS Extended Community Filtering

### Example: Configuring BGP MVPN Source-AS Extended Community Filtering

The following example configures BGP MVPN source-AS extended community filtering:

```
Device# configure terminal
Device(config)# router bgp 45000
Device(config)# address-family ipv4 vrf vpn1
Device(config-router-af)# unicast-reachability source-as disable
Device(config-router-af)# exit
```

The following example shows summary output for the `show ip bgp vpnv4 vrf vpn1` command.

```
Device# show ip bgp vpnv4 vrf vpn1

BGP routing table entry for 10:10:1.1.1.1/32, version 25
Paths: (2 available, best #2, table red)
Multipath: eBGP
  Advertised to update-groups: 1
  Refresh Epoch 1
Local, imported path from 10:11:1.1.1.1/32 (global)
  1.1.1.2 (metric 11) (via default) from 1.1.1.5 (1.1.1.5)
    Origin incomplete, metric 11, localpref 100, valid, internal
    Extended Community: RT:1:1 OSPF DOMAIN ID:0x0005:0x000000C80200
    MVPN AS:55:0.0.0.0 MVPN VRF:1.1.1.2:2 OSPF RT:0.0.0.0:2:0
    OSPF ROUTER ID:10.10.20.2:0
    Originator: 1.1.1.2, Cluster list: 1.1.1.5
    Connector Attribute: count=1
    type 1 len 12 value 10:11:1.1.1.2
    mpls labels in/out 20/21
    rx pathid: 0, tx pathid: 0
  Refresh Epoch 1
Local
  10.10.10.100 (via vrf red) from 0.0.0.0 (1.1.1.1)
    Origin incomplete, metric 11, localpref 100, weight 32768, valid, sourced, best
    Extended Community: RT:1:1 OSPF DOMAIN ID:0x0005:0x000000C80200
    MVPN VRF:1.1.1.1:1 OSPF RT:0.0.0.0:2:0 OSPF ROUTER ID:10.10.10.1:0
```
mpls labels in/out 20/nolabel
rx pathid: 0, tx pathid: 0x0

Additional References for BGP MVPN Source-AS Extended Community Filtering

Related Documents

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<td><a href="http://www.cisco.com/support">http://www.cisco.com/support</a></td>
</tr>
</tbody>
</table>

Feature Information for BGP MVPN Source-AS Extended Community Filtering

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Table 105: Feature Information for BGP MVPN Source-AS Extended Community Filtering

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP MVPN Source-AS Extended Community Filtering</td>
<td>Cisco IOS XE</td>
<td>The BGP MVPN Source-AS Extended Community Filtering feature enables the provider edge (PE) device to suppress attaching the multicast VPN (MVPN)-related extended communities to routes learned from a customer edge (CE) device or redistributed in a virtual routing and forwarding (VRF) instance for a specified neighbor. The following command was introduced or modified: <em>unicast-reachability</em>.</td>
</tr>
<tr>
<td></td>
<td>Release 3.13S</td>
<td></td>
</tr>
</tbody>
</table>
BGP AS-Override Split-Horizon

The BGP AS-Override Split-Horizon feature enables a Provider Edge (PE) device using split-horizon to avoid advertisement of routes propagated by a Customer Edge (CE) device to the same CE device. The BGP AS-Override Split-Horizon feature also enables a PE or CE device to send route updates to a specific PE or CE device in the same replication group.

- Finding Feature Information, on page 1159
- Information About BGP AS-Override Split-Horizon, on page 1159
- How to Configure BGP AS-Override Split-Horizon, on page 1160
- Verifying BGP AS-Override Split-Horizon, on page 1161
- Configuration Examples for BGP AS-Override Split-Horizon, on page 1162
- Additional References for BGP AS-Override Split-Horizon, on page 1164
- Feature Information for BGP AS-Override Split-Horizon, on page 1165

Finding Feature Information

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Information About BGP AS-Override Split-Horizon

BGP AS-Override Split-Horizon Overview

When you configure split-horizon on a device, the Provider Edge (PE) device may advertise routes propagated from a Customer Edge (CE) device to the same CE device. The BGP AS-Override Split Horizon feature groups all the BGP neighbors into separate replication-groups, even when they are in the same update-group, and ensures that the route updates propagated from a CE device are not sent to the same CE device.

The BGP AS-Override Split Horizon feature enables a PE or CE device to selectively send and block updates to one or more neighboring PE or CE devices in the same update-group. The PE or CE device sends or blocks
a message to a neighboring PE or CE device based on the type of the message and on whether the originator of the message matches the router ID of the PE or CE device.

How to Configure BGP AS-Override Split-Horizon

Configuring BGP AS-Override Split-Horizon

SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp autonomous-system-number
4. address family ipv4 vrf vrf-name
5. neighbor ip-address remote-as autonomous-system-number
6. neighbor ip-address activate
7. neighbor ip-address as-override split-horizon
8. Repeat Step 5 to Step 7 to enable split-horizon for different neighbors in a virtual routing and forwarding (VRF) instance.
9. end

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> router bgp autonomous-system-number</td>
<td>Configures the Border Gateway Protocol (BGP) routing process and enters router configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# router bgp 21</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> address family ipv4 vrf vrf-name</td>
<td>Specifies the name of the VPN routing and forwarding (VRF) instance to associate with subsequent IPv4 address family configuration mode commands and enters address-family configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-router)# address-family ipv4 vrf vrf1</td>
<td></td>
</tr>
</tbody>
</table>
Verifying BGP AS-Override Split-Horizon

**SUMMARY STEPS**

1. `enable`
2. `show ip bgp vpn4 all update-group`
3. `show ip bgp vpnv4 all neighbors ip-address`
4. `show ip bgp vpnv4 all neighbors ip-address policy`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td><code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td>Step 2</td>
<td><code>show ip bgp vpnv4 all neighbors ip-address</code></td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td><code>show ip bgp vpnv4 all neighbors ip-address policy</code></td>
<td></td>
</tr>
</tbody>
</table>

**Purpose**

- **Step 5**
  - `neighbor ip-address remote-as autonomous-system-number`
  - **Example:**
    
      `Device(config-router-af)# neighbor 192.0.2.1 remote-as 1`
  - Configures peering with a BGP neighbor in the specified autonomous system.

- **Step 6**
  - `neighbor ip-address activate`
  - **Example:**
    
      `Device(config-router-af)# neighbor 192.0.2.1 activate`
  - Enables the neighbor to exchange prefixes for the IPv4 address family with the local device.

- **Step 7**
  - `neighbor ip-address as-override split-horizon`
  - **Example:**
    
      `Device(config-router-af)# neighbor 192.0.2.1 as-override split-horizon`
  - Enables split-horizon per neighbor in a VRF instance.

- **Step 8**
  - Repeat Step 5 to Step 7 to enable split-horizon for different neighbors in a virtual routing and forwarding (VRF) instance.

- **Step 9**
  - `end`
  - **Example:**
    
      `Device(config-router-af)# end`
  - Exits router address-family configuration mode and enters privileged EXEC mode.
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 2** show ip bgp vpn4 all update-group  
Example: Device# show ip bgp vpn4 all update-group | Displays information on update groups. |
| **Step 3** show ip bgp vpnv4 all neighbors ip-address  
Example: Device# show ip bgp vpnv4 all neighbors 192.0.2.1 | Displays details about neighbor connections. |
| **Step 4** show ip bgp vpnv4 all neighbors ip-address policy  
Example: Device# show ip bgp vpnv4 all neighbors 192.0.2.1 policy | Displays neighbor policies per address-family. |

**Configuration Examples for BGP AS-Override Split-Horizon**

**Example: BGP AS-Override Split-Horizon Configuration**

Device> enable  
Device# configure terminal  
Device(config)# router bgp 21  
Device(config-router)# address-family ipv4 vrf vrf1  
Device(config-router-af)# neighbor 192.0.2.1 remote-as 1  
Device(config-router-af)# neighbor 192.0.2.1 activate  
Device(config-router-af)# neighbor 192.0.2.1 as-override split-horizon  
Device(config-router-af)# neighbor 198.51.100.1 remote-as 1  
Device(config-router-af)# neighbor 198.51.100.1 activate  
Device(config-router-af)# neighbor 198.51.100.1 as-override split-horizon  
Device(config-router-af)# end

**Example: Verifying BGP AS-Override Split-Horizon**

Sample output for the show ip bgp vpn4 all update-group command

To display information about update groups, use the show ip bgp vpn4 all update-group command in privileged EXEC mode.

Device> enable  
Device# show ip bgp vpn4 all update-group  
BGP version 4 update-group 3, external, Address Family: VPNv4 Unicast  
BGP Update version : 5/0, messages 0 active RGs: 2 <<<<<<<<<<<<<  
Overrides the neighbor AS 1 with my AS before sending updates  
Topology: blue, highest version: 5, tail marker: 5  
Format state: Current working (OK, last not in list)  
Refresh blocked (not in list, last not in list)  
Update messages formatted 1, replicated 2, current 0, refresh 0, limit 1000  
Number of NLRI s in the update sent: max 4, min 0
Minimum time between advertisement runs is 0 seconds
Has 2 members:
  192.0.2.1  198.51.100.1

Sample output for the `show ip bgp vpnv4 all neighbors ip-address` command

To display details about neighbor connections, use the `show ip bgp vpnv4 all neighbors ip-address` command in privileged EXEC mode.

```
Device> enable
Device# show ip bgp vpnv4 all neighbors 209.165.200.228
BGP neighbor is 209.165.200.228, vrf vrf1, remote AS 1, external link
  BGP version 4, remote router ID 209.165.201.28
  BGP state = Established, up for 00:01:26
  Last read 00:00:35, last write 00:00:28, hold time is 180, keepalive interval is 60 seconds

Neighbor sessions:
  1 active, is not multisession capable (disabled)
Neighbor capabilities:
  Route refresh: advertised and received(new)
  Four-octets ASN Capability: advertised and received
  Address family IPv4 Unicast: advertised and received
  Enhanced Refresh Capability: advertised and received
  Multisession Capability:
    Stateful switchover support enabled: NO for session 1
Message statistics:
  Inq depth is 0
  OutQ depth is 0
  Sent  Rcvd
  Opens: 1  1
  Notifications: 0  0
  Updates: 6  2
  Keepalives: 3  3
  Route Refresh: 0  0
  Total: 12  6
Default minimum time between advertisement runs is 0 seconds

For address family: VPNv4 Unicast
  Translates address family IPv4 Unicast for VRF vrf1
  Session: 209.165.200.228
  BGP table version 40, neighbor version 40/0
  Output queue size : 0
  Index 1, Advertise bit 1
  1 update-group member
  Overrides the neighbor AS with my AS before sending updates
  Split horizon processing before sending updates
  Slow-peer detection is disabled
  Slow-peer split-update-group dynamic is disabled

Prefix activity:
  Prefixes Current: 10  2 (Consumes 160 bytes)
  Prefixes Total: 10  2
  Implicit Withdraw: 0  0
  Explicit Withdraw: 0  0
  Used as bestpath: n/a  2
  Used as multipath: n/a  0
Outbound  Inbound
  Local Policy Denied Prefixes: ---  ---
  Total: 0  0
Number of NLRIs in the update sent: max 5, min 0
Last detected as dynamic slow peer: never
Dynamic slow peer recovered: never
Refresh Epoch: 1
```
Address tracking is enabled, the RIB does have a route to 209.165.200.228
Connections established 3; dropped 2
Last reset 00:00:35, due to split-horizon config change of session 1
Transport(tcp) path-mtu-discovery is enabled
Graceful-Restart is disabled
Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Connection is ECN Disabled
Minimum incoming TTL 0, Outgoing TTL 1
Local host: 209.165.200.225, Local port: 22789
Foreign host: 209.165.200.228, Foreign port: 179
Connection tableid (VRF): 2

Sample output for the show ip bgp vpnv4 all neighbors ip-address policy command
To display neighbor policies per address-family, use the show ip bgp vpnv4 all neighbors ip-address policy command in privileged EXEC mode.

Additional References for BGP AS-Override Split-Horizon

### Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
</tbody>
</table>

### Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/support">http://www.cisco.com/support</a></td>
</tr>
</tbody>
</table>
Feature Information for BGP AS-Override Split-Horizon

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 106: Feature Information for BGP AS-Override Split-Horizon

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP AS-Override Split-Horizon</td>
<td>Cisco IOS XE Release 3.14S</td>
<td>The BGP AS-Override Split-Horizon feature enables a Provider Edge (PE) device using split-horizon to avoid advertisement of routes propagated by a Customer Edge (CE) device to the same CE device. The BGP AS-Override Split-Horizon feature also enables a PE or CE device to send route updates to specific PE or CE device in the same replication group. The following command was introduced or modified: <code>neighbor ip-address as-override split-horizon</code>.</td>
</tr>
</tbody>
</table>
CHAPTER 87

BGP Support for Multiple Sourced Paths Per Redistributed Route

The BGP Support for Multiple Sourced Paths per Redistributed Route feature allows multiple paths with route redistribution or other sourcing mechanisms like the `network` command into BGP. This feature also allows multiple paths from the same source to be imported and exported across virtual routing and forwarding (VRF) instances.

This module provides an overview of the feature and describes how to configure it.

- Finding Feature Information, on page 1167
- Restrictions for BGP Support for Multiple Sourced Paths Per Redistributed Route, on page 1167
- Information About BGP Support for Multiple Sourced Paths Per Redistributed Route, on page 1168
- How to Configure BGP Support for Multiple Sourced Paths Per Redistributed Routes, on page 1168
- Configuration Examples for BGP Multiple Sourced Paths Per Redistributed Route, on page 1170
- Additional References for BGP Support for Multiple Sourced Paths Per Redistributed Route, on page 1172
- Feature Information for BGP Support for Multiple Sourced Paths Per Redistributed Route, on page 1172

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

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Restrictions for BGP Support for Multiple Sourced Paths Per Redistributed Route

The following restriction apply to this feature:

- Paths that are sourced with 0.0.0.0 as the gateway address will not have multiple paths redistributed into the Border Gateway Protocol (BGP). As a result, every sourced path must have a unique gateway.
Suppose that for a prefix in the RIB we have a manually configured static route with a tag and a route without a tag inserted through RRI. In such a scenario, the route selection may be inconsistent, and either the manually configured route or the RRI route may be chosen.

To prevent such an inconsistency, perform one of the following actions:

- If you are manually configuring static routes to all the peer VPN networks of the router, disable RRI by removing reverse route configuration from the crypto map.
- Set an identical tag in the crypto map for the route inserted through RRI.

### Information About BGP Support for Multiple Sourced Paths Per Redistributed Route

#### BGP Support for Multiple Sourced Paths Per Redistributed Route Overview

The BGP Support for Multiple Sourced Paths per Redistributed Route feature allows multiple paths with route redistribution or other sourcing mechanisms like the `network` command into the Border Gateway Protocol (BGP). Prior to this feature, BGP accepted only one path from the Routing Information Base (RIB) to create a single BGP-sourced path for a redistributed network; even if the RIB had more than one path for the same network.

This feature also allows multiple paths from the same source to be imported and exported across virtual routing and forwarding (VRF) instances. Import of more than the default path into a VRF instance was already supported in BGP. However, these multiple paths had to be from different neighbors or sources and not from the same source.

By enabling this feature, customers can export Equal Cost Multipath (ECMP) sourced paths or next-hops from one VRF into hundreds of VRFs on the same device using BGP. Each of these paths are installed as multipaths into the RIB, and provides ECMP paths in other VRFs also.

For BGP to accept all the paths or next-hops per route from the redistributing protocol in the RIB, configure the `bgp sourced-paths` command. If you either disable or do not enable this command, BGP allows the import of only one sourced path per network from the RIB.

### How to Configure BGP Support for Multiple Sourced Paths Per Redistributed Routes

#### Configuring Multiple Sourced Paths

When you configure the `bgp sourced-paths` command, the Border Gateway Protocol (BGP) accepts all paths from the Routing Information Base (RIB). When the `bgp sourced-paths` command is removed, the configuration returns to the default behavior of allowing only one sourced path per network from the RIB.
**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `router bgp autonomous-system-number`
4. `address-family ipv4 vrf vrf-name`
5. `bgp sourced-paths per-net static all`
6. `redistribute static`
7. `neighbor ip-address remote-as neighbor-as`
8. `neighbor ip-address activate`
9. `neighbor ip-address send-community both`
10. `end`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** enable | Enables privileged EXEC mode.  
  Example:  
  `Device> enable`
|                     | • Enter your password if prompted. |
| **Step 2** configure terminal | Enters global configuration mode. |
| Example: Device# configure terminal | |
| **Step 3** router bgp autonomous-system-number | Configures the BGP routing process and enters the routing configuration mode. |
| Example: Device(config)# router bgp 65000 | |
| **Step 4** address-family ipv4 vrf vrf-name | Enters address family configuration mode to configure a routing session using standard IPv4 address prefixes.  
  Note You can also configure the `address-family ipv6` command based on your network configuration. |
| Example: Device(config-router)# address-family ipv4 vrf blue | |
| **Step 5** bgp sourced-paths per-net static all | Allows per network sourcing of all static paths in the RIB. |
| Example: Device(config-router-af)# bgp sourced-paths per-net static all | |
| **Step 6** redistribute static | Redistributes static routes from another routing protocol. |
| Example: Device(config-router-af)# redistribute static | |
| **Step 7** neighbor ip-address remote-as neighbor-as | Adds an entry into the BGP or multiprotocol BGP neighbor table. |
| Example: Device(config-router-af)# neighbor 204.0.0.3 remote-as 65000 | |
### Configuration Examples for BGP Multiple Sourced Paths Per Redistributed Route

#### Example: Configuring Multiple Sourced Paths

![Deployment Scenario for BGP Multiple Paths Replication](image)

The above figure displays a deployment scenario in which BGP replicates multiple paths from VRF BLUE to VRF RED. VRF RED can import more paths, in addition to the best-path, by using the same route target export in VRF BLUE and VRF RED. This helps multiple paths to get into VRF RED.

Device# configure terminal
Device(config)# ip vrf blue
Device(config-vrf)# rd 100:200

---

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td><code>neighbor ip-address activate</code></td>
<td>Enables the exchange of information with a BGP neighbor.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong> Device(config-router-af)# neighbor 204.0.0.3 activate</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td><code>neighbor ip-address send-community both</code></td>
<td>Specifies that a communities attribute should be sent to a BGP neighbor.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong> Device(config-router-af)# neighbor 204.0.0.3 send-community both</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td><code>end</code></td>
<td>Exits address family configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong> Device(config-router-af)# end</td>
<td></td>
</tr>
</tbody>
</table>
Device(config-vrf)# route-target export 200:200
Device(config-vrf)# route-target import 200:200
Device(config-vrf)# exit

Device(config)# ip vrf red
Device(config-vrf)# rd 200:200
Device(config-vrf)# route-target export 300:200
Device(config-vrf)# route-target import 300:200
Device(config-vrf)# route-target import 200:200
Device(config-vrf)# exit

Device(config)# interface Loopback 0
Device(config-if)# ip address 198.51.100.1 255.255.255.255
Device(config-if)# exit

Device(config)# interface Ethernet 1/0
Device(config-if)# ip address 203.0.113.1 19.0.0.32 255.255.255.255
Device(config-if)# no shutdown
Device(config-if)# exit

Device(config)# interface Ethernet 1/2
Device(config-if)# ip address 209.165.200.225 255.255.255.240
Device(config-if)# no shutdown
Device(config-if)# exit

Device(config)# interface Ethernet 1/2.2
Device(config-subif)# encapsulation dot1Q 2
Device(config-subif)# ip vrf forwarding blue
Device(config-subif)# ip address 192.168.0.1 255.255.255.240
Device(config-subif)# no shutdown
Device(config-subif)# exit

Device(config)# interface Ethernet 1/2.3
Device(config-subif)# encapsulation dot1Q 3
Device(config-subif)# ip vrf forwarding blue
Device(config-subif)# ip address 192.168.0.17 255.255.255.240
Device(config-subif)# no shutdown
Device(config-subif)# exit

Device(config)# router ospf 2 vrf blue
Device(config-router)# network 192.68.0.0 0.0.0.255 area 0
Device(config-router)# network 192.68.1.16 0.0.0.255 area 0
Device(config-router)# exit

Device(config)# router ospf 1
Device(config-router)# network 209.165.200.224 0.0.255.255 area 0
Device(config-router)# exit

Device(config)# router bgp 65000
Device(config-router)# no bgp default ipv4-unicast
Device(config-router)# neighbor 10.0.0.2 remote-as 65000
Device(config-router)# neighbor 10.0.0.2 update-source Loopback0
Device(config-router)# address-family ipv4
Device(config-router-af)# exit-address-family

Device(config-router)# address-family vpnv4
Device(config-router-af)# neighbor 10.0.0.2 activate
Device(config-router-af)# neighbor 10.0.0.2 send-community extended
Device(config-router-af)# exit-address-family

Device(config-router)# address-family ipv4 vrf blue
Device(config-router-af)# bgp sourced-paths per-net static all

IP Routing: BGP Configuration Guide, Cisco IOS XE 17 1171
Additional References for BGP Support for Multiple Sourced Paths Per Redistributed Route

Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>BGP commands</td>
<td>Cisco IOS IP Routing: BGP Command Reference</td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support website provides extensive online resources, including</td>
<td><a href="http://www.cisco.com/support">http://www.cisco.com/support</a></td>
</tr>
<tr>
<td>documentation and tools for troubleshooting and resolving technical issues</td>
<td></td>
</tr>
<tr>
<td>with Cisco products and technologies.</td>
<td></td>
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<tr>
<td>To receive security and technical information about your products, you can</td>
<td></td>
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<tr>
<td>subscribe to various services, such as the Product Alert Tool (accessed from</td>
<td></td>
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<tr>
<td>Field Notices), the Cisco Technical Services Newsletter, and Really Simple</td>
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<tr>
<td>Syndication (RSS) Feeds.</td>
<td></td>
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<tr>
<td>Access to most tools on the Cisco Support website requires a Cisco.com user</td>
<td></td>
</tr>
<tr>
<td>ID and password.</td>
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</tr>
</tbody>
</table>

Feature Information for BGP Support for Multiple Sourced Paths Per Redistributed Route

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.
Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to [www.cisco.com/go/cfn](http://www.cisco.com/go/cfn). An account on Cisco.com is not required.

### Table 107: Feature Information for BGP Support for Multiple Sourced Paths Per Redistributed Route

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGP Support for Multiple Sourced Paths Per Redistributed Route</td>
<td>Cisco IOS XE Release 3.15S</td>
<td>The BGP Support for Multiple Sourced Paths per Redistributed Route feature allows multiple paths with route redistribution or other sourcing mechanisms like the <code>network</code> command into BGP. This feature also allows multiple paths from the same source to be imported and exported across virtual routing and forwarding (VRF) instances. In Cisco IOS XE Release 3.15S, this feature was introduced on Cisco ASR 1000 Series Aggregation Services Routers. The following command was introduced: <code>bgp sourced-paths</code>.</td>
</tr>
</tbody>
</table>
CHAPTER 88

Maintenance Function: BGP Routing Protocol

From Cisco IOS XE Everest 16.4.1 release, the event trace functionality is supported for BGP. Event Trace provides the functionality to capture BGP traces by enabling the event trace using commands. You can disable the command if you do not want to log traces. When convergence happens and connection states are getting changed, the BGP traces are logged into Event Trace infrastructure.

- Finding Feature Information, on page 1175
- Information About Maintenance Function: BGP Routing Protocol, on page 1175
- Configuring BGP Event Trace in Global Configuration Mode, on page 1176
- Configuring BGP Event Trace in EXEC Mode, on page 1177
- Verifying the BGP Event Traces, on page 1178
- Feature Information for Maintenance Function: BGP Routing Protocol, on page 1178

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About Maintenance Function: BGP Routing Protocol

BGP Event trace supports the following functionalities:

- BGP Event Trace creates buffers for peer connection state change and updates event logging. The size of the buffer is 100,000, which means 100,000 trace entries will be stored at a time. The buffer can be resized by using configuration command and maximum size of the buffer can be extended till 1,000,000.

- These buffers are circular in nature, that is, if the buffer reaches the end then it starts logging from the beginning. If "one-shot" is not configured, it continuously logs from the beginning.

- Considering the contribution is a small addition to performance, BGP event trace will be disabled by default. It can be enabled by executing the `enable` command in EXEC mode.

- BGP Event Traces:
Neighbor: All the peer events such as state changes, error handling, unrecognized/malformed packet handling will be captured into this buffer.

BGP logs the traces in binary format into corresponding buffers on runtime, which helps in logging the trace efficiently. Use the `monitor event-trace bgp neighbor` command to print the traces in human-readable format on the console. This command provides the functionality of dumping the event traces into the file in binary or human-readable format as well.

The show commands are provided with afi/safi/vrf/neighbor address filtering options to display the event logs. Event Trace logging under different afi/safi/vrf is completely based on the different traces.

### Configuring BGP Event Trace in Global Configuration Mode

BGP Event Trace provides the commands in global configuration and privileged EXEC mode for connection state event traces. Use the following configuration steps to enable the event-traces for BGP. With this configuration, BGP traces are enabled after the active/standby router is rebooted because of a crash or switchover.

#### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `monitor event-trace bgp neighbor {dump-file filename | size entries}`
4. `end`

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td></td>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td><code>configure terminal</code></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>`monitor event-trace bgp neighbor {dump-file filename</td>
<td>size entries}`</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>Use the <code>no monitor event-trace bgp neighbor</code> command to disable the event traces.</td>
</tr>
<tr>
<td></td>
<td>Device(config)# monitor event-trace bgp neighbor size 10</td>
<td>• <code>dump-file</code>—Set the name of the trace dump file.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• <code>size</code>—Set the size of trace.</td>
</tr>
<tr>
<td>4</td>
<td><code>end</code></td>
<td>Exits global configuration mode and enters privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
</tbody>
</table>
### Purpose

#### Command or Action

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device(config)# end</td>
<td></td>
</tr>
</tbody>
</table>

---

### Configuring BGP Event Trace in EXEC Mode

#### SUMMARY STEPS

1. enable  
2. monitor event-trace bgp neighbor {clear | continuous | destroy-buffer | disable | dump filename | enable | one-shot}  
3. exit

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Command or Action</th>
<th>Purpose</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
<td>Device&gt; enable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Enter your password if prompted.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 2</th>
<th>Command or Action</th>
<th>Purpose</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>monitor event-trace bgp neighbor {clear</td>
<td>continuous</td>
<td>destroy-buffer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use the no monitor event-trace bgp neighbor command to disable the event traces.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• clear--Clear the event trace buffer.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• continuous--Display the event traces getting logged continuously on the console.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• destroy-buffer--Destroy buffer allocated for traces.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• disable--Disable the event trace functionality. This command must be given on active and standby to disable both nodes.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• dump filename--Dump all neighbor event traces into file in binary or ASCII format.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• enable--Enable the event trace functionality. This command must be given on active and standby to enable both nodes.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• one-shot--Log the event trace only once. When the buffer is full, the event-trace logging will stop.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 3</th>
<th>Command or Action</th>
<th>Purpose</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>exit</td>
<td>Exits the privileged EXEC configuration mode.</td>
<td>Device# exit</td>
</tr>
</tbody>
</table>
Verifying the BGP Event Traces

You can use the following `show` commands to browse through the event traces captured. These `show` commands will filter the traces based on the AFI/SAFI/VRF/neighbor address and different combinations.

- `show monitor event-trace bgp all`
- `show monitor event-trace bgp back`
- `show monitor event-trace bgp clock`
- `show monitor event-trace bgp from-boot`
- `show monitor event-trace bgp ipv4 {all | back | clock | flowspec | from-boot | latest | mdt | multicast | mvpn | unicast}`
- `show monitor event-trace bgp ipv4 flowspec neighbors`
- `show monitor event-trace bgp ipv4 mdt vrf`
- `show monitor event-trace bgp ipv6 {all | back | clock | flowspec | from-boot | latest | multicast | mvpn | unicast}`
- `show monitor event-trace bgp l2vpn {all | back | clock | evpn | from-boot | latest | vpls}`
- `show monitor event-trace bgp latest`
- `show monitor event-trace bgp neighbors`
- `show monitor event-trace bgp nsap`
- `show monitor event-trace bgp parameters`
- `show monitor event-trace bgp rtfilter`
- `show monitor event-trace bgp vpnv4 {all | back | clock | from-boot | latest | vrf}`
- `show monitor event-trace bgp vpnv6 {all | back | clock | flowspec | from-boot | latest | multicast | unicast}`

Feature Information for Maintenance Function: BGP Routing Protocol

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to [www.cisco.com/go/cfn](http://www.cisco.com/go/cfn). An account on Cisco.com is not required.

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance Function: BGP Routing Protocol</td>
<td>Cisco IOS XE Everest 16.4.1 Release</td>
<td>From Cisco IOS XE Everest 16.4.1 release, the event trace functionality is supported for BGP. Event Trace provides the functionality to capture BGP traces by enabling the event trace using commands. You can disable the command if you do not want to log traces. When convergence happens and connection states are getting changed, the BGP traces are logged into Event Trace infrastructure.</td>
</tr>
</tbody>
</table>
CHAPTER 89

BGP Support for TCP Authentication Option

This document describes how to configure Message Digest 5 (MD5) authentication on a Transmission Control Protocol (TCP) connection between two BGP peers.

• BGP Support for TCP AO Overview, on page 1179
• How to Configure BGP Using TCP AO, on page 1180
• Verifying TCP-AO Key Chain and Key Configuration, on page 1183
• Verifying TCP-AO Key Chain Information in the TCB, on page 1184
• Example: Verifying BGP Configuration, on page 1185

BGP Support for TCP AO Overview

On a secure control plane, BGP uses Message Digest 5 (MD5) algorithm as the authentication mechanism. It uses the TCP API to configure the keychain on a TCP connection. When authentication is enabled, any Transmission Control Protocol (TCP) segments belonging to BGP are exchanged between peers, verified and then accepted only if authentication is successful. BGP application use the TCP API to configure the keychain on a TCP connection. It owns the configuration to associate a TCP-AO keychain name with a neighbor, a peer-group, or a peer-session template.

You can validate the authentication configuration per neighbor/peer-group/peer-session template. Authentication Option is supported for BGP dynamic neighbor, BGP Non-stop forwarding (NSF) and Non-stop routing (NSR). Routing protocols support a different set of cryptographic algorithms, however, BGP supports only MD5. For example, if BGP is configured with the TCP MD5 key (md5-key), it will not allow to configure TCP-AO and vice versa. There are two options to configure BGP:

• **include-tcp-options** - option to specify if the TCP option headers (other than TCP AO option) will be included while computing the MAC digest of the packets.

• **accept-ao-mismatch-connections** - option to accept the connection as non-TCP AO connection when receives a connection from peer without TCP AO option. Similarly, if the connection is initiated from one side, the peer acknowledges with TCP AO, it accepts the ACK and continues the connection.

Restrictions

• Configuring and deconfiguring TCP AO for a certain neighbor or peer-group or peer-session causes existing established BGP session(s) to flap.

• Do not change the configuration of an existing TCP key chain because existing BGP sessions may break.
TCP AO picks up the most valid key under the key chain. The most valid key is the one which has the longest send lifetime. If there are two keys with the same send lifetime, the first best key is selected.

In a configuration, where one of the devices is configured with the TCP MD5 option and the other with the TCP-AO option not supported, BGP session is not established between the devices until you correct the configuration.

After a session is established using a specific key chain, if you modify the key chain, the session ends, and an attempt is made to renegotiate the session based on the modified key chain.

How to Configure BGP Using TCP AO

The BGP application must be configured on both the devices. To establish a peer connection with TCP-AO, you must configure the following:

Configuring TCP Key Chain and Keys

Before you begin

TCP-AO key chain and keys must be configured on both the peers communicating through a TCP connection.

• Ensure that the key-string, send-lifetimes, and ids of keys match on both peers.
• Ensure that the send-id on a router matches the receiver-id on the peer router. Also, use the same ID for the parameters.
• The send-id and recv-id of a key cannot be reused for another key in the same key chain.
• Do not modify a key that is in use. Disassociate the key from the TCP connection before modifying the key.

Step 1  
enable

Example:
Router# enable
Enables privileged EXEC mode. Enter your password if prompted.

Step 2  
configure terminal

Example:
Router# configure terminal
Enters global configuration mode.

Step 3  
key chain key-chain-name tcp

Example:
Router(config)# key chain kcl tcp
Creates a TCP-AO key chain with the specified name and enters the TCP-AO key chain configuration mode.
The key chain name can have a maximum of 256 characters.
Step 4  key  key-id

Example:
Router(config-keychain-tcp)# key 10
Creates a key with the specified key-id and enters the the TCP-AO key chain key configuration mode.
The key-id must be in the range 0 to 2147483647.

Step 5  send-id  send-identifier

Example:
Router(config-keychain-tcp-key)# send-id 218
Specifies the send identifier for the key.
The send-identifier must be in the range 0 to 255.

Step 6  recv-id  receive-identifier

Example:
Router(config-keychain-tcp-key)# recv-id 218
Specifies the receive identifier for the key.
The receive-identifier must be in the range 0 to 255.

Step 7  cryptographic-algorithm {aes-128-cmac | hmac-sha-1 | hmac-sha-256}

Example:
Router(config-keychain-tcp-key)# cryptographic-algorithm hmac-sha-1
Specifies the algorithm to be used to compute MACs for TCP segments.

Step 8  include-tcp-options

Example:
Router(config-keychain-tcp-key)# include-tcp-options
(Optional)
This flag indicates whether TCP options other than TCP-AO must be used to calculate MACs.
With the flag enabled, the content of all options, in the order present, is included in the MAC and TCP-AO’s MAC field is filled with zeroes.
When the flag is disabled, all options other than TCP-AO are excluded from MAC calculations.
This flag is disabled by default.

Step 9  send-lifetime [local]  start-time duration

Example:
Router(config-keychain-tcp-key)# send-lifetime local 12:00:00 28 Feb 2018 duration 20
Specifies the time for which the key is valid to be used for TCP-AO authentication.
Use the local keyword to specify the start-time in the local time zone. By default, the start-time corresponds to UTC time.

Step 10  accept-lifetime [local]  start-time duration
Example:
Router(config-keychain-tcp-key)# accept-lifetime local 12:00:00 28 Feb 2018 duration 20

Specifies the time for which the key is valid to be used for TCP-AO authentication.

Use the local keyword to specify the start-time in the local time zone. By default, the start-time corresponds to UTC time.

Step 11  key-string master-key

Example:
Router(config-keychain-tcp-key)# key-string master-key

Specifies the master-key for deriving traffic keys.

The master-key must have 32 or 64 hexadecimal digits.

The master-keys must be identical on both the peers. If the master-keys do not match, authentication fails and segments may be rejected by the receiver.

Step 12  accept-ao-mismatch

Example:
Router(config-keychain-tcp-key)# accept-ao-mismatch

(Optional) This flag indicates whether the receiver should accept segments for which the MAC in the incoming TCP AO does not match the MAC generated on the receiver.

Step 13  end

Example:
Router(config-keychain-tcp-key)# end

Exits TCP-AO key chain key configuration mode and returns to privileged EXEC mode.

Example
A simple key chain configuration show on 2 end points A and B of the TCP AO enabled connection:

R1:
key chain kc1 tcp
key 7890
  send-id 215
  recv-id 215
  key-string klomn
  cryptographic-algorithm hmac-sha-1
  include-tcp-options

R2:
key chain kc1 tcp
key 7890
  send-id 215
  recv-id 215
  key-string klomn
  cryptographic-algorithm hmac-sha-1
  include-tcp-options
BGP neighbor configuration

To configure a BGP neighbor using TCP AO:

Router(config)# router bgp <own-AS>
Router(config-router)# neighbor <peer-IP-address|peer-IPv6-address> ao <keychain-name> [include-tcp-options] [accept-ao-mismatch-connections]

You can also configure BGP dynamic neighbor using the above command. Use the no form of the commands to deconfigure BGP neighbor.

BGP peer-group configuration

To configure a BGP peer-group using TCP AO:

Router(config-router)# neighbor <peer-group-name> ao <keychain-name> [include-tcp-options] [accept-ao-mismatch-connections]

You can also configure BGP dynamic neighbor using the above command. Use the no form of the commands to deconfigure BGP peer-group.

BGP peer-session configuration

To configure a BGP peer-session template using TCP AO:

Router(config-router)# template peer-session <session-name>
Router(config-router-stmp)# ao <keychain-name> [include-tcp-options] [accept-ao-mismatch-connections]

Use the no form of the command to deconfigure BGP peer-session.

Verifying TCP-AO Key Chain and Key Configuration

Use the show key chain key-chain-name command in the privileged exec mode to display information about a TCP-AO key chain and keys.

Router# show key chain key-chain-name

Router1# show key chain kc2
Key-chain kc2:
TCP key chain
key 7893 -- text "abcde"
cryptographic-algorithm: hmac-sha-1
accept lifetime (12:32:00 IST Nov 9 2018) - (10:30:00 IST Dec 30 2019) [valid now]
send lifetime (13:05:00 IST Jan 12 2019) - (10:31:00 IST Dec 30 2019) [valid now]
send-id - 218
recv-id - 218
include-tcp-options
MKT ready - true
MKT preferred - true
MKT in-use - true
MKT id - 7893
MKT send-id - 218
MKT recv-id - 218
MKT alive (send) - true
MKT alive (recv) - true
MKT include TCP options - true
Verifying TCP-AO Key Chain Information in the TCB

Use the `show tcp tcb address-of-tcb` command in the privileged exec mode to display information about TCP-AO in the Transmission Control Block. Obtain address-of-tcb (the hexadecimal address of the TCB) from the output of the `show key chain key-chain-name` command.

```
Router# show tcp tcb address-of-tcb

Router1# sh tcp tcb 7FBD68361838
```

Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Connection is ECN Disabled, Minimum incoming TTL 0, Outgoing TTL 255
Local host: 1.0.2.1, Local port: 40125
Foreign host: 1.0.2.2, Foreign port: 5555
Connection tableid (VRF): 0
Maximum output segment queue size: 50
Enqueued packets for retransmit: 0, input: 0 mis-ordered: 0 (0 bytes)

```
Event Timers (current time is 0x2818B07):  

<table>
<thead>
<tr>
<th>Timer</th>
<th>Starts</th>
<th>Wakeups</th>
<th>Next</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retrans</td>
<td>1</td>
<td>0</td>
<td>0x0</td>
</tr>
<tr>
<td>TimeWait</td>
<td>0</td>
<td>0</td>
<td>0x0</td>
</tr>
<tr>
<td>AckHold</td>
<td>1</td>
<td>0</td>
<td>0x0</td>
</tr>
<tr>
<td>SendWnd</td>
<td>0</td>
<td>0</td>
<td>0x0</td>
</tr>
<tr>
<td>KeepAlive</td>
<td>6651</td>
<td>0</td>
<td>0x281AC36</td>
</tr>
<tr>
<td>GiveUp</td>
<td>0</td>
<td>0</td>
<td>0x0</td>
</tr>
<tr>
<td>PmtuAger</td>
<td>0</td>
<td>0</td>
<td>0x0</td>
</tr>
<tr>
<td>DeadWait</td>
<td>0</td>
<td>0</td>
<td>0x0</td>
</tr>
<tr>
<td>Linger</td>
<td>0</td>
<td>0</td>
<td>0x0</td>
</tr>
<tr>
<td>ProcessQ</td>
<td>0</td>
<td>0</td>
<td>0x0</td>
</tr>
</tbody>
</table>

iss: 3307331702  snduna: 3307331703  sndnxt: 3307331703
irs: 725047078  rcvnxt: 725047079

sndwnd: 4128 scale: 0 maxrcvwnd: 4128
rcvwnd: 4128 scale: 0 delrcvwnd: 0

SRTT: 125 ms, RTTO: 2625 ms, RTV: 2500 ms, KRTT: 0 ms
minRTT: 15 ms, maxRTT: 1000 ms, ACK hold: 200 ms
uptime: 40996359 ms, Sent idletime: 6505 ms, Receive idletime: 6505 ms
Status Flags: active open
Option Flags: keepalive running, nagle, Retrans timeout
IP Precedence value : 0

TCP AO Key chain: kc2

TCP AO Current Key:  
Id: 7893, Send-Id: 218, Recv-Id: 218  
Include TCP Options: Yes*  
Accept AO Mismatch: No*

TCP AO Next Key:  
Id: 7893, Send-Id: 218, Recv-Id: 218  
Include TCP Options: Yes*  
Accept AO Mismatch: No*
Datagrams (max data segment is 1460 bytes):
Rcvd: 4372 (out of order: 0), with data: 0, total data bytes: 0
Sent: 4372 (retransmit: 0, fastretransmit: 0, partialack: 0, Second Congestion: 0), with
data: 0, total data bytes: 0

Packets received in fast path: 0, fast processed: 0, slow path: 0
fast lock acquisition failures: 0, slow path: 0
TCP Semaphore 0x7FBD6801B2E0 FREE

* = Derived from Key

Example: Verifying BGP Configuration

Use the `show ip bgp peer-group peer-group-name` and `show ip bgp template peer-session peer-session-name` commands in the privileged exec mode to display information about BGP configuration on peer groups and peer sessions.

Router# `show ip bgp peer-group ABC`

BGP peer-group is ABC, remote AS 100
BGP version 4
... AO keychain <keychain-name> include-tcp-options accept-ao-mismatch-connections
...

Router# `show ip bgp template peer-session ABC`

Template:ABC, index:1
Local policies:<hex-value>, Inherited polices:<hex-value>
Locally configured session commands:
... AO keychain <keychain-name> include-tcp-options accept-ao-mismatch-connections
... Inherited session commands:
... AO keychain <keychain-name> include-tcp-options accept-ao-mismatch-connections
Example: Verifying BGP Configuration
CHAPTER 90

BGP Unlabeled and Labeled Unicast in the Same Session: Label-Unicast Unique Mode

Cisco IOS XE provides a mode called "label-unicast unique". With this mode enabled, in BGP sessions that include unlabeled unicast and labeled unicast, the unlabeled and labeled forms of a given prefix are treated as unique. This improves interoperability with other operating systems that also treat these as unique, such as Cisco IOS XR.

- Overview, on page 1187
- Configuration, on page 1190

Overview

Devices operating with the Border Gateway Protocol (BGP) are termed BGP speakers. They maintain a Routing Information Base (RIB) that stores routing information for other BGP speakers in the network. The RIB includes a separate “Adjacent Routing Information Base, Incoming” (Adj-RIB-In) component for each BGP speaker, storing routing information received from that specific speaker.

For a given BGP speaker, neighboring speakers are considered peers. Typically, a speaker has only one peering relationship with another BGP speaker, but in some cases it may have multiple peering relationships with another BGP speaker. Typically, unless the multi-session feature is used, only one session is established for each peering relationship.

When a BGP speaker advertises unicast routes to its peers, it sends an UPDATE message. The routes include a prefix and possibly a label.

- Unlabeled unicast (uses SAFI 1): Unicast prefix only.
- Labeled unicast (uses SAFI 4): Unicast prefix, and an MPLS label associated to that prefix.

SAFI = Subsequent Address Family Identifier

Unlabeled and Labeled Unicast in the Same Session

In a single session, two BGP speakers can use both unlabeled and labeled unicast. Different BGP implementations handle this differently. When keeping track of the latest route information for a given prefix:
• (a) Some systems treat all unlabeled or labeled forms of a prefix as **equivalent**. These systems store the route information provided by the most recent update for the prefix, whether unlabeled or labeled.

• (b) Other systems treat each form of the prefix, whether unlabeled (SAFI 1) or labeled (SAFI 4), as **unique**. With these systems, the Adj-RIB-In for each peer stores routing information separately for the unlabeled prefix and the labeled prefix.

For a BGP session to propagate routes correctly, the way that one speaker sends a prefix must match the way that the other side receives the prefix. If they are not matched, the routes will not be received correctly. In that case, the receiver will then install the routes incorrectly, but without indicating any error, so the problem may go unaddressed.

Before Cisco IOS XE Gibraltar 16.12.1, IOS XE used only the method described in (a) above. It supported unlabeled and labeled unicast in the same session, but only among Cisco IOS XE speakers. Any two forms of the same prefix, whether unlabeled or labeled, were considered **equivalent**. For a given peer, the last received version of route information for any specific prefix was stored in the Adj-RIB-In, regardless of whether it was unlabeled or labeled.

Beginning with release 16.12.1, Cisco IOS XE provides a mode called "label-unicast unique", which supports sessions with BGP speakers that handle each form (unlabeled or labeled) of a prefix as **unique**. In this mode, the Adj-RIB-In for a given peer can store two routes for the same prefix, one route for unlabeled (received as SAFI 1) and one route for labeled (received as SAFI 4).

In this mode:

• Inbound processing: The device can store one labeled path and one unlabeled path from a neighbor.

• Outbound processing: The device executes update-generation twice, once for SAFI 1 and once for SAFI 4. Prefixes are advertised and withdrawn independently for each SAFI. In most scenarios, a prefix is only advertised in one of the SAFI types, but this depends on policy and may not be true in all cases.

The following figures show some of the difference in behavior that "label-unicast unique" mode provides by storing route information separately for unlabeled and labeled forms of the same prefix.
1. UPDATE message: unlabeled unicast
Prefix: 192.168.1.0/24
Route information includes: COMMUNITY=1:1

2. UPDATE message: labeled unicast
Prefix: [Label: 16] 192.168.1.0/24
Route information includes: COMMUNITY=1:2

**Result:** In the Adj-RIB-In on Device B, storing information for peer A, the route information for the labeled prefix replaces the route information for the unlabeled prefix. This is not the intended result, and can cause problems in the session between the two devices.
Interoperability

The "label-unicast unique" mode improves interoperability between Cisco IOS XE and operating systems, such as Cisco IOS XR, that treat unlabeled and labeled forms of a prefix as unique.

Backward Compatibility

To preserve backward compatibility, Cisco IOS XE Gibraltar 16.12.1 operates by default in the same mode as in previous releases. To change to the "label-unicast unique" mode, use the `update {in|out} labeled-unicast unique` command.

Configuration

Symmetrical Configuration

The term "symmetrical" applies to sessions between BGP speakers that both treat unlabeled and labeled prefixes as unique, for inbound (when receiving) and outbound (when advertising). This is the ideal scenario. An example would be a device using Cisco IOS XE communicating with a device using Cisco IOS XR.

See below for details of configuring symmetrical devices.
Two Cisco IOS XE Devices

In this configuration example:

- Device A: Using Cisco IOS XE. Configured with IP address 10.0.0.1, Autonomous System (AS) identifier 100.
- Device B: Using Cisco IOS XE. Configured with IP address 10.0.0.2, AS identifier 200.

On device A, in router configuration mode:

```text
router bgp 100
neighbor 10.0.0.2 remote-as 200
neighbor 10.0.0.2 update in labeled-unicast unique
neighbor 10.0.0.2 update out labeled-unicast unique
address-family ipv4 unicast
neighbor 10.0.0.2 send-label
```

On device B, in router configuration mode:

```text
router bgp 200
neighbor 10.0.0.1 remote-as 100
neighbor 10.0.0.1 update in labeled-unicast unique
neighbor 10.0.0.1 update out labeled-unicast unique
address-family ipv4 unicast
neighbor 10.0.0.1 send-label
```

One Cisco IOS XE Device and One Other Device

In this configuration example:

- Device A: Using Cisco IOS XE. Configured with IP address 10.0.0.1, Autonomous System (AS) identifier 100.
- Device B: Using Cisco IOS XR. Configured with IP address 10.0.0.2, AS identifier 200.

The configuration steps are required only on device A, running IOS XE.

On device A, in router configuration mode:

```text
router bgp 100
neighbor 10.0.0.2 remote-as 200
neighbor 10.0.0.2 update in labeled-unicast unique
neighbor 10.0.0.2 update out labeled-unicast unique
address-family ipv4 unicast
neighbor 10.0.0.2 send-label
```

Asymmetrical Configuration

The term "asymmetrical" applies to sessions between BGP speakers, where one speaker treats unlabeled and labeled prefixes as unique for inbound and as equivalent for outbound; and the other speaker treats unlabeled and labeled prefixes as equivalent for inbound and unique for outbound.

This is not ideal, but arises in some network scenarios.

In this configuration example:

- Device A: Using Cisco IOS XE. Configured with IP address 10.0.0.1, Autonomous System (AS) identifier 100.
- Device B: Using Cisco IOS XE. Configured with IP address 10.0.0.2, AS identifier 200.
On device A, in router configuration mode:

```
router bgp 100
neighbor 10.0.0.2 remote-as 200
neighbor 10.0.0.2 update-labeled in unicast unique
neighbor 10.0.0.2 send-label
```

On device B, in router configuration mode:

```
router bgp 200
neighbor 10.0.0.1 remote-as 100
neighbor 10.0.0.1 update-labeled out unicast unique
neighbor 10.0.0.1 send-label
```
BGP Replace ASNs in the AS Path

This chapter explains how BGP replaces ASNs in the route map.

- Information about BGP Replace ASNs, on page 1193
- Restrictions for BGP Replace ASNs in the AS Path, on page 1193
- Configure BGP Replace ASNs in the AS Path, on page 1194
- Configuration Examples for BGP Replace ASNs in the AS Path, on page 1194
- Feature Information for BGP Replace ASNs in the AS Path, on page 1195

Information about BGP Replace ASNs

This document describes how using the BGP policy, any of the configured Autonomous System Numbers (ASNs) are replaced with its own ASN. You can replace one or many ASNs using the AS_PATH attribute.

Loop prevention in BGP is based on the verification of AS numbers in the AS Path. If the receiving router sees its own AS number in the AS Path of the received BGP packet, the packet is dropped. However, this may cause issue in an inter-AS Hub and Spoke, such as a central Firewall location which must advertise more specific prefixes back to the spokes so the inter-AS crossing can happen twice (back and forth). The existing set as-path command under route-map provides functionality to prepend to the as-path and set tag. This solution expands the set as-path command to allow replace a sequence of ASNs to own or local AS.

Restrictions for BGP Replace ASNs in the AS Path

- BGP Replace ASNs in the AS Path feature supports only eBGP neighbors on a per AFI basis.
- When configuring BGP replace ASNs on iBGP neighbors, a warning message appears saying, the route-map configuration is taken (not failed), but the set as-path replace clause is ignored.
- The route-map with replace as-path functionality is applied to both inbound and outbound side of BGP neighbor. For inbound side, BGP replaces ASNs after the AS-PATH loop detection.
- The set as-path replace command only operates on AS_SEQUENCE and AS_CONFED_SEQUENCE, not AS_SET and AS_CONFED_SET attributes.
- Translate 4-byte AS number to 2 byte AS number before sending BGP messages to a BGP speaker.
• If confederation id is configured, when talking to a peer that is outside the confederation, use confederation ID to replace the ASNs. When talking to a peer that belong to the same confederation, use member-AS number to replace the ASNs.

• When the BGP Local-AS feature is configured, the configured Local-AS is used to replace the ASNs defined.

• The maximum length of a command is defined by PARSEBUF, which is 256 bytes. So, the max number of ASNs that are allowed in a single is 256 bytes.

• When multiple set as-path replace are configured, each entry is applied in a chain recursively, where the output of the current entry is the next entry in the chain.

• If you configure both set as-path prepend and set as-path replace, BGP processes set as-path replace first, and then set as-path prepend.

Configure BGP Replace ASNs in the AS Path

To replace a sequence of ASNs to its own AS, use the set as-path replace command:

```
Device(config-route-map)# set as-path replace {any | as-path-string} 
```

any replaces each AS number in the AS path with the local AS number.

```
Device(config-route-map)# set as-path replace {any | as-path-string} 
as-path-string is a sequence of AS numbers.
```

Configuration Examples for BGP Replace ASNs in the AS Path

The following example shows how to replace AS numbers in the AS path. In the example, AS-Path is "67 100 65533 5 78 89 6 5 28 100 9", and locally configured ASN is 900:

```
Device(config)#route-map test
R1(config-route-map)# set as-path replace 100
```

In this configuration, all occurrences of 100 in the AS-path are replaced with a local AS. The new AS-Path will be "67 900 65533 5 78 89 6 5 28 900 9".

```
Device(config)#route-map test
Device(config-route-map)# set as-path replace 5 78
```

In this configuration, all occurrences of AS sequence "5 78" in the AS-path replaces all the ASN in the configured AS sequence with local AS. The new AS-Path will be "67 100 65533 900 900 89 6 5 28 100 9".

The following example configures to replace multiple individual ASNs or AS sequences:

```
Device(config)#route-map test
Device(config-route-map)# set as-path replace 100
Device(config-route-map)# set as-path replace 6
Device(config-route-map)# set as-path replace 5 78
```

With this configuration, the feature finds all occurrences of 6, 100, and AS sequence "5 78" in the AS-path and replace all of them with own AS. The new AS-Path will be "67 900 65533 900 900 89 6 5 28 900 9".

The following example replaces every AS numbers in the AS-path:

```
Device(config)#route-map test
Device(config-route-map)# set as-path replace any
```
In this configuration, the new AS-Path will be "900 900 900 900 900 900 900 900 900 900 900 900".

**Feature Information for BGP Replace ASNs in the AS Path**

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to [www.cisco.com/go/cfn](http://www.cisco.com/go/cfn). An account on Cisco.com is not required.

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
</table>
| BGP Replace ASNs in the AS Path | Cisco IOS XE Amsterdam 17.1.1 | BGP Replace Autonomous System Numbers (ASNs) feature is a BGP policy on the router that allows replacing any of the configured AS number with its own AS. Many AS numbers can be specified to allow such a replace to happen to more than one AS number using the AS_PATH attribute. The following command has been introduced:  
  * set as-path replace |
Feature Information for BGP Replace ASNs in the AS Path
CHAPTER 92

Configuring Graceful Insertion and Removal

Graceful Insertion and Removal (GIR) provides an alternative method to minimize network service impact caused by device maintenance. GIR leverages redundant paths in the network to smoothly remove a device under maintenance, out of service, and insert it back to service when the maintenance is complete. This module describes the how to configure GIR.

- Restrictions for Graceful Insertion and Removal, on page 1197
- Information About Graceful Insertion and Removal, on page 1197
- How to Configure Graceful Insertion and Removal, on page 1199
- Monitoring Graceful Insertion and Removal, on page 1201
- Configuration Examples for Graceful Removal and Insertion, on page 1202
- Feature History and Information for Graceful Insertion and Removal, on page 1204

Restrictions for Graceful Insertion and Removal

GIR is supported on the Cisco ASR 1000 series of routers only for BGP. GIR is configured either by creating customized templates or without a template.

Information About Graceful Insertion and Removal

Overview

Graceful Insertion and Removal (GIR) isolates a router from the network for debugging or an upgrade. The router can be put into maintenance mode using the `start maintenance` command. When router maintenance is complete, the router returns to normal mode on either reaching the configured maintenance timeout, or when the `stop maintenance` command is used.

Create a maintenance mode template before you put the router in maintenance mode. The objective of maintenance mode for a router is to minimize traffic disruption at the time of removal from the network, as well as during the time of insertion. There are mainly three stages:

- Graceful removal of the node from network.
- Performing maintenance on the device.
- Graceful insertion into the network.
A router can be put into maintenance mode using default template or a custom template.

**Snapshot Template**

Snapshots are taken automatically while entering and exiting the maintenance mode. You can use the `snapshot-template template-name` command to capture and store snapshots for pre-selected features. Snapshots are useful to compare the state of a router before it went into maintenance mode and after it came back to normal mode. The snapshot process consists of three parts:

- Creating a snapshot of the states of a few preselected features on the router and storing them on the persistent storage media.
- Listing the snapshots taken at various time intervals and managing them.
- Comparing snapshots and showing the summary and details of each feature.

You can create multiple snapshot templates. But you can apply only one snapshot template at a time. If you do not specify a custom snapshot template, a default snapshot template is applied.

Snapshot templates can be created to generate specific snapshots. A new snapshot template can be created using the `snapshot-template template-name` command. The command `default-snapshot-template` can be used to specify the default snapshot template in the maintenance mode.

The following example shows the creation of a snapshot template named `gir_1`:

```
snapshot-template gir_1
  router bgp
```

**Maintenance Template**

As a network administrator, you can create a maintenance template that is applied when the system goes into maintenance mode. This allows you to isolate specific protocol instances. All instances that need to be isolated must be explicitly specified.

You can create multiple templates with different configurations. However, only a single template is applied to the maintenance mode CLI. Once applied, the template cannot be updated. If the template has to be updated, then you must remove it, make the changes, and then re-apply.

```
maintenance-template t1
  router bgp 100
```

**System Mode Maintenance Counters**

GIR has counters to track the following events:

- Number of times the router went into maintenance.
- Ack statistics per client.
- Nack statistics per client
- Number of times a particular client did not acknowledge.
- Number of times switchover happened during GIR. GIR infra will rsync this counter to track multiple switchovers.
- Number of times the failsafe timer expired.
- Number of times system got out of maintenance on a timeout expiry.

Enter the `show system mode maintenance counters` command in privileged EXEC mode, to display the counters that are being tracked by the feature.

Enter the `clear system mode maintenance counters` command in privileged EXEC mode, to clear the counters supported by the feature.

The client-ack timeout value can be configured using the `failsafe failsafe-timeout-value` command. Failsafe time is the time that the GIR engine allows a client to transition. Each client sends a notification to the GIR engine about its transition. If it takes more than the failsafe time to transition, it is assumed to have transitioned. The failsafe timer can be configured between 5 - 180 minutes, with a default of 30 minutes.

### How to Configure Graceful Insertion and Removal

#### Creating a Maintenance Template

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `maintenance-template template_name`
4. `router routing_protocol instance_id`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode. Enter your password if prompted.</td>
</tr>
<tr>
<td><code>enable</code></td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td><code>Device&gt; enable</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Enters the global configuration mode.</td>
</tr>
<tr>
<td><code>configure terminal</code></td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td><code>Device# configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Creates a template with the specified name. For example, see Examples: Creating customer profile.</td>
</tr>
<tr>
<td><code>maintenance-template template_name</code></td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td><code>Device(config)# maintenance-template gir1</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>Creates instances that should be isolated under this template.</td>
</tr>
<tr>
<td><code>router routing_protocol instance_id</code></td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td><code>Device(config-maintenance-templ)# router bgp AS-number</code></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

[IP Routing: BGP Configuration Guide, Cisco IOS XE 17](#)
### Configuring System Mode Maintenance

#### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `system mode maintenance`
4. `timeout timeout-value | template template-name | snapshot-template snapshot name | failsafe failsafe-timeout-value | on-reload reset-reason maintenance`

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Device&gt; enable</td>
<td>Enables privileged EXEC mode. Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> <code>configure terminal</code>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Device# configure terminal</td>
<td>Enters the global configuration mode.</td>
</tr>
<tr>
<td><strong>Step 3</strong> <code>system mode maintenance</code>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;Device(config)# system mode maintenance</td>
<td>Enters system mode maintenance configuration mode. Different sub commands to create maintenance mode parameters are configured in this mode.</td>
</tr>
<tr>
<td><strong>Step 4</strong> `timeout timeout-value</td>
<td>template template-name</td>
</tr>
<tr>
<td></td>
<td>• <code>timeout</code> Configures maintenance mode timeout period in minutes, after which the system automatically returns to normal mode. The default timeout value is never.</td>
</tr>
<tr>
<td></td>
<td>• <code>template</code> Configures maintenance mode using the specified maintenance template.</td>
</tr>
<tr>
<td></td>
<td>• <code>snapshot-template</code>: Configures maintenance mode using the specified snapshot template.</td>
</tr>
<tr>
<td></td>
<td>• <code>failsafe</code>: Configures client-ack timeout value. If the system is going into maintenance mode, it will continue to reach maintenance. If the system is exiting from maintenance mode, then it will reach normal mode.</td>
</tr>
<tr>
<td></td>
<td>• <code>on-reload reset-reason maintenance</code>: Configures the system such that when the system is reloaded it enters the maintenance mode. If it is not configured the system enters the normal mode when it is reloaded.</td>
</tr>
</tbody>
</table>
Starting and Stopping Maintenance Mode

SUMMARY STEPS

1. enable
2. start maintenance
3. stop maintenance

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1**
| enable | Enables privileged EXEC mode. Enter your password if prompted. |
| Example: Device> enable | |
| **Step 2**
| start maintenance | Puts the system into maintenance mode. |
| Example: Device# start maintenance | |
| **Step 3**
| stop maintenance | Puts the system back into normal mode. |
| Example: Device# stop maintenance | |

Monitoring Graceful Insertion and Removal

Use the following commands to check the status of or display statistics generated by the GIR feature:

Table 110: Privileged EXEC Commands

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>show system mode [maintenance [clients</td>
<td>template template-name]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>show system snapshots [dump &lt; snapshot-file-name&gt;]</td>
<td>Displays all the snapshots present on the device.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>show system snapshots [dump &lt; snapshot-file-name&gt;</td>
<td>xml</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>show system snapshots compare snapshot-name1 snapshot-name2</td>
<td>Displays differences between snapshots taken before entering maintenance mode and after exiting from the maintenance mode.</td>
</tr>
</tbody>
</table>
### Configuration Examples for Graceful Removal and Insertion

The following examples show the sequence followed to enable GIR during a maintenance window.

#### Example: Configuring Snapshot and Maintenance Templates

This example shows how to configure a snapshot template gir_1 with a BGP routing protocol instance.

```
Device# configure terminal
Device(config)# snapshot-template gir_1
Device(config)# router BGP 1
```

This example shows how to configure a maintenance template t1 with a BGP routing protocol instance.

```
Device# configure terminal
Device(config)# maintenance-template t1
Device(config)# router BGP 1
```

#### Example: Configuring System Mode Maintenance

This example shows how to create a maintenance template and configure the maintenance mode parameters.

```
Device# configure terminal
Device(config)# system mode maintenance
Device(config-maintenance)# timeout 20
Device(config-maintenance)# failsafe 30
Device(config-maintenance)# on-reload reset-reason maintenance
Device(config-maintenance)# template t1
Device(config-maintenance)# snapshot-template gir_1
Device(config-maintenance)# exit
```

#### Example: Starting and Stopping the Maintenance Mode

This example shows how to put the system into maintenance mode.

```
Device# start maintenance
Template t1 will be applied. Do you want to continue?[confirm]
Device#
```

After the activity is completed, the system can be put out of maintenance mode.

```
Device(maint-mode)# stop maintenance
Device(maint-mode)#
Device#
```
Example: Displaying System Mode Settings

This example shows how to display system mode settings using different options.

```
Device# show system mode
  System Mode: Normal

Device# show system mode maintenance
  System Mode: Normal
  Current Maintenance Parameters:
  Maintenance Duration: 20(mins)
  Failsafe Timeout: 30(mins)
  Maintenance Template: t1
  Snapshot Template: gir_1
  Reload in Maintenance: True

Device# show system mode maintenance clients
  System Mode: Normal
  Maintenance Clients:
  CLASS-EGP
  router bgp 1000: Transition None
  CLASS-IGP
  CLASS-MCAST
  CLASS-FHRP
  CLASS-L2

Device# show system mode maintenance template default
  System Mode: Normal
  default maintenance-template details:
  router bgp 1000

Device# show system mode maintenance template t1
  System Mode: Normal
  Maintenance Template t1 details:
  router bgp 1000
```

Example: Displaying System Differences Between Entering and Exiting Maintenance Mode

This example shows how to display differences between snapshots taken before entering maintenance mode and after exiting maintenance mode.

```
Device# show system snapshots compare before_maintenance after_maintenance
================================================================================
Feature  Tag before_maintenance after_maintenance
================================================================================
[bgp_summary]

[Neighbor:192.168.10.2]
  MsgRcvd 2 **7**
  up 00:07:30 **00:11:29**
```
Feature History and Information for Graceful Insertion and Removal

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 112: Feature History and Information for Graceful Insertion and Removal

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Release</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graceful Insertion and Removal</td>
<td>Cisco IOS XE Gibraltar 16.12.1</td>
<td>This feature was introduced on the Cisco ASR 1000 series of routers with support for BGP.</td>
</tr>
</tbody>
</table>