Configuring BGP

BGP

Border Gateway Protocol (BGP) is an inter-domain routing protocol that provides loop-free routing between organizations or autonomous systems. Cisco NX-OS supports BGP version 4, which includes multiprotocol extensions that allow BGP to carry routing information for IP multicast routes and multiple Layer 3 protocol address families. BGP uses TCP as a reliable transport protocol to create TCP sessions with other BGP-enabled devices called BGP peers. When connecting to an external organization, a router creates external BGP (eBGP) peering sessions. When connecting to a BGP peer within the same organization to exchange routing information, a router creates internal BGP (iBGP) peering sessions.

BGP uses a path-vector routing algorithm to exchange routing information among BGP-enabled networking devices or BGP speakers. Based on this information, each BGP speaker determines a path to reach a destination while detecting and avoiding paths with routing loops. The routing information includes the prefix for a destination, the path of autonomous systems to the destination, and other path attributes.

By default, BGP selects a single path as the best path to a destination host or network. Each path includes well-known mandatory attributes, well-known discretionary attributes, and optional transitive attributes for BGP best-path analysis. You can influence BGP path selection by altering some of theses attributes by configuring BGP policies. For more information, see Route Policies and Resetting BGP Sessions. BGP also supports load balancing or equal-cost multipath (ECMP). For more information, see Load Sharing and Multipath.

Beginning with Cisco NX-OS Release 10.5(1)F, Configuring Basic BGP and Configuring Advanced BGP chapters are merged to create Configuring BGP chapter.

BGP Autonomous Systems

An autonomous system (AS) is a network controlled by a single administration entity. An autonomous system forms a routing domain with one or more interior gateway protocols (IGPs) and a consistent set of routing policies. BGP supports 16-bit and 32-bit autonomous system numbers. For more information, see the Autonomous Systems section.

Separate BGP autonomous systems dynamically exchange routing information through external BGP (eBGP) peering sessions. BGP speakers within the same autonomous system can exchange routing information through internal BGP (iBGP) peering sessions.

4-Byte AS Number Support

BGP supports 2-byte autonomous system (AS) numbers in plain-text notation or as.dot notation and 4-byte AS numbers in plain-text notation.

When BGP is configured with a 4-byte AS number, the **route-target auto** VXLAN command cannot be used because the AS number along with the VNI (which is already a 3-byte value) is used to generate the route target. For more information, see the Cisco Nexus 9000 Series NX-OS VXLAN Configuration Guide.

Administrative Distance

An administrative distance is a rating of the trustworthiness of a routing information source. By default, BGP uses the administrative distances shown in the table.

Table 1: BGP Default Administrative Distances

Distance	Default Value	Function
External	20	Applied to routes learned from eBGP.
Internal	200	Applied to routes learned from iBGP.
Local	220	Applied to routes originated by the router.

Note The administrative distance does not influence the BGP path selection algorithm, but it does influence whether BGP-learned routes are installed in the IP routing table.

For more information, see the Administrative Distance section.

BGP Peers

A BGP speaker does not discover another BGP speaker automatically. You must configure the relationships between BGP speakers. A BGP peer is a BGP speaker that has an active TCP connection to another BGP speaker.

BGP Sessions

BGP uses TCP port 179 to create a TCP session with a peer. When a TCP connection is established between peers, each BGP peer initially exchanges all of its routes—the complete BGP routing table—with the other peer. After this initial exchange, the BGP peers send only incremental updates when a topology change occurs in the network or when a routing policy change occurs. In the periods of inactivity between these updates, peers exchange special messages called keepalives. The hold time is the maximum time limit that can elapse between receiving consecutive BGP update or keepalive messages.

Cisco NX-OS supports the following peer configuration options:

- Individual IPv4 or IPv6 address—BGP establishes a session with the BGP speaker that matches the remote address and AS number.
- IPv4 or IPv6 prefix peers for a single AS number—BGP establishes sessions with BGP speakers that match the prefix and the AS number.
- Dynamic AS number prefix peers—BGP establishes sessions with BGP speakers that match the prefix and an AS number from a list of configured AS numbers.

Dynamic AS Numbers for Prefix Peers and Interface Peers

Cisco NX-OS accepts a range or list of AS numbers to establish BGP sessions. For example, if you configure BGP to use IPv4 prefix 192.0.2.0/8 and AS numbers 33, 66, and 99, BGP establishes a session with 192.0.2.1 with AS number 66 but rejects a session from 192.0.2.2 with AS number 50.

Beginning with Cisco NX-OS Release 9.3(6), support for dynamic AS numbers is extended to interface peers in addition to prefix peers. See Configuring BGP Interface Peering via IPv6 Link-Local for IPv4 and IPv6 Address Families, on page 58.

Cisco NX-OS does not associate prefix peers with dynamic AS numbers as either interior BGP (iBGP) or external BGP (eBGP) sessions until after the session is established. See *Configuring Advanced BGP* for more information on iBGP and eBGP.

Note The dynamic AS number prefix peer configuration overrides the individual AS number configuration that is inherited from a BGP template. For more information, see *Configuring Advanced BGP*.

BGP Router Identifier

To establish BGP sessions between peers, BGP must have a router ID, which is sent to BGP peers in the OPEN message when a BGP session is established. The BGP router ID is a 32-bit value that is often represented by an IPv4 address. You can configure the router ID. By default, Cisco NX-OS sets the router ID to the IPv4 address of a loopback interface on the router. If no loopback interface is configured on the router, the software chooses the highest IPv4 address configured to a physical interface on the router to represent the BGP router ID. The BGP router ID must be unique to the BGP peers in a network.

If BGP does not have a router ID, it cannot establish any peering sessions with BGP peers.

Each routing process has an associated router ID. You can configure the router ID to any interface in the system. If you do not configure the router ID, Cisco NX-OS selects the router ID based on the following criteria:

- Cisco NX-OS prefers loopback0 over any other interface. If loopback0 does not exist, then Cisco NX-OS prefers the first loopback interface over any other interface type.
- If you have not configured a loopback interface, Cisco NX-OS uses the first interface in the configuration file as the router ID. If you configure any loopback interface after Cisco NX-OS selects the router ID, the loopback interface becomes the router ID. If the loopback interface is not loopback0 and you configure loopback0 with an IP address, the router ID changes to the IP address of loopback0.

- If the interface that the router ID is based on changes, that new IP address becomes the router ID. If any other interface changes its IP address, there is no router ID change.

BGP Path Selection

BGP supports sending and receiving multiple paths per prefix and advertising such paths. For information on configuring additional BGP paths, see *Configuring Advanced BGP*.

The best-path algorithm runs each time that a path is added or withdrawn for a given network. The best-path algorithm also runs if you change the BGP configuration. BGP selects the best path from the set of valid paths available for a given network.

Cisco NX-OS implements the BGP best-path algorithm in the following steps:

1. Compares two paths to determine which is better (see the Step 1—Comparing Pairs of Paths section).
2. Explores all paths and determines in which order to compare the paths to select the overall best path (see the “Step 2—Determining the Order of Comparisons section).
3. Determines whether the old and new best paths differ enough so that the new best path should be used (see the “Step 3—Determining the Best-Path Change Suppressionsection).

Note The order of comparison determined in Part 2 is important. Consider the case where you have three paths, A, B, and C. When Cisco NX-OS compares A and B, it chooses A. When Cisco NX-OS compares B and C, it chooses B. But when Cisco NX-OS compares A and C, it might not choose A because some BGP metrics apply only among paths from the same neighboring autonomous system and not among all paths.

The path selection uses the BGP AS-path attribute. The AS-path attribute includes the list of autonomous system numbers (AS numbers) traversed in the advertised path. If you subdivide your BGP autonomous system into a collection or confederation of autonomous systems, the AS-path contains confederation segments that list these locally defined autonomous systems.

Note VXLAN deployments use a BGP path selection process that differs from the normal selection of local over remote paths. For the EVPN address family, BGP compares the sequence number in the MAC Mobility attribute (if present) and selects the path with the higher sequence number. If both paths being compared have the attribute and the sequence numbers are the same, BGP prefers the path that is learned from the remote peer over a locally originated path. For more information, see the Cisco Nexus 9000 Series NX-OS VXLAN Configuration Guide.

BGP Path Selection - Comparing Pairs of Paths

This first step in the BGP best-path algorithm compares two paths to determine which path is better. The following sequence describes the basic steps that Cisco NX-OS uses to compare two paths to determine the better path:

1. Cisco NX-OS chooses a valid path for comparison. (For example, a path that has an unreachable next hop is not valid.)
2. Cisco NX-OS chooses the path with the highest weight.

3. Cisco NX-OS chooses the path with the highest local preference.
4. If one of the paths is locally originated, Cisco NX-OS chooses that path.
5. Cisco NX-OS chooses the path with the shorter AS path.

Note When calculating the length of the AS-path, Cisco NX-OS ignores confederation segments and counts AS sets as 1. See the *AS Confederations* section for more information.

6. Cisco NX-OS chooses the path with the lower origin. Interior Gateway Protocol (IGP) is considered lower than EGP.
7. Cisco NX-OS chooses the path with the lower multiexit discriminator (MED).

   You can configure Cisco NX-OS to always perform the best-path algorithm MED comparison, regardless of the peer autonomous system in the paths. See the *Tuning the Best-Path Algorithm* section for more information. Otherwise, Cisco NX-OS performs a MED comparison that depends on the AS-path attributes of the two paths being compared:

   You can configure Cisco NX-OS to always perform the best-path algorithm MED comparison, regardless of the peer autonomous system in the paths. Otherwise, Cisco NX-OS performs a MED comparison that depends on the AS-path attributes of the two paths being compared:

   a. If a path has no AS-path or the AS-path starts with an AS_SET, the path is internal and Cisco NX-OS compares the MED to other internal paths.
   b. If the AS-path starts with an AS_SEQUENCE, the peer autonomous system is the first AS number in the sequence and Cisco NX-OS compares the MED to other paths that have the same peer autonomous system.
   c. If the AS-path contains only confederation segments or starts with confederation segments followed by an AS_SET, the path is internal and Cisco NX-OS compares the MED to other internal paths.
   d. If the AS-path starts with confederation segments that are followed by an AS_SEQUENCE, the peer autonomous system is the first AS number in the AS_SEQUENCE and Cisco NX-OS compares the MED to other paths that have the same peer autonomous system.

Note If Cisco NX-OS receives no MED attribute with the path, Cisco NX-OS considers the MED to be 0 unless you configure the best-path algorithm to set a missing MED to the highest possible value. See the *Tuning the Best-Path Algorithm* section for more information.

   e. If the non-deterministic MED comparison feature is enabled, the best-path algorithm uses the Cisco IOS style of MED comparison.

8. If one path is from an internal peer and the other path is from an external peer, Cisco NX-OS chooses the path from the external peer.
9. If the paths have different IGP metrics to their next-hop addresses, Cisco NX-OS chooses the path with the lower IGP metric.
10. Cisco NX-OS uses the path that was selected by the best-path algorithm the last time that it was run.

If all path parameters in Step 1 through Step 9 are the same, you can configure the best-path algorithm to enforce comparison of the router IDs when both paths are eBGP by configuring “compare router-id”. In all other cases, the router-id comparison is done by default.

See the *Tuning the Best-Path Algorithm* section for more information. If the path includes an originator attribute, Cisco NX-OS uses that attribute as the router ID to compare to; otherwise, Cisco NX-OS uses the router ID of the peer that sent the path. If the paths have different router IDs, Cisco NX-OS chooses the path with the lower router ID.

Note When using the attribute originator as the router ID, it is possible that two paths have the same router ID. It is also possible to have two BGP sessions with the same peer router, so you could receive two paths with the same router ID.

11. Cisco NX-OS selects the path with the shorter cluster length. If a path was not received with a cluster list attribute, the cluster length is 0.
12. Cisco NX-OS chooses the path received from the peer with the lower IP address. Locally generated paths (for example, redistributed paths) have a peer IP address of 0.

Note Paths that are equal after Step 9 can be used for multipath if you configure multipath. See the *Load Sharing and Multipath* section for more information.

BGP Path Selection - Determining the Order of Comparisons

The second step of the BGP best-path algorithm implementation is to determine the order in which Cisco NX-OS compares the paths:

1. Cisco NX-OS partitions the paths into groups. Within each group, Cisco NX-OS compares the MED among all paths. Cisco NX-OS uses the same rules as in the Step 1—Comparing Pairs of Paths section to determine whether MED can be compared between any two paths. Typically, this comparison results in one group being chosen for each neighbor autonomous system. If you configure the **bgp bestpath med always** command, Cisco NX-OS chooses just one group that contains all the paths.
2. Cisco NX-OS determines the best path in each group by iterating through all paths in the group and keeping track of the best one so far. Cisco NX-OS compares each path with the temporary best path found so far and if the new path is better, it becomes the new temporary best path and Cisco NX-OS compares it with the next path in the group.
3. Cisco NX-OS forms a set of paths that contain the best path selected from each group in Step 2. Cisco NX-OS selects the overall best path from this set of paths by going through them as in Step 2.

BGP Path Selection - Determining the Best-Path Change Suppression

The next part of the implementation is to determine whether Cisco NX-OS uses the new best path or suppresses the new best path. The router can continue to use the existing best path if the new one is identical to the old path (if the router ID is the same). Cisco NX-OS continues to use the existing best path to avoid route changes in the network.

You can turn off the suppression feature by configuring the best-path algorithm to compare the router IDs. See the *Tuning the Best-Path Algorithm* section for more information. If you configure this feature, the new best path is always preferred to the existing one.

BGP and the Unicast RIB

BGP communicates with the unicast routing information base (unicast RIB) to store IPv4 routes in the unicast routing table. After selecting the best path, if BGP determines that the best path change needs to be reflected in the routing table, it sends a route update to the unicast RIB.

BGP receives route notifications regarding changes to its routes in the unicast RIB. It also receives route notifications about other protocol routes to support redistribution.

BGP also receives notifications from the unicast RIB regarding next-hop changes. BGP uses these notifications to keep track of the reachability and IGP metric to the next-hop addresses.

Whenever the next-hop reachability or IGP metrics in the unicast RIB change, BGP triggers a best-path recalculation for affected routes.

BGP communicates with the IPv6 unicast RIB to perform these operations for IPv6 routes.

BGP Prefix Independent Convergence

The BGP prefix independent convergence (PIC) edge feature achieves faster convergence in the forwarding plane for BGP IP routes to a BGP backup path when there is a link failure.

The BGP PIC edge feature improves BGP convergence after a network failure. This convergence applies to edge failures in an IP network. This feature creates and stores a backup path in the routing information base (RIB) and forwarding information base (FIB) so that when the primary path fails, the backup path can immediately take over, enabling fast failover in the forwarding plane. BGP PIC edge supports only IPv4 address families.

When BGP PIC edge is configured, BGP calculates a second-best path (the backup path) along with the primary best path. BGP installs both best and backup paths for the prefixes with PIC support into the BGP RIB. BGP also downloads the backup path along with the remote next hop through APIs to the URIB, which then updates the FIB with the next hop marked as a backup. The backup path provides a fast reroute mechanism to counter a singular network failure.

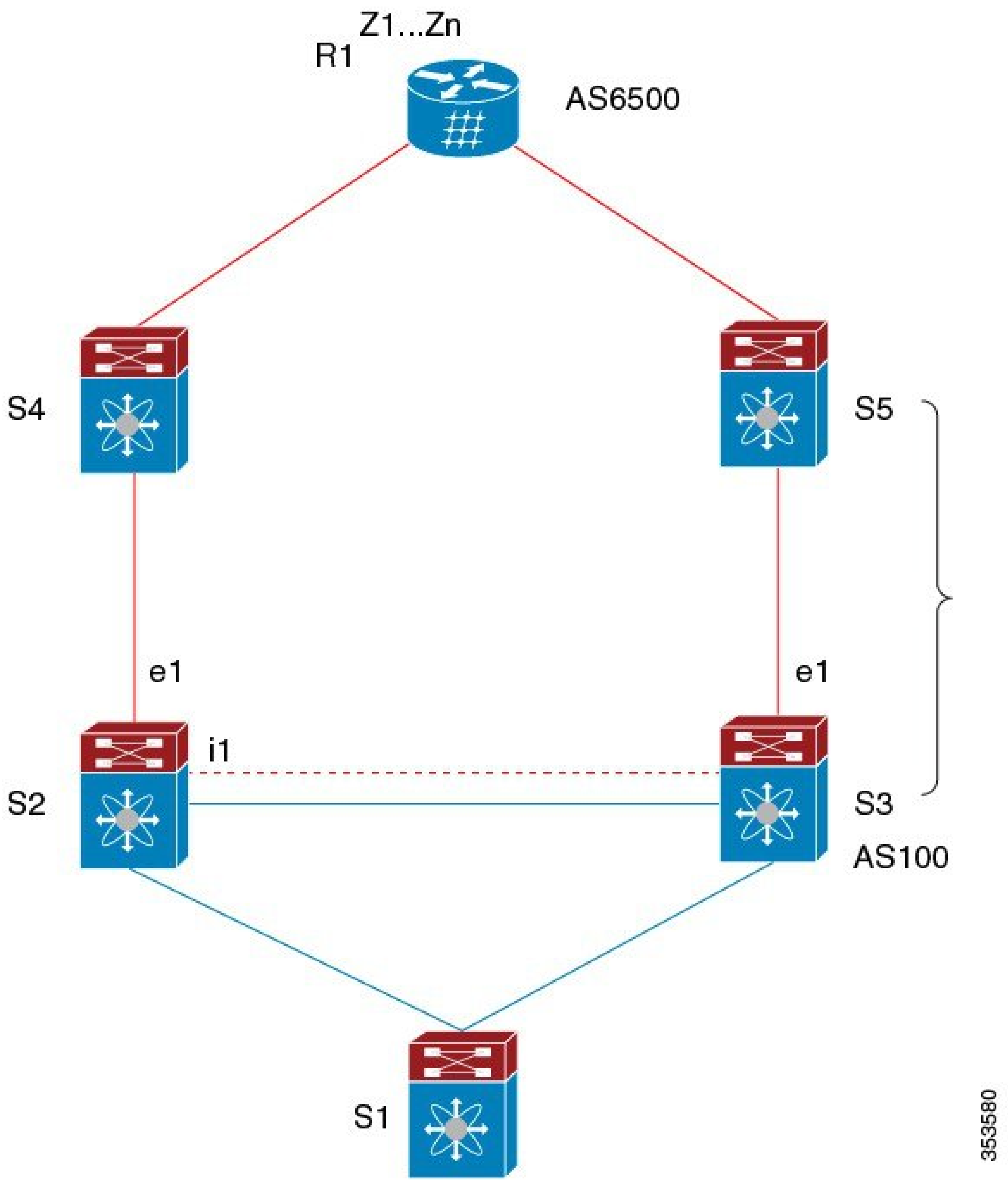
This feature detects both local interface failures and remote interface or link failures and triggers the use of the backup path

BGP PIC edge supports both unipath and multipath.

BGP PIC Edge Unipath

The following figure shows a BGP PIC edge unipath topology.

Figure 1: BGP PIC Edge Unipath



In this figure:

- eBGP sessions are between S2-S4 and S3-S5.
- The iBGP session is between S2-S3.

- Traffic from S1 uses S2 and uses the e1 interface to reach prefixes Z1...Zn.
- S2 has two paths to reach Z1…Zn:
  - A primary path through S4
  - A backup path through S5

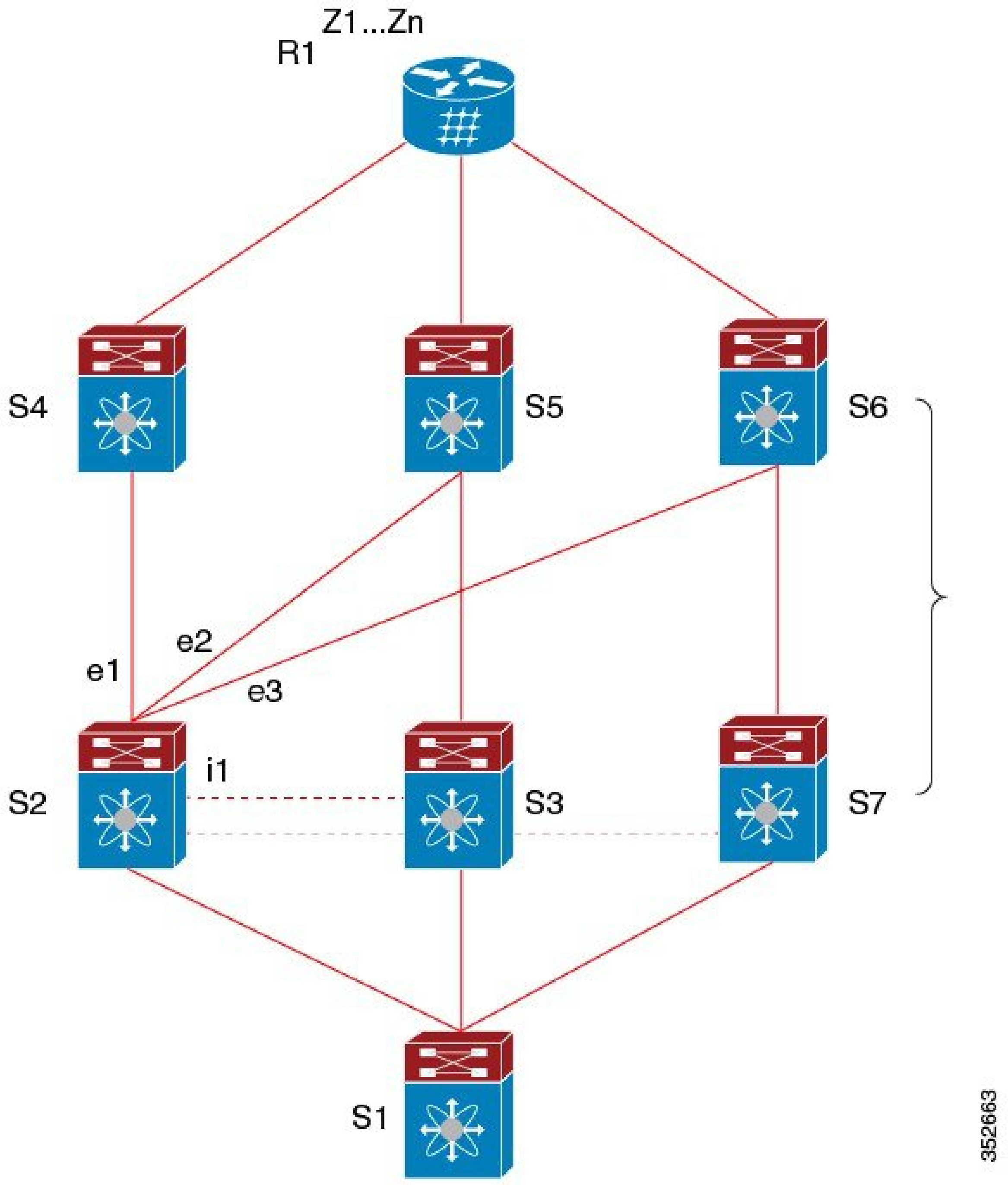
In this example, S3 advertises to S2 the prefixes Z1…Zn to reach (with itself as the next hop). With BGP PIC edge enabled, BGP on S2 installs both the best path (through S4) and the backup path (through S3 or S5) toward the AS6500 into the RIB. Then the RIB downloads both routes to the FIB.

If the S2-S4 link goes down, the FIB on S2 detects the link failure. It automatically switches from the primary path to the backup path and points to the new next hop S3. Traffic is quickly rerouted due to the local fast re-convergence in the FIB. After learning of the link failure event, BGP on S2 recomputes the best path (which is the previous backup path), removes next hop S4 from the RIB, and reinstalls S3 as the primary next hop into the RIB. BGP also computes a new backup path, if any, and notifies the RIB. With the support of the BGP PIC edge feature, the FIB can switch to the available backup route instantly upon detection of a link failure on the primary route without waiting for BGP to select the new best path and converge to achieve a fast reroute.

BGP PIC Edge with Multipath

The following figure shows a BGP PIC edge multipath topology.

Figure 2: BGP PIC Edge Multipaths



In this topology, there are six paths for a given prefix:

- eBGP paths: e1, e2, e3
- iBGP paths: i1, i2, i3

The order of preference is e1 > e2 > e3 > i1 > i2 > i3.

The potential multipath situations are:

- No multipaths configured:
    - bestpath = e1
    - multipath-set = []
    - backup path = e2
    - PIC behavior: When e1 fails, e2 is activated.
- Two-way eBGP multipaths configured:
    - bestpath = e1
    - multipath-set = [e1, e2]
    - backup path = e3
    - PIC behavior: Active multipaths are mutually backed up. When all multipaths fail, e3 is activated.
- Three-way eBGP multipaths configured:
    - bestpath = e1
    - multipath-set = [e1, e2, e3]
    - backup path = i1
    - PIC behavior: Active multipaths are mutually backed up. When all multipaths fail, i1 is activated.
- Four-way eBGP multipaths configured:
    - – bestpath = e1
    - – multipath-set = [e1, e2, e3, i1]
    - – backup path = i2
    - – PIC behavior: Active multipaths are mutually backed up. When all multipaths fail, i2 is activated.

When the Equal Cost Multipath Protocol (ECMP) is enabled, none of the multipaths can be selected as the backup path.

For multipaths with the backup path scenario, faster convergence is not expected with simultaneous failure of all active multipaths.

BGP PIC Core

BGP Prefix Independent Convergence (PIC) in Core improves BGP convergence after a network failure. For example, if a link fails on Provider Edge (PE), the Routing Information Base (RIB) updates the Forwarding Information Base (FIB) with new next hop. FIB must update all BGP prefixes that point to the failed next hop and point to the new one. This can be time and resource consuming. With BGP PIC Core enabled, the prefix is programmed in the FIB in a hierarchical way. All prefixes point to the ECMP group instead of the recursive next hop. When the same failure happens, the FIB only needs to update the ECMP group to point to the new next hop without updating prefixes. This gives BGP immediate leveraging of IGP convergence.

BGP PIC Feature Support Matrix

Table 2: BGP PIC Feature Support Matrix

BGP PIC	IPv4 Unicast	IPv6 Unicast
Edge unipath	Yes	No
Edge with multipath (multiple active ECMPs, only one backup)	Yes	No
Core	Yes	Yes

BGP Virtualization

BGP supports virtual routing and forwarding (VRF) instances.

Prerequisites

BGP has the following prerequisites:

- You must enable BGP (see the *Enabling BGP* section).
- You should have a valid router ID configured on the system.
- You must have an AS number, either assigned by a Regional Internet Registry (RIR) or locally administered.
- You must have reachability (such as an interior gateway protocol [IGP], a static route, or a direct connection) to the peer that you are trying to make a neighbor relationship with.
- You must explicitly configure an address family under a neighbor for the BGP session establishment.

Guidelines and Limitations for Basic and Advanced BGP

BGP has the following configuration guidelines and limitations:

- With sufficient scale (such as - hundreds of peers and thousands of routes per peer), the Graceful Restart mechanism may fail because the default 5 minute stale-path timer might not be enough for BGP convergence to complete before the timer expires. Use the following command to verify the actual time taken for the convergence process:

```
switch# show bgp vrf all all neighbors | in First|RIB
  Last End-of-RIB received 0.022810 after session start
  Last End-of-RIB sent 00:08:36 after session start
  First convergence 00:08:36 after session start with 398002 routes sent
```

- Beginning with Cisco NX-OS 9.3(5), a packet with a TTL value of 1 to a vPC peer is hardware forwarded.
- For large routing tables (250 K or above) when using the SNMP bulkwalk with record option (-Cr), do not use more than 10 records to avoid SNMP performance degradation.

- There are three scenarios in which the command behavior has changed beginning with Cisco NX-OS Release 9.3(5):

  -
    ```
    Router bgp 1
        Template peer abc
            Ttl-security hops 30
        Neighbor 1.2.3.4
            Inherit peer abc
    ```

    If you later enter the **ebgp-multihop 20** command, the configuration is blocked due to the presence of **ttl-security hops 30** command. Beginning with the Cisco NX-OS Release 9.3(5), the configuration is no longer blocked. However, the **ttl-security hops** command has priority and would be the enabled functionality.

  -
    ```
    Router bgp 1
        Template peer abc
            Ebgp-multihops 20
        Neighbor 1.2.3.4
            Inherit peer abc
    ```

    If you later enter the **ttl-security hops 30** command, the configuration is blocked due to the presence of **ebgp-multihop 20** command. Beginning with Cisco NX-OS Release 9.3(5), the configuration is no longer blocked. However again, the **ttl-security hops** command has priority and would be the enabled functionality.

  -
    ```
    Router bgp 1
        Template peer abc
            Remote-as 1
        Neighbor 1.2.3.4
            Inherit peer abc
    ```

    If you later enter the **ttl-security hops 30** or **ebgp-multihop 20** commands, they are blocked. Beginning with Cisco NX-OS Release 9.3(5), the configuration is not blocked. However, their functionalities are turned off as the **remote-as** command has priority which makes the peer an iBGP peer.

- If you are writing JSON payload, use the standard JSON syntax defined on RFC 8259: The JavaScript Object Notation (JSON) Data Interchange Format.
- Prefix peering operates only in passive TCP mode. It accepts incoming connections from remote peers if the peer address falls within the prefix.
- Beginning with Cisco NX-OS 9.3(5), a packet with a TTL value of 1 to a vPC peer is hardware that is forwarded.
- Configuring the **advertise-maps** command multiple times is not supported.
- Names in the prefix-list are case-insensitive. We recommend using unique names. Do not use the same name by modifying uppercase and lowercase characters. For example, CTCPrimaryNetworks and CtcPrimaryNetworks are not two different entries.
- The dynamic AS number prefix peer configuration overrides the individual AS number configuration that is inherited from a BGP template.
- If you configure a dynamic AS number for prefix peers in an AS confederation, BGP establishes sessions with only the AS numbers in the local confederation.
- BGP sessions that are created through a dynamic AS number prefix peer ignore any configured eBGP multihop time-to-live (TTL) value or a disabled check for directly connected peers.

- Configure a router ID for BGP to avoid automatic router ID changes and session flaps.
- Use the maximum-prefix configuration option per peer to restrict the number of routes that are received and system resources used.
- Configure the update source to establish a session with BGP/eBGP multihop sessions.
- Specify a BGP policy if you configure redistribution.
- Define the BGP router ID within a VRF.
- For IPv6 neighbors, Cisco recommends that you configure a router ID per VRF. If a VRF does not have any IPv4 interfaces, the IPv6 BGP neighbor will not come up because its router ID must be an IPv4 address. The numerically lowest loopback IPv4 address is elected to be the router ID. If a loopback address does not exist, the lowest IP address from the VRF interfaces is elected. If that does not exist, the BGP neighbor relationship is not established.
- If you decrease the keepalive and hold timer values, you might experience BGP session flaps.
- You can configure a minimum route advertisement interval (MRAI) between the sending of BGP routing updates by using the **advertisement-interval** command.
- Although the **show ip bgp** commands are available for verifying the BGP configuration, Cisco recommends that you use the **show bgp** commands instead.
- When you redistribute BGP to IGP, iBGP is redistributed as well. To override this behavior, you must insert an extra deny statement into the route map.
- Edge Services Gateway (ESG) route-inject into BGP is assigned weight 0.
- To enable BFD for iBGP single-hop peers, you must configure the **update-source** option on the physical interface.
- Beginning with Cisco NX-OS Release 9.3(3), BFD for BGP is supported for BGP IPv4 and IPv6 prefix peers.
- The following guidelines and limitations apply to the **remove-private-as** command:
    - It applies only to eBGP peers.
    - It applies only 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.
    - It can be configured only in neighbor configuration mode and not in neighbor-address-family mode.
    - If the AS-path includes both private and public AS numbers, the private AS numbers are not removed.
    - If the AS-path contains the AS number of the eBGP neighbor, the private AS numbers are not removed.
    - Private AS numbers are removed only if all AS numbers in that AS-path belong to a private AS number range. Private AS numbers are not removed if a peer's AS number or a non-private AS number is found in the AS-path segment.
- In case the AS-Path is missing from the matching route for the next-hop in the BGP table or there is no matching route for the nexthop in the BGP table then the AS number is not printed in the traceroute output along with the next hop.

- If you use the **aggregate-address** command to configure aggregate addresses and the **suppress-fib-pending** command to suppress BGP routes, lossless traffic for aggregates cannot be ensured on BGP or system triggers.
- When you enable FIB suppression on the switch and route programming fails in the hardware, BGP advertises routes that are not programmed locally in the hardware.
- If you disable a command in the neighbor, template peer, template peer-session, or template peer-policy configuration mode (and the **inherit peer** or **inherit peer-session** command is present), you must use the **default** keyword to return the command to its default state. For example, to disable the **update-source loopback 0** command from the running configuration, you must enter the **default update-source loopback 0** command.
- When next-hop-self is configured for route-reflector clients, the route reflector advertises routes to its clients with itself as the next hop.
- The following guidelines and limitations apply to weighted ECMP:
  - Weighted ECMP is supported only for the IPv4 address family.
  - BGP uses the Link Bandwidth EXTCOMM defined in the draft-ietf-idr-link-bandwidth-06.txt to implement the weighted ECMP feature.
  - BGP accepts the Link Bandwidth EXTCOMM from both iBGP and eBGP peers.
- The following guidelines and limitations apply to BGP Interface Peering via IPv6 Link-Local for IPv4 and IPv6 Address Families:
  - This feature does not support having the same link-local address configured across multiple interfaces.
  - While configuring BGP interface peering using IP6 Link-Local static IPv6 address, ensure the subnet is matching with the peer for BGP to work.
  - This feature is not supported on logical interfaces (loopback). Only Ethernet interfaces, port-channel interfaces, subinterfaces, and breakout interfaces are supported.
  - Beginning with Cisco NX-OS Release 9.3(6), VLAN interfaces are supported.
  - This feature is supported only for IPv6-enabled interfaces with link-local addresses.
  - This feature is not supported when the configured prefix peer and interface have the same remote peer.
  - The following commands are not supported in neighbor interface configuration mode:
    - **disable-connected-check**
    - **maximum-peers**
    - **update-source**
    - **ebgp-multihop**
  - BFD multihop and the following commands are not supported for BGP Interface Peering via IPv6 Link-Local for IPv4 and IPv6 Address Families:
    - **bfd-multihop**
    - **bfd multihop interval**

        - **bfd multihop authentication**

    - BGP requires faster convergence time for route advertisements. To speed up detection of the Route Advertisement (RA) link-level protocol, enter the following commands on each IPv6-enabled interface that is using BGP Interface Peering via IPv6 Link-Local for IPv4 and IPv6 Address Families:

      ```
      interface Ethernet
                               port/slot

      ipv6 nd ra-interval 4 min 3
      ipv6 nd ra-lifetime 10
      ```

- Beginning with Cisco NX-OS Release 9.3(1)F, path type is introduced in the **rn** key to distinguish among the multiple entries with different path type while using REST API to see BGP routing table for IPv4 unicast routes. In the earlier releases, the output is displayed as single entry.
- Route-map deletion feature adds a mechanism to block the deletion of entire route-map that is associated with the BGP. With the route-map deletion blocked, the modifications to the route-map statement are still allowed.
- If there are more than one sequence in the route-map, user can still delete any route map sequence until there is at least one sequence available.
- Users can have the forward reference case for route-map from client. However, once route-map is created and associated, the deletion of route-map is blocked.
- Blocking deletion functionality is configurable dynamically using the knob.
- It is allowed to delete the BGP association to the route-map and deletion of route-map itself in a single transaction payload.
- It is allowed to add the BGP association to the route-map and an error must be thrown for deletion of route-map.
- The following is the list of the dual stage related behaviors:
    - If knob and deletion occur together, dual stage has to verify and throw an error without commit.
    - If knob already exists and route-map deletion occurs in dual stage, it must throw an error.
    - If route-map and CLI knob is single commit with different order, it must throw an error.
    - If knob is not enabled and route-map deletion occurs in dual stage, it has to execute successfully.
    - In a single verify, if "cli knob is disabled AND route-map deletion" is executed, the route-map deletion is allowed.
- If the route-map used by BGP template is not inherited by any of the BGP neighbors, the enitre route-map deletion will still be blocked.
- There are few commands under vrf context that are owned by BGP, but are not part of bgpInst.
- As the VPN address family (L3VPN and EVPN) is not supported, the routes received from confederate peers are not advertised in the VPN address family.
- Cloudscale IPv6 link-local BGP support requires carving > 512 ing-sup TCAM region (this requires a reload to take effect).

- As the VPN address family (L3VPN and EVPN) is not supported, the routes received from confederate peers are not advertised in the VPN address family.
- Beginning with Cisco NX-OS Release 10.3(1)F, BGP is supported on the Cisco Nexus 9808 switches.
- Beginning with Cisco NX-OS Release 10.4(1)F, BGP is supported on the Cisco Nexus 9804 switches.
- Beginning with Cisco NX-OS Release 10.3(1)F, VXLAN EVPN is supported only as transit on Cisco Nexus 9808 switches.
- Beginning with Cisco NX-OS Release 10.4(1)F, VXLAN EVPN is supported only as transit on Cisco Nexus 9804 switches.
- Encryption decrypt type6 is not supported for BGP passwords and keychain.
- Beginning with Cisco NX-OS Release 10.4(1)F, BGP is supported on Cisco Nexus X98900CD-A and X9836DM-A line cards with 9808 and 9804 switches.
- Beginning with Cisco NX-OS Release 10.6(1)F, BGP is supported on Cisco Nexus N9336C-SE1 platform switches.
- Beginning with Cisco NX-OS Release 10.6(1)F, ECMP is supported on Cisco Nexus N9336C-SE1 platform switches.

Default Settings

Table 3: Default BGP Parameters

Parameters	Default
BGP feature	Disabled
Keep alive interval	60 seconds
Hold timer	180 seconds
BGP PIC edge	Disabled
Auto-summary	Always disabled
Synchronization	Always disabled

Configuring Basic BGP

CLI Configuration Modes

The following sections describe how to enter each of the CLI configuration modes for BGP. From a mode, you can enter the **?** command to display the commands available in that mode.

Global Configuration Mode

Use global configuration mode to create a BGP process and configure advanced features such as AS confederation and route dampening. For more information, see *Configuring Advance BGP*.

This example shows how to enter router configuration mode:

```
switch# configuration
switch(config)# router bgp 64496
switch(config-router)#
```

BGP supports VRF. You can configure BGP within the appropriate VRF if you are using VRFs in your network. See the Configuring Virtualization section for more information.

This example shows how to enter VRF configuration mode:

```
switch(config)# router bgp 64497
switch(config-router)# vrf vrf_A
switch(config-router-vrf)#
```

Address Family Configuration Mode

You can optionally configure the address families that BGP supports. Use the address-family command in router configuration mode to configure features for an address family. Use the address-family command in neighbor configuration mode to configure the specific address family for the neighbor.

You must configure the address families if you are using route redistribution, address aggregation, load balancing, and other advanced features.

The following example shows how to enter address family configuration mode from the router configuration mode:

```
switch(config)# router bgp 64496
switch(config-router)# address-family ipv6 unicast
switch(config-router-af)#
```

The following example shows how to enter VRF address family configuration mode if you are using VRFs:

```
switch(config)# router bgp 64497
switch(config-router)# vrf vrf_A
switch(config-router-vrf)# address-family ipv6 unicast
switch(config-router-vrf-af)#
```

Neighbor Configuration Mode

Cisco NX-OS provides the neighbor configuration mode to configure BGP peers. You can use neighbor configuration mode to configure all parameters for a peer.

The following example shows how to enter neighbor configuration mode:

```
switch(config)# router bgp 64496
switch(config-router)# neighbor 192.0.2.1
switch(config-router-neighbor)#
```

The following example shows how to enter VRF neighbor configuration mode:

```
switch(config)# router bgp 64497
switch(config-router)# vrf vrf_A
switch(config-router-vrf)# neighbor 192.0.2.1
switch(config-router-vrf-neighbor)#
```

Neighbor Address Family Configuration Mode

An address family configuration submode inside the neighbor configuration submode is available for entering address family-specific neighbor configuration and enabling the address family for the neighbor. Use this mode for advanced features such as limiting the number of prefixes allowed for this neighbor and removing private AS numbers for eBGP.

With the introduction of RFC 5549, you can configure an IPv4 address family for a neighbor with an IPv6 address.

This example shows how to enter the IPv4 neighbor address family configuration mode for a neighbor with an IPv4 address:

```
switch(config)# router bgp 64496
switch(config-router# neighbor 192.0.2.1
switch(config-router-neighbor)# address-family ipv4 unicast
switch(config-router-neighbor-af)#
```

This example shows how to enter the IPv4 neighbor address family configuration mode for a neighbor with an IPv6 address:

```
switch(config)# router bgp 64496
switch(config-router# neighbor 2001:db8::/64 eui64
switch(config-router-neighbor)# address-family ipv4 unicast
switch(config-router-neighbor-af)#
```

This example shows how to enter the VRF IPv4 neighbor address family configuration mode or a neighbor with an IPv4 address:

```
switch(config)# router bgp 64497
switch(config-router)# vrf vrf_A
switch(config-router-vrf)# neighbor 209.165.201.1
switch(config-router-vrf-neighbor)# address-family ipv4 unicast
switch(config-router-vrf-neighbor-af)#
```

This example shows how to enter the VRF IPv4 neighbor address family configuration mode for a neighbor with an IPv6 address:

```
switch(config)# router bgp 64497
switch(config-router)# vrf vrf_A
switch(config-router-vrf)# neighbor 2001:db8::/64 eui64
switch(config-router-vrf-neighbor)# address-family ipv4 unicast
switch(config-router-vrf-neighbor-af)#
```

Configuring Basic BGP

To configure a basic BGP, you must enable BGP and configure a BGP peer. Configuring a basic BGP network consists of a few required tasks and many optional tasks. You must configure a BGP routing process and BGP peers.

Note If you are familiar with the Cisco IOS CLI, be aware that the Cisco NX-OS commands for this feature might differ from the Cisco IOS commands that you would use.

Enabling BGP

You must enable BGP before you can configure BGP.

SUMMARY STEPS

1. **configure terminal**
2. **[no] feature bgp**
3. (Optional) **show feature**
4. (Optional) **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters configuration mode.

Step 2	**[no] feature bgp** **Example:** `switch(config)# feature bgp`	Enables BGP. Use the **no** form of this command to disable this feature.
Step 3	(Optional) **show feature** **Example:** `switch(config)# show feature`	Displays enabled and disabled features.
Step 4	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Saves this configuration change.

Create a BGP Instance

You can create a BGP instance and assign a router ID to the BGP instance. For more information, see *BGP Router Identifier* section.

Before you begin

- You must enable BGP (see the Enabling BGP section).
- BGP must be able to obtain a router ID (for example, a configured loopback address).

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:**	Enters configuration mode.

	Command or Action	Purpose

	`switch# configure terminal`
	`switch(config)#`	

Step 2	[**no**] **router bgp** {*autonomous-system-number* | *auto*}
	Example:
	`switch(config)# router bgp 64496`
	`switch(config-router)#`
		Enables BGP and assigns the AS number to the local BGP speaker. The AS number can be a 16-bit integer or a 32-bit integer in the form of a higher 16-bit decimal number and a lower 16-bit decimal number in xx.xx format.
		Auto option generates 4-Byte Private Autonomous System Number automatically based on system MAC address.
		Use the **no** option with this command to remove the BGP process and the associated configuration.

Step 3	**router-id** {*ip-address* | *auto*}
	Example:
	`switch(config-router)# router-id 192.0.2.255`
		(Optional) Configures the BGP router ID. This IP address identifies this BGP speaker.
		"auto" option will enable the BGP router ID based on system MAC address.

Step 4	(Optional) **address-family** {**ipv4**|**ipv6**} {**unicast**|**multicast**}
	Example:
	`switch(config-router)# address-family ipv4 unicast`
	`switch(config-router-af)#`
		Enters global address family configuration mode for the IPv4 or IPv6 address family.

Step 5	(Optional) **network** {*ip-address/length* | *ip-address* **mask** *mask*} [**route-map** *map-name*]
	Example:
	`switch(config-router-af)# network 10.10.10.0/24`
	Example:
	`switch(config-router-af)# network 10.10.10.0 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 6	(Optional) **show bgp all** **Example:** `switch(config-router-af)# show bgp all`	Displays information about all BGP address families.
Step 7	(Optional) **copy running-config startup-config** **Example:** `switch(config-router-af)# copy running-config startup-config`	Saves this configuration change.

Example

This example shows how to enable BGP with the IPv4 unicast address family and manually add one network to advertise:

```
switch# configure terminal
switch(config)# router bgp 64496
switch(config-router)# address-family ipv4 unicast
switch(config-router-af)# network 192.0.2.0
switch(config-router-af)# copy running-config startup-config
```

Restarting a BGP Instance

You can restart a BGP instance and clear all peer sessions for the instance.

To restart a BGP instance and remove all associated peers, use the following command:

SUMMARY STEPS

1. **restart bgp***instance-tag*

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**restart bgp***instance-tag* **Example:** `switch(config)# restart bgp 201`	Restarts the BGP instance and resets or reestablishes all peering sessions.

Shutting Down BGP

You can shut down the BGP protocol and gracefully disable BGP while retaining the configuration.

To shut down BGP, use the following command in router configuration mode:

SUMMARY STEPS

1. **shutdown**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**shutdown** **Example:** `switch(config-router)# shutdown`	Restarts the BGP instance and resets or reestablishes all peering sessions.

Configuring BGP Peers

You can configure a BGP peer within a BGP process. Each BGP peer has an associated keepalive timer and hold timers. You can set these timers either globally or for each BGP peer. A peer configuration overrides a global configuration.

Note You must configure the address family under neighbor configuration mode for each peer.

Before you begin

- You must enable BGP (see the Enabling BGP section).

SUMMARY STEPS

1. **configure terminal**
2. **router bgp** *autonomous-system-number*
3. **neighbor** {*ip-address* | *ipv6-address*} **remote-as** {*as-number* | *external* | *internal*}
4. **remote-as** {*as-number* | *external* | *internal*}
5. (Optional) **description** *text*
6. (Optional) **timers***keepalive-time hold-time*
7. (Optional) **shutdown**
8. **address-family**{**ipv4**|**ipv6**} {**unicast**|**multicast**}
9. (Optional) **weight** *value*
10. (Optional) **show bgp** {**ipv4**|**ipv6**} {**unicast**|**multicast**} **neighbors**
11. (Optional) **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters configuration mode.

Step 2	**router bgp** *autonomous-system-number*
	
	Example:
	`switch(config)# router bgp 64496`
	`switch(config-router)#`
		Enables BGP and assigns the AS number to the local BGP speaker. The AS number can be a 16-bit integer or a 32-bit integer in the form of a higher 16-bit decimal number and a lower 16-bit decimal number in xx.xx format.

Step 3	**neighbor** {*ip-address* | *ipv6-address*} **remote-as** {*as-number* | *external* | *internal*} **Example:**	Configures the IPv4 or IPv6 address and AS number for a remote BGP peer. *The ip-address* format is x.x.x.x. The *ipv6-address* format is A:B::C:D.

	Command or Action	Purpose
	`switch(config-router)# neighbor 209.165.201.1 remote-as 64497 switch(config-router)# neighbor`	The external and internal options allow eBGP and iBGP sessions to be established without manually providing remote-as values.

Step 4	**remote-as** {*as-number* | *external* | *internal*}
	
	Example:
	`switch(config-router-neighbor)# remote-as 64497`
		Configures the AS number for a remote external BGP peer.
		
		The external and internal options allow eBGP and iBGP sessions to be established without manually providing remote-as values.

Step 5	(Optional) **description** *text* **Example:** `switch(config-router-neighbor)# description Peer Router B switch(config-router-neighbor)#`	Adds a description for the neighbor. The description is an alphanumeric string up to 80 characters.
Step 6	(Optional) **timers***keepalive-time hold-time* **Example:** `switch(config-router-neighbor)# timers 30 90`	Adds the keepalive and hold time BGP timer values for the neighbor. The range is from 0 to 3600 seconds. The default value of keepalive time is 60 seconds and hold time is 180 seconds. **Note** BGP sessions with a hold-timer of 10 seconds or less are not effective until the BGP session has been up for 60 seconds or more. Once the session has been up for 60 seconds, the hold-timer will work as configured.
Step 7	(Optional) **shutdown** **Example:** `switch(config-router-neighbor)# shutdown`	Administratively shuts down this BGP neighbor. This command triggers an automatic notification and session reset for the BGP neighbor sessions.

Step 8	**address-family**{**ipv4**|**ipv6**} {**unicast**|**multicast**}
	
	Example:
	`switch(config-router-neighbor)# address-family ipv4 unicast switch(config-router-neighbor-af)#`
		Enters neighbor address family configuration mode for the unicast IPv4 or IPv6 address family.

Step 9	(Optional) **weight** *value* **Example:** `switch(config-router-neighbor-af)# weight 100`	Sets the default weight for routes from this neighbor. The range is from 0 to 65535. All routes learned from this neighbor have the assigned weight initially. The route with the highest weight is chosen as the preferred route when multiple routes are available to a particular network. The weights assigned with the **set weight route-map** command override the weights assigned with this command. If you specify a BGP peer policy template, all the members of the template inherit the characteristics configured with this command.

	Command or Action	Purpose
Step 10	(Optional) **show bgp** {**ipv4**|**ipv6**} {**unicast**|**multicast**} **neighbors** **Example:** `switch(config-router-neighbor-af)# show bgp ipv4 unicast neighbors`	Displays information about BGP peers.
Step 11	(Optional) **copy running-config startup-config** **Example:** `switch(config-router-neighbor-af)# copy running-config startup-config`	Saves this configuration change.

Example

The following example shows how to configure a BGP peer:

```
switch# configure terminal
switch(config)# router bgp 64496
switch(config-router)# neighbor 192.0.2.1 remote-as 64497
switch(config-router-neighbor)# description Peer Router B
switch(config-router-neighbor)# address-family ipv4 unicast
switch(config-router-neighbor)# weight 100
switch(config-router-neighbor-af)# copy running-config startup-config
```

Configuring Dynamic AS Numbers for Prefix Peers

You can configure multiple BGP peers within a BGP process. You can limit BGP session establishment to a single AS number or multiple AS numbers in a route map.

BGP sessions configured through dynamic AS numbers for prefix peers ignore the **ebgp-multihop** command and the **disable-connected-check** command.

You can change the list of AS numbers in the route map, but you must use the no neighbor command to change the route-map name. Changes to the AS numbers in the configured route map affect only new sessions.

Before you begin

- You must enable BGP (see the Enabling BGP section).

SUMMARY STEPS

1. **configure terminal**
2. **router bgp** *autonomous-system-number*
3. **neighbor** *prefix* **remote-as route-map** *map-name*
4. **neighbor-as** *as-number*
5. (Optional) **show bgp** {**ipv4** | **ipv6**} {**unicast** | **multicast**} **neighbors**
6. (Optional) **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters configuration mode.

Step 2	**router bgp** *autonomous-system-number*
	Example:
	`switch(config)# router bgp 64496`
	`switch(config-router)#`
		Enables BGP and assigns the AS number to the local BGP speaker. The AS number can be a 16-bit integer or a 32-bit integer in the form of a higher 16-bit decimal number and a lower 16-bit decimal number in xx.xx format.

Step 3	**neighbor** *prefix* **remote-as route-map** *map-name*
	Example:
	`switch(config-router)# neighbor 192.0.2.0/8 remote-as routemap BGPPeers`
	`switch(config-router-neighbor)#`
		Configures the IPv4 or IPv6 prefix and a route map for the list of accepted AS numbers for the remote BGP peers. The *prefix* format for IPv4 is x.x.x.x/length. The length range is from 1 to 32. The *prefix* format for IPv6 is A:B::C:D/length. The length range is from 1 to 128.
		The *map-name* can be any case-sensitive, alphanumeric string up to 63 characters.

Step 4	**neighbor-as** *as-number* **Example:** `switch(config-router-neighbor)# remote-as 64497`	Configures the AS number for a remote BGP peer.
Step 5	(Optional) **show bgp** {**ipv4** | **ipv6**} {**unicast** | **multicast**} **neighbors** **Example:** `switch(config-router-neighbor-af)# show bgp ipv4 unicast neighbors`	Displays information about BGP peers.
Step 6	(Optional) **copy running-config startup-config** **Example:** `switch(config-router-neighbor-af)# copy running-config startup-config`	Saves this configuration change.

Example

This example shows how to configure dynamic AS numbers for a prefix peer:

```
switch# configure terminal
switch(config)# route-map BGPPeers
switch(config-route-map)# match as-number 64496, 64501-64510
switch(config-route-map)# match as-number as-path-list List1, List2
switch(config-route-map)# exit
switch(config)# router bgp 64496
switch(config-router)# neighbor 192.0.2.0/8 remote-as route-map BGPPeers
switch(config-router-neighbor)# description Peer Router B
switch(config-router-neighbor)# address-family ipv4 unicast
switch(config-router-af)# end
switch# copy running-config startup-config
```

See Configuring Route Policy Manager for information on route maps.

Configuring BGP PIC Edge

Follow these steps to configure BGP PIC edge.

Note The BGP PIC edge feature supports only IPv4 address families.

Before you begin

You must enable BGP (see the Enabling BGP section).

SUMMARY STEPS

1. **configure terminal**
2. **router bgp** *autonomous-system-number*
3. **address-family ipv4 unicast**
4. **[no] additional-paths install backup**
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters configuration mode.

Step 2	**router bgp** *autonomous-system-number*
	Example:
	`switch(config)# router bgp 64496`
	`switch(config-router)#`
		Enables BGP and assigns the AS number to the local BGP speaker. The AS number can be a 16-bit integer or a 32-bit integer in the form of a higher 16-bit decimal number and a lower 16-bit decimal number in xx.xx format.

Step 3	**address-family ipv4 unicast**
	Example:
	`switch(config-router)# address-family ipv4 unicast`
	`switch(config-router-af)#`
		Enters address family configuration mode for the IPv4 address family.

	Command or Action	Purpose
Step 4	**[no] additional-paths install backup** **Example:** `switch(config-router-af)# [no] additional-paths install backup`	Enables BGP to install the backup path to the routing table.

Step 5	(Optional) **copy running-config startup-config**
	Example:
	`switch(config-router-af)# end`
	`switch# copy running-config startup-config`
		Saves this configuration change.

Example

This example shows how to configure the device to support BGP PIC edge in an IPv4 network:

```
interface Ethernet2/2
 ip address 1.1.1.5/24
 no shutdown

interface Ethernet2/3
 ip address 2.2.2.5/24
 no shutdown

router bgp 100
 address-family ipv4 unicast
  additional-paths install backup
 neighbor 2.2.2.6
   remote-as 100
   address-family ipv4 unicast
```

If BGP receives the same prefix (for example, 99.0.0.0/24) from the two neighbors 1.1.1.6 and 2.2.2.6, both paths are installed in the URIB, one as the primary path and the other as the backup path.

BGP output:

```
switch(config)# show ip bgp 99.0.0.0/24
BGP routing table information for VRF default, address family IPv4 Unicast BGP routing table
 entry
for 99.0.0.0/24, version 4
Paths: (2 available, best #2)
Flags: (0x00001a) on xmit-list, is in urib, is best urib route

Path type: internal, path is valid, not best reason: Internal path, backup path AS-Path:
200 , path
sourced external to AS
2.2.2.6 (metric 0) from 2.2.2.6 (2.2.2.6)
Origin IGP, MED not set, localpref 100, weight 0

Advertised path-id 1
Path type: external, path is valid, is best path AS-Path: 200 , path sourced external to
AS
1.1.1.6 (metric 0) from 1.1.1.6 (99.0.0.1)
Origin IGP, MED not set, localpref 100, weight 0
```

```
Path-id 1 advertised to peers: 2.2.2.6
```

URIB output:

```
switch(config)# show ip route 99.0.0.0/24
IP Route Table for VRF "default" '*' denotes best ucast next-hop '**' denotes best mcast
next-hop
'[x/y]' denotes [preference/metric]
'%<string>' in via output denotes VRF <string>
99.0.0.0/24, ubest/mbest: 1/0
*via 1.1.1.6, [20/0], 14:34:51, bgp-100, external, tag 200
via 2.2.2.6, [200/0], 14:34:51, bgp-100, internal, tag 200 (backup)
```

UFIB output:

```
switch# show forwarding route 123.1.1.0 detail module 8
Prefix 123.1.1.0/24, No of paths: 1, Update time: Wed Jul 11 19:00:12 2018
Vobj id: 141   orig_as: 65002   peer_as: 65100  rnh: 10.3.0.2
10.4.0.2           Ethernet8/4         DMAC: 0018.bad8.4dfd
packets: 2  bytes: 3484   Repair path  10.3.0.2   Ethernet8/3 DMAC: 0018.bad8.4dfd packets:
 0
bytes: 1
```

Configuring BGP PIC Core

Follow these steps to configure BGP PIC Core.

SUMMARY STEPS

1. **configure terminal**
2. **[no] system pic-core**
3. **copy running-config startup-config**
4. **reload**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `switch# configure terminal`	Enter global configuration mode.
Step 2	**[no] system pic-core** **Example:** `switch(config)# system pic-core`	Manage PIC enable.
Step 3	**copy running-config startup-config** **Example:**	Saves this configuration change.

	Command or Action	Purpose
	`switch(config)# copy running-config startup-config`	
Step 4	**reload** **Example:** `switch(config)# reload`	Reboots the entire device.

Clearing BGP Information

To clear BGP information, use the following commands:

Command	Purpose
clear bgp all {*neighbor* | * | *as-number* | **peer-template** *name* | *prefix*} [**vrf** *vrf-name*]	Clears one or more neighbors from all address families. * clears all neighbors in all address families. The arguments are as follows: • *neighbor*—IPv4 or IPv6 address of a neighbor. • *as-number*— Autonomous system number. The AS number can be a 16-bit integer or a 32-bit integer in the form of higher 16-bit decimal number and a lower 16-bit decimal number in xx.xx format. • *name*—Peer template name. The name can be any case-sensitive, alphanumeric string up to 64 characters. • *prefix*—IPv4 or IPv6 prefix. All neighbors within that prefix are cleared. • *vrf-name*—VRF name. All neighbors in that VRF are cleared. The name can be any case-sensitive, alphanumeric string up to 64 characters.
clear bgp all dampening [**vrf** *vrf-name*]	Clears route flap dampening networks in all address families. The *vrf-name* can be any case-sensitive, alphanumeric string up to 64 characters.
clear bgp all flap-statistics [**vrf** *vrf-name*]	Clears route flap statistics in all address families. The *vrf-name* can be any case-sensitive, alphanumeric string up to 64 characters.
clear bgp {**ipv4** | **ipv6**} {**unicast** | **multicast**} **dampening** [**vrf** *vrf-name*]	Clears route flap dampening networks in the selected address family. The*vrf-name* can be any case-sensitive, alphanumeric string up to 64 characters.
clear bgp {**ipv4** | **ipv6**} {**unicast** | **multicast**} **flap-statistics** [**vrf** *vrf-name*]	Clears route flap statistics in the selected address family. The *vrf-name* can be any case-sensitive, alphanumeric string up to 64 characters.

Command	Purpose
clear bgp {**ipv4** | **ipv6** } {*neighbor* |* | *as-number* | **peer-template** *name* | *prefix*} [**vrf** *vrf-name*]	Clears one or more neighbors from the selected address family. * clears all neighbors in the address family. The arguments are as follows: • *neighbor*—IPv4 or IPv6 address of a neighbor. • *as-number*— Autonomous system number. The AS number can be a 16-bit integer or a 32-bit integer in the form of higher 16-bit decimal number and a lower 16-bit decimal number in xx.xx format. • *name*—Peer template name. The name can be any case-sensitive, alphanumeric string up to 64 characters. • *prefix*—IPv4 or IPv6 prefix. All neighbors within that prefix are cleared. • *vrf-name*—VRF name. All neighbors in that VRF are cleared. The name can be any case-sensitive, alphanumeric string up to 64 characters.
clear bgp {**ip** {**unicast** | **multicast**}} {*neighbor* |* |*as-number* | **peer-template** *name* | *prefix*} [**vrf** *vrf-name*]	Clears one or more neighbors. * clears all neighbors in the address family. The arguments are as follows: • *neighbor*—IPv4 or IPv6 address of a neighbor. • *as-number*— Autonomous system number. The AS number can be a 16-bit integer or a 32-bit integer in the form of higher 16-bit decimal number and a lower 16-bit decimal number in xx.xx format. • *name*—Peer template name. The name can be any case-sensitive, alphanumeric string up to 64 characters. • *prefix*—IPv4 or IPv6 prefix. All neighbors within that prefix are cleared. • *vrf-name*—VRF name. All neighbors in that VRF are cleared. The name can be any case-sensitive, alphanumeric string up to 64 characters.

Command	Purpose
clear bgp dampening [*ip-neighbor* | *ip-prefix*] [**vrf** *vrf-name*]	Clears route flap dampening in one or more networks. The arguments are as follows: • *ip-neighbor*—IPv4 address of a neighbor. • *ip-prefix*—IPv4. All neighbors within that prefix are cleared. • *vrf-name*—VRF name. All neighbors in that VRF are cleared. The name can be any case-sensitive, alphanumeric string up to 64 characters.
clear bgp flap-statistics [*ip-neighbor* | *ip-prefix*] [**vrf** *vrf-name*]	Clears route flap statistics in one or more networks. The arguments are as follows: • *ip-neighbor*—IPv4 address of a neighbor. • *ip-prefix*—IPv4. All neighbors within that prefix are cleared. • *vrf-name*—VRF name. All neighbors in that VRF are cleared. The name can be any case-sensitive, alphanumeric string up to 64 characters.
clear ip mbgp {**ip** {**unicast** | **multicast**}} {*neighbor* | * | *as-number* | **peer-template** *name* | *prefix*} [**vrf** *vrf-name*]	Clears one or more neighbors. * clears all neighbors in the address family. The arguments are as follows: • *neighbor*—IPv4 or IPv6 address of a neighbor. • *as-number*— Autonomous system number. The AS number can be a 16-bit integer or a 32-bit integer in the form of higher 16-bit decimal number and a lower 16-bit decimal number in xx.xx format. • *name*—Peer template name. The name can be any case-sensitive, alphanumeric string up to 64 characters. • *prefix*—IPv4 or IPv6 prefix. All neighbors within that prefix are cleared. • *vrf-name*—VRF name. All neighbors in that VRF are cleared. The name can be any case-sensitive, alphanumeric string up to 64 characters.

Command	Purpose
clear ip mbgp dampening [*ip-neighbor* | *ip-prefix*] [**vrf** *vrf-name*]	Clears route flap dampening in one or more networks. The arguments are as follows: • *ip-neighbor*—IPv4 address of a neighbor. • *ip-prefix*—IPv4. All neighbors within that prefix are cleared. • *vrf-name*—VRF name. All neighbors in that VRF are cleared. The name can be any case-sensitive, alphanumeric string up to 64 characters.
clear ip mbgp flap-statistics [*ip-neighbor* | *ip-prefix*] [**vrf** *vrf-name*]	Clears route flap statistics in one or more networks. The arguments are as follows: • *ip-neighbo*r—IPv4 address of a neighbor. • *ip-prefix*—IPv4. All neighbors within that prefix are cleared. • *vrf-name*—VRF name. All neighbors in that VRF are cleared. The name can be any case-sensitive, alphanumeric string up to 64 characters.

Verifying the Basic BGP Configuration

To display the BGP configuration, perform one of the following tasks:

Command	Purpose
show bgp all [summary] [**vrf** *vrf-name*]	Displays the BGP information for all address families.
show bgp convergence [**vrf** *vrf-name*]	Displays the BGP information for all address families.
show bgp {**ipv4** | **ipv6**} {**unicast** | **multicast**} [*ip-address* | *ipv6-prefix* **community** [**regexp** *expression* | [**community**] [**no-advertise**] [**no-export**] [**no-export-subconfed**]} [**vrf** *vrf-name*]	Displays the BGP routes that match a BGP community.
show bgp [**vrf** *vrf-name*] {**ipv4** | **ipv6**} {**unicast** | **multicast**} [*ip-address* | *ipv6-prefix*] **community-list** *list-name* [**vrf** *vrf-name*]	Displays the BGP routes that match a BGP community list.
show bgp {**ipv4** | **ipv6**} {**unicast** | **multicast**} [*ip-address* | *ipv6-prefix* **extcommunity** [**regexp** *expression* | [**generic** [**non-transitive** | **transitive**] *aa4:nn* [**exact-match**]} [**vrf** *vrf-name*]	Displays the BGP routes that match a BGP extended community.
show bgp {**ipv4** | **ipv6**} {**unicast** | **multicast**} [*ip-address* | *ipv6-prefix* **extcommunity-list** *list-name* [**exact-match**]} [**vrf** *vrf-name*]	Displays the BGP routes that match a BGP extended community list.

Command	Purpose
show bgp {**ipv4** | **ipv6**} {**unicast** | **multicast**} [*ip-address* | *ipv6-prefix* {**dampening dampened-paths** [**regexp** *expression*]} [**vrf** *vrf-name*]	Displays the information for BGP route dampening. Use the **clear bgp dampening** command to clear the route flap dampening information.
show bgp {**ipv4** | **ipv6**} {**unicast** | **multicast**} [*ip-address* | *ipv6-prefix* **history-paths** [**regexp** *expression*] [**vrf** *vrf-name*]	Displays the BGP route history paths.
show bgp {**ipv4** | **ipv6**} {**unicast** | **multicast**} [*ip-address* | *ipv6-prefix* **filter-list** *list-name* [**vrf** *vrf-name*]	Displays the information for the BGP filter list.
show bgp {**ipv4** | **ipv6**} {**unicast** | **multicast**} [*ip-address* | *ipv6-prefix*] **neighbors** [*ip-address* | *ipv6-prefix*] [**vrf** *vrf-name*]	Displays the information for BGP peers. Use the **clear bgp neighbors** command to clear these neighbors.
show bgp {**ipv4** | **ipv6**} **unicast neighbors** [*ip-address* | *ipv6-prefix*] { [**advertised-routes** |**received-routes**] } [**detail**] [**vrf** *vrf-name*] **show bgp** {**ipv4** | **ipv6**} **unicast neighbors** [*ip-address* | *ipv6-prefix*] [**routes**] { [**advertised** |**received**] } [**detail**] [**vrf** *vrf-name*]	Displays the detailed information of all routes: • received from the peer before evaluating inbound route map. • advertised to the peer before updating attributes by outbound route map.
show bgp {**ipv4** | **ipv6**} **unicast neighbors** [*ip-address* | *ipv6-prefix*] [**routes**] [**detail**] [**vrf** *vrf-name*]	Displays the detailed information of all routes received from this peer after evaluating inbound route map.
show bgp {**ipv4** | **ipv6**} **unicast neighbors** [*ip-address* | *ipv6-prefix*] [**advertised-routes processed**] [**vrf** *vrf-name*]	Displays brief information of all routes advertised to the peer after updating path attributes by outbound route map with **processed** option.
show bgp {**ipv4** | **ipv6**} **unicastneighbors** [*ip-address* | *ipv6-prefix*] [**advertised-routes processed**] [**detail**] [**vrf** *vrf-name*]	Displays detailed information of all routes advertised to the peer after updating path attributes by outbound route map with **processed** option.
show bgp {**ipv4** | **ipv6**} {**unicast** | **multicast**} [*ip-address* | *ipv6-prefix*] **neighbors** [*ip-address* | *ipv6-prefix*] {**nexthop** | **nexthop-database**} [**vrf** *vrf-name*]	Displays the information for the BGP route next hop.
show bgp paths	Displays the BGP path information.
show bgp {**ipv4** | **ipv6**} {**unicast** | **multicast**} [*ip-address* | *ipv6-prefix*] **policy** *name* [**vrf** *vrf-name*]	Displays the BGP policy information. Use the **clear bgp polic**y command to clear the policy information.
show bgp {**ipv4** | **ipv6**} {**unicast** | **multicast**} [*ip-address* | *ipv6-prefix*] **prefix-list** *list-name* [**vrf** *vrf-name*]	Displays the BGP routes that match the prefix list.

Command	Purpose
show bgp {**ipv4** | **ipv6**} {**unicast** | **multicast**} [*ip-address* | *ipv6-prefix*] **received-paths** [**vrf** *vrf-name*]	Displays the BGP paths stored for soft reconfiguration.
show bgp {**ipv4** | **ipv6**} {**unicast** | **multicast**} [*ip-address* | *ipv6-prefix*] **regexp** *expression* [**vrf** *vrf-name*]	Displays the BGP routes that match the AS_path regular expression.
show bgp {**ipv4** | **ipv6**} {**unicast** | **multicast**} [*ip-address* | *ipv6-prefix*] **route-map** *map-name* [**vrf** *vrf-name*]	Displays the BGP routes that match the route map.
show bgp peer-policy *name* [**vrf** *vrf-name*]	Displays the information about BGP peer policies.
show bgp peer-session *name* [**vrf** *vrf-name*] show bgp peer-session	Displays the information about BGP peer sessions.
show bgp peer-template *name* [**vrf** *vrf-name*]	Displays the information about BGP peer templates. Use the **clear bgp peer-template** command to clear all neighbors in a peer template.
show bgp process	Displays the BGP process information.
show {**ipv** | **ipv6**} **bgp** [*options*]	Displays the BGP status and configuration information.
show {**ipv** | **ipv6**} **mbgp** [*options*]	Displays the BGP status and configuration information.
show running-configuration bgp	Displays the current running BGP configuration.

Monitoring BGP Statistics

To display BGP statistics, use the following commands:

Command	Purpose
show bgp {**ipv4** | **ipv6**} {**unicast** | **multicast**} [*ip-address* | *ipv6-prefix*] **flap-statistics** [**vrf** *vrf-name*]	Displays the BGP route flap statistics. Use the **clear bgp flap-statistics command** to clear these statistics.
show bgp sessions [**vrf** *vrf-name*]	Displays the BGP sessions for all peers. Use the **clear bgp sessions** command to clear these statistics.
show bgp statistics	Displays the BGP statistics.

Configuration Examples for Basic BGP

This example shows a basic BGP configuration:

```
switch(config)# feature bgp
switch(config)# router bgp 64496
switch(config-router)# neighbor 2001:ODB8:0:1::55 remote-as 64496
switch(config-router)# address-family ipv6 unicast
switch(config-router-af)# next-hop-self
```

Related Topics

The following topics relate to BGP:

- *Configuring Advance BGP*
- *Configuring Route Policy Manager*

Where to Go Next

See *Configuring Advance BGP*, for details on the following features:

- Peer templates
- Route redistribution
- Route maps

Additional References

For additional information related to implementing BGP, see the following sections:

MIBs for Basic BGP

MIBs	MIBs Link
MIBs related to BGP	To locate and download MIBs, go to the following URL: ftp://ftp.cisco.com/pub/mibs/supportlists/nexus9000/Nexus9000MIBSupportList.html

Configuring Advance BGP

About Advanced BGP

BGP is an interdomain routing protocol that provides loop-free routing between organizations or autonomous systems. Cisco NX-OS supports BGP version 4. BGP version 4 includes multiprotocol extensions that allow BGP to carry routing information for IP multicast routes and multiple Layer 3 protocol address families. BGP uses TCP as a reliable transport protocol to create TCP sessions with other BGP-enabled devices called BGP peers. When connecting to an external organization, the router creates external BGP (eBGP) peering sessions. BGP peers within the same organization exchange routing information through internal BGP (iBGP) peering sessions.

Beginning with Cisco NX-OS Release 10.5(1)F, Configuring Basic BGP and Configuring Advanced BGP chapters are merged to create Configuring BGP chapter.

Peer Templates

BGP peer templates allow you to create blocks of common configuration that you can reuse across similar BGP peers. Each block allows you to define a set of attributes that a peer then inherits. You can choose to override some of the inherited attributes as well, making it a very flexible scheme for simplifying the repetitive nature of BGP configurations.

Cisco NX-OS implements three types of peer templates:

- The peer-session template defines BGP peer session attributes, such as the transport details, remote autonomous system number of the peer, and session timers. A peer-session template can also inherit attributes from another peer-session template (with locally defined attributes that override the attributes from an inherited peer-session).
- A peer-policy template defines the address-family dependent policy aspects for a peer including the inbound and outbound policy, filter-lists, and prefix-lists. A peer-policy template can inherit from a set of peer-policy templates. Cisco NX-OS evaluates these peer-policy templates in the order specified by the preference value in the inherit configuration. The lowest number is preferred over higher numbers.
- The peer template can inherit the peer-session and peer-policy templates to allow for simplified peer definitions. It is not mandatory to use a peer template but it can simplify the BGP configuration by providing reusable blocks of configuration.

Authentication

You can configure authentication for a BGP neighbor session. This authentication method adds an MD5 authentication digest to each TCP segment sent to the neighbor to protect BGP against unauthorized messages and TCP security attacks.

Note The MD5 password must be identical between BGP peers.

Route Policies and Resetting BGP Sessions

You can associate a route policy to a BGP peer. Route policies use route maps to control or modify the routes that BGP recognizes. You can configure a route policy for inbound or outbound route updates. The route policies can match on different criteria, such as a prefix or AS_path attribute, and selectively accept or deny the routes. Route policies can also modify the path attributes.

When you change a route policy applied to a BGP peer, you must reset the BGP sessions for that peer. Cisco NX-OS 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. This option interrupts packet flow through the BGP network. Hard reset is disabled by default.
- Soft reconfiguration inbound—A soft reconfiguration inbound triggers routing updates for the specified peer without resetting the session. You can use this option if you change an inbound route policy. Soft reconfiguration inbound saves a copy of all routes received from the peer before processing the routes through the inbound route policy. If you change the inbound route policy, Cisco NX-OS passes these stored routes through the modified inbound route policy to update the route table without tearing down existing peering sessions. Soft reconfiguration inbound can use significant memory resources to store the unfiltered BGP routes. Soft reconfiguration inbound is disabled by default.

- Route Refresh—A route refresh updates the inbound routing tables dynamically by sending route refresh requests to supporting peers when you change an inbound route policy. The remote BGP peer responds with a new copy of its routes that the local BGP speaker processes with the modified route policy. Cisco NX-OS automatically sends an outbound route refresh of prefixes to the peer.
- BGP peers advertise the route refresh capability as part of the BGP capability negotiation when establishing the BGP peer session. Route refresh is the preferred option and enabled by default.

Note BGP also uses route maps for route redistribution, route aggregation, route dampening, and other features. See Configuring Route Policy Manager, for more information on route maps.

eBGP

External BGP (eBGP) allows you to connect BGP peers from different autonomous systems to exchange routing updates. Connecting to external networks enables traffic from your network to be forwarded to other networks and across the Internet.

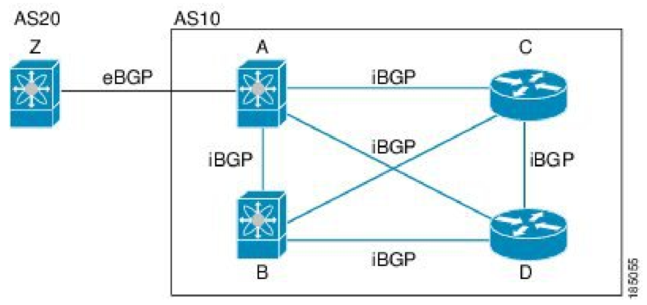
Typically eBGP peerings need to be over directly connected interfaces so that convergence will be faster when the interface goes down.

iBGP

Internal BGP (iBGP) allows you to connect BGP peers within the same autonomous system. You can use iBGP for multihomed BGP networks (networks that have more than one connection to the same external autonomous system).

The figure shows an iBGP network within a larger BGP network.

Figure 3: iBGP Network



iBGP networks are fully meshed. Each iBGP peer has a direct connection to all other iBGP peers to prevent network loops.

For single-hop iBGP peers with update-source configured under neighbor configuration mode, the peer supports fast external fall-over.

You should use loopback interfaces for establishing iBGP peering sessions because loopback interfaces are less susceptible to interface flapping. An interface flap occurs when the interface is administratively brought up or down because of a failure or maintenance issue. See the Configuring eBGP, on page 83 section for information on multihop, fast external fallovers, and limiting the size of the AS_path attribute.

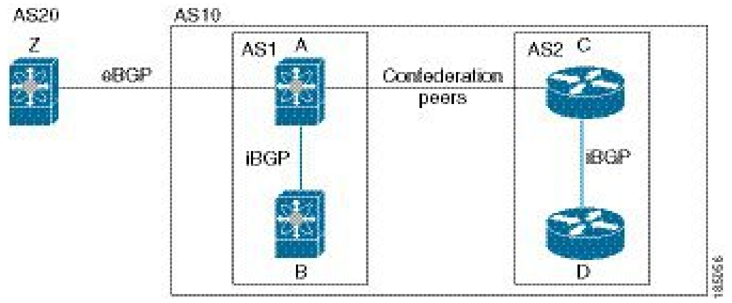
Note You should configure a separate interior gateway protocol in the iBGP network.

AS Confederations

A fully meshed iBGP network becomes complex as the number of iBGP peers grows. You can reduce the iBGP mesh by dividing the autonomous system into multiple subautonomous systems and grouping them into a single confederation. A confederation is a group of iBGP peers that use the same autonomous system number to communicate to external networks. Each subautonomous system is fully meshed within itself and has a few connections to other subautonomous systems in the same confederation.

The figure shows the BGP network, split into two subautonomous systems and one confederation.

Figure 4: AS Confederation



In this example, AS10 is split into two subautonomous systems, AS1 and AS2. Each subautonomous system is fully meshed, but there is only one link between the subautonomous systems. By using AS confederations, you can reduce the number of links compared to the fully meshed autonomous system.

Route Reflector

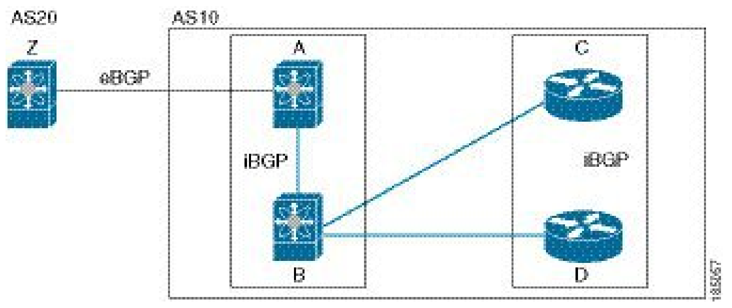
You can alternately reduce the iBGP mesh by using a route reflector configuration where route reflectors pass learned routes to neighbors so that all iBGP peers do not need to be fully meshed.

When you configure an iBGP peer to be a route reflector, it becomes responsible for passing iBGP learned routes to a set of iBGP neighbors.

The figure shows a simple iBGP configuration with four meshed iBGP speakers (routers A, B, C, and D). Without route reflectors, when router A receives a route from an external neighbor, it advertises the route to all three iBGP neighbors.

In the figure, router B is the route reflector. When the route reflector receives routes advertised from router A, it advertises (reflects) the routes to routers C and D. Router A no longer has to advertise to both routers C and D.

Figure 5: Route Reflector



The route reflector and its client peers form a cluster. You do not have to configure all iBGP peers to act as client peers of the route reflector. You must configure any nonclient peer as fully meshed to guarantee that complete BGP updates reach all peers.

Capabilities Negotiation

A BGP speaker can learn about BGP extensions that are supported by a peer by using the capabilities negotiation feature. Capabilities negotiation allows BGP to use only the set of features supported by both BGP peers on a link.

If a BGP peer does not support capabilities negotiation, Cisco NX-OS attempts a new session to the peer without capabilities negotiation if you have configured the address family as IPv4. Any other multiprotocol configuration (such as IPv6) requires capabilities negotiation.

Route Dampening

Route dampening is a BGP feature that minimizes the propagation of flapping routes across an internetwork. A route flaps when it alternates between the available and unavailable states in rapid succession.

For example, consider a network with three BGP autonomous systems: AS1, AS2, and AS3. Suppose that a route in AS1 flaps (it becomes unavailable). Without route dampening, AS1 sends a withdraw message to AS2. AS2 propagates the withdrawal message to AS3. When the flapping route reappears, AS1 sends an advertisement message to AS2, which sends the advertisement to AS3. If the route repeatedly becomes unavailable, and then available, AS1 sends many withdrawal and advertisement messages that propagate through the other autonomous systems.

Route dampening can minimize flapping. Suppose that the route flaps. AS2 (in which route dampening is enabled) assigns the route a penalty of 1000. AS2 continues to advertise the status of the route to neighbors. Each time that the route flaps, AS2 adds to the penalty value. When the route flaps so often that the penalty exceeds a configurable suppression limit, AS2 stops advertising the route, regardless of how many times that it flaps. The route is now dampened.

The penalty placed on the route decays until the reuse limit is reached. At that time, AS2 advertises the route again. When the reuse limit is at 50 percent, AS2 removes the dampening information for the route.

Note The router does not apply a penalty to a resetting BGP peer when route dampening is enabled, even though the peer reset withdraws the route.

Load Sharing and Multipath

BGP can install multiple equal-cost eBGP or iBGP paths into the routing table to reach the same destination prefix. Traffic to the destination prefix is then shared across all the installed paths.

To configure as-path multipath-relax command effectively, configure the command per VRF under BGP. Also, configure as-path multipath-relax command under the custom VRF so that multiple routers get installed in the custom VRF Route-Target (RT).

The BGP best-path algorithm considers the paths as equal-cost paths if the following attributes are identical:

- Weight
- Local preference
- AS_path
- Origin code
- Multi-exit discriminator (MED)
- IGP cost to the BGP next hop

BGP selects only one of these multiple paths as the best path and advertises the path to the BGP peers. For more information, see the BGP Additional Paths section.

Note Paths that are received from different AS confederations are considered as equal-cost paths if the external AS_path values and the other attributes are identical.

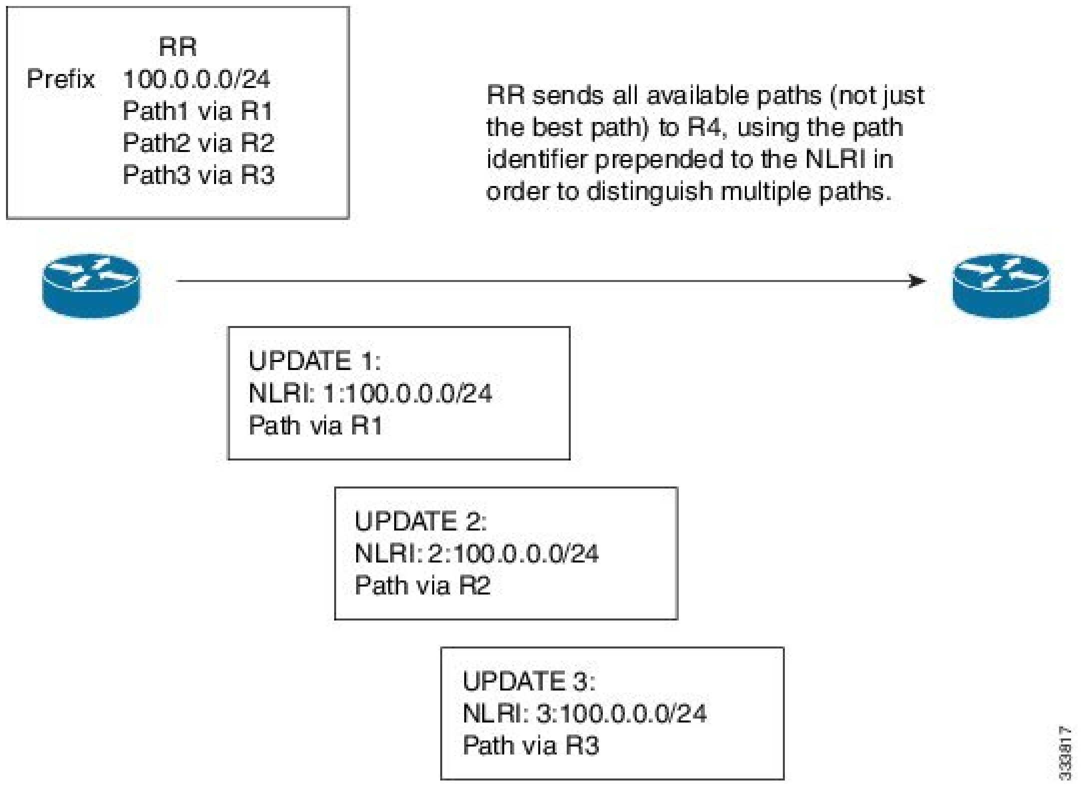
Note When you configure a route reflector for iBGP multipath, and the route reflector advertises the selected best path to its peers, the next hop for the path is not modified.

BGP Additional Paths

Only one BGP best path is advertised, and the BGP speaker accepts only one path for a given prefix from a given peer. If a BGP speaker receives multiple paths for the same prefix within the same session, it uses the most recent advertisement.

BGP supports the additional paths feature, which allows the BGP speaker to propagate and accept multiple paths for the same prefix without the new paths replacing any previous ones. This feature allows BGP speaker peers to negotiate whether they support advertising and receiving multiple paths per prefix and advertising such paths. A special 4-byte path ID is added to the network layer reachability information (NLRI) to differentiate multiple paths for the same prefix sent across a peer session. The following figure illustrates the BGP additional paths capability.

Figure 6: BGP Route Advertisement with the Additional Paths Capability



For information on configuring BGP additional paths, see the Configuring BGP Additional Paths, on page 79section.

Route Aggregation

You can configure aggregate addresses. Route aggregation simplifies route tables by replacing a number of more specific addresses with an address that represents all the specific addresses. For example, you can replace these three more specific addresses, 10.1.1.0/24, 10.1.2.0/24, and 10.1.3.0/24 with one aggregate address, 10.1.0.0/16.

Aggregate prefixes are present in the BGP route table so that fewer routes are advertised.

Note Cisco NX-OS does not support automatic route aggregation.

Route aggregation can lead to forwarding loops. To avoid this problem, when BGP generates an advertisement for an aggregate address, it automatically installs a summary discard route for that aggregate address in the local routing table. BGP sets the administrative distance of the summary discard to 220 and sets the route type to discard. BGP does not use discard routes for next-hop resolution.

A summary entry is created in the BGP table when you issue the **aggregate-address** command, but the summary entry is not eligible for advertisement until a subset of the aggregate is found in the table.

BGP Conditional Advertisement

BGP conditional advertisement allows you to configure BGP to advertise or withdraw a route based on whether or not a prefix exists in the BGP table. This feature is useful, for example, in multihomed networks, in which you want BGP to advertise some prefixes to one of the providers only if information from the other provider is not present.

Consider an example network with three BGP autonomous systems: AS1, AS2, and AS3, where AS1 and AS3 connect to the Internet and to AS2. Without conditional advertisement, AS2 propagates all routes to both AS1 and AS3. With conditional advertisement, you can configure AS2 to advertise certain routes to AS3 only if routes from AS1 do not exist (if for example, the link to AS1 fails).

BGP conditional advertisement adds an exist or not-exist test to each route that matches the configured route map. See the Configuring BGP Conditional Advertisement section for more information.

BGP Next-Hop Address Tracking

BGP monitors the next-hop address of installed routes to verify next-hop reachability and to select, install, and validate the BGP best path. BGP next-hop address tracking speeds up this next-hop reachability test by triggering the verification process when routes change in the Routing Information Base (RIB) that may affect BGP next-hop reachability.

BGP receives notifications from the RIB when the next-hop information changes (event-driven notifications). BGP is notified when any of the following events occurs:

- The next hop becomes unreachable.
- The next hop becomes reachable.
- The fully recursed Interior Gateway Protocol (IGP) metric to the next hop changes.
- The first hop IP address or first hop interface changes.
- The next hop becomes connected.
- The next hop becomes unconnected.
- The next hop becomes a local address.
- The next hop becomes a nonlocal address.

Note Reachability and recursed metric events trigger a best-path recalculation.

Event notifications from the RIB are classified as critical and noncritical. Notifications for critical and noncritical events are sent in separate batches. However, a noncritical event is sent with the critical events if the noncritical event is pending and there is a request to read the critical events.

- Critical events are related to next-hop reachability, such as the loss of next hops resulting in a switchover to a different path. A change in the IGP metric for a next hop resulting in a switchover to a different path can also be considered a critical event.
- Non-critical events are related to next hops being added without affecting the best path or changing the IGP metric to a single next hop.

See the Configuring BGP Next-Hop Address Tracking section for more information.

Route Redistribution

You can configure BGP to redistribute static routes or routes from other protocols. You must configure a route map with the redistribution to control which routes are passed into BGP. A route map allows you to filter routes based on attributes such as the destination, origination protocol, route type, route tag, and so on. See Configuring Route Policy Manager, for more information.

You can use route maps to override the default behavior in both scenarios, but be careful when doing so as incorrect use of route maps can result in network loops. The following examples show how to use route maps to change the default behavior.

You can change the default behavior for scenario 1 by modifying the route map as follows:

```
route-map foo permit 10
   match route-type internal
router ospf 1
   redistribute bgp 100 route-map foo
```

Similarly, you can change the default behavior for scenario 2 by modifying the route map as follows:

```
route-map foo deny 10
  match route-type internal
router ospf 1
   vrf bar
     redistribute bgp 100 route-map foo
```

Labeled and Unlabeled Unicast Routes

In release 7.0(3)I7(6), SAFI-1 (unlabeled unicast) and SAFI-4 (labeled unicast routing) are now supported for IPv4 BGP on a single session. For more information, see the *Cisco Nexus 9000 Series NX-OS Label Switching Configuration Guide, Release 7.x*.

BFD

This feature supports bidirectional forwarding detection (BFD) for IPv4 and IPv6. BFD is a detection protocol designed to provide fast forwarding-path failure detection times. BFD provides subsecond failure detection between two adjacent devices and can be less CPU-intensive than protocol hello messages because some of the BFD load can be distributed onto the data plane on supported modules.

BFD for BGP is supported on eBGP peers and iBGP single-hop peers. Configure the **update-source** option in neighbor configuration mode for iBGP single-hop peers using BFD.

Beginning with Cisco NX-OS Release 9.3(3), BFD for BGP is also supported for BGP IPv4 and IPv6 prefix peers. This support enables BGP to use multihop BFD, which improves BGP convergence times. Both single-hop and multihop BGP are supported for prefix peers.

Beginning with Cisco NX-OS Release 9.3(3), BFD supports BGP Interface Peering via IPv6 Link-Local for IPv4 and IPv6 Address Families. However, BFD multihop is not supported with unnumbered BGP.

See the Cisco Nexus 9000 Series NX-OS Interfaces Configuration Guide for more information.

Tuning BGP

You can modify the default behavior of BGP through BGP timers and by adjusting the best-path algorithm.

BGP Timers

BGP uses different types of timers for neighbor session and global protocol events. Each established session has a minimum of two timers for sending periodic keepalive messages and for timing out sessions when peer keepalives do not arrive within the expected time. In addition, there are other timers for handling specific features. Typically, you configure these timers in seconds. The timers include a random adjustment so that the same timers on different BGP peers trigger at different times.

Tuning the Best-Path Algorithm

You can modify the default behavior of the best-path algorithm through optional configuration parameters, including changing how the algorithm handles the multi-exit discriminator (MED) attribute and the router ID.

Multiprotocol BGP

BGP on Cisco NX-OS supports multiple address families. Multiprotocol BGP (MP-BGP) carries different sets of routes depending on the address family. 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 IPv6 multicast routing. You can use MP-BGP for reverse-path forwarding (RPF) checks in IP multicast networks.

Note Because Multicast BGP does not propagate multicast state information, you need a multicast protocol, such as Protocol Independent Multicast (PIM).

Use the router address-family and neighbor address-family configuration modes to support multiprotocol BGP configurations. MP-BGP maintains separate RIBs for each configured address family, such as a unicast RIB and a multicast RIB for BGP.

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

RFC 5549

BGP supports RFC 5549, which allows an IPv4 prefix to be carried over an IPv6 next hop. Because BGP is running on every hop, all routers can forward IPv4 and IPv6 traffic. Therefore, there is no need to support IPv6 tunnels between any routers. BGP installs IPv4 over an IPv6 route to the Unicast Route Information Base (URIB).

Beginning with Cisco NX-OS Release 9.2(2), Cisco Nexus 9500 platform switches with -R line cards support RFC 5549.

Currently, NX-OS does not support IPv6 recursive next-hops (RNH) for an IPv4 route.

RFC 6368

Introduction

This section describes how the Internal Border Gateway Protocol (iBGP) between Provider Edge (PE) and Customer Edge (CE) feature is implemented in Cisco NX-OS.

In current deployments, when BGP is used as the Provider/Customer Edge routing protocol, these peering sessions are configured as an external peering between the VPN provider autonomous system (AS) and the customer network autonomous system.

RFC 6368 adds support for these peers to be configured as iBGP peers instead.

Beginning with Cisco NX-OS Release 10.1(2), RFC 6368 support is enabled for EVPN-VxLANv4 and EVPN-VxLANv6.

Framework

Beginning with Cisco NX-OS Release 10.1(2), deploying iBGP PE-CE feature:

- You can have one single Autonomous System Number (ASN) on the multiple sites of the VRF, without the deployment of External Border Gateway Protocol (eBGP) with as-override.
- You can give internal route reflection towards the CE routers, acting as if the Provider core is one transparent Route Reflector (RR).

With this feature, the VRF sites can have the same ASN as the provider core. However, in case the ASN of the VRF sites are different than the ASN of the provider core, it can be made to appear the same with the use of the feature local Autonomous System (AS).

Implement iBGP PE-CE

Here are the two major parts to make this feature work:

- A new attribute `ATTR_SET` added to the BGP protocol to carry the VPN BGP attributes across the provider core in a transparent manner.
- Make the PE router a RR for the iBGP sessions towards the CE routers in the VRF.

The new `ATTR_SET` attribute allows the provider to carry all the BGP attributes of the customer transparently and does not interfere with the provider attributes and BGP policies. Such attributes are the cluster list, local preference, and so on.

BGP Customer Route Attribute

`ATTR_SET` is the new BGP attribute used to carry the VPN BGP attributes of the provider customer. It is an optional transitive attribute. In this attribute, Local Preference, Med, Origin, AS Path, Originator ID, Cluster list attributes will be carried across the provider network. The `ATTR_SET` attribute has the format:

```
+------------------------------+
| Attr Flags (O|T) Code = 128  |
+------------------------------+
| Attr. Length (1 or 2 octets) |
+------------------------------+
| Origin AS (4 octets)         |
+------------------------------+
|Path Attributes (variable)    |
+------------------------------+
```

- Attribute Flags are regular BGP attribute flags.
- Attribute length indicates whether the length is one or two octets.
- Origin AS field is to prevent a leak of one route that originated in one AS to be leaked to another AS without proper manipulation of the `AS_PATH`.
- The variable-length path attributes field carries VPN BGP attributes that must be carried across the provider core.

For more information on the implementation of iBGP PE-CE, see IOS Implementation of the iBGP PE-CE Feature.

This example shows BGP neighbor configuration on PE device for iBGP Customer Edge device:

```
router bgp 200
vrf nxbgp3-leaf2-2
address-family ipv4 unicast
redistribute static route-map ALLOW-ALL
address-family ipv6 unicast
redistribute static route-map ALLOW-ALL
neighbor 101.101.101.101 remote-as 200
description ibgp sample config
internal-vpn-client (1)
address-family ipv4 unicast
route-reflector-client (2)
next-hop-self (3)
```

BGP Monitoring Protocol

The BGP Monitoring Protocol (BMP) monitors BGP updates and peer statistics and is supported for all Cisco Nexus 9000 Series switches.

Using this protocol, the BGP speaker connects to external BMP servers and sends them information regarding BGP events. A maximum of two BMP servers can be configured in a BGP speaker, and each BGP peer can be configured for monitoring by all or a subset of the BMP servers. The BGP speaker does not accept any information from the BMP server.

Graceful Restart and High Availability

Cisco NX-OS supports nonstop forwarding and graceful restart for BGP.

You can use nonstop forwarding (NSF) for BGP to forward data packets along known routes in the Forward Information Base (FIB) while the BGP routing protocol information is being restored following a failover. With NSF, BGP peers do not experience routing flaps. During a failover, the data traffic is forwarded through intelligent modules while the standby supervisor becomes active.

If a Cisco NX-OS router experiences a cold reboot, the network does not forward traffic to the router and removes the router from the network topology. In this scenario, BGP experiences a nongraceful restart and removes all routes. When Cisco NX-OS applies the startup configuration, BGP reestablishes peering sessions and relearns the routes.

A Cisco NX-OS router that has dual supervisors can experience a stateful supervisor switchover. During the switchover, BGP uses nonstop forwarding to forward traffic based on the information in the FIB, and the system is not removed from the network topology. A router whose neighbor is restarting is referred to as a "helper." After the switchover, a graceful restart operation begins. When it is in progress, both routers reestablish their neighbor relationship and exchange their BGP routes. The helper continues to forward prefixes pointing to the restarting peer, and the restarting router continues to forward traffic to peers even though those neighbor relationships are restarting. When the restarting router has all route updates from all BGP peers that are graceful restart capable, the graceful restart is complete, and BGP informs the neighbors that it is operational again.

BGP needs to converge before graceful-restart timer expires. BGP graceful-restart timer needs to be increased in high route scale network accordingly in order to avoid temporary traffic loss. If BGP itself provides the reachability to open other BGP sessions, then stalepath-time should also be increased to accommodate for the extra time needed to converge the overlay session after the initial underlay session has already converged.

When a router detects that a graceful restart operation is in progress, both routers exchange their topology tables. When the router has route updates from all BGP peers, it removes all the stale routes and runs the best-path algorithm on the updated routes.

After the switchover, Cisco NX-OS applies the running configuration, and BGP informs the neighbors that it is operational again.

For single-hop iBGP peers with update-source configured under neighbor configuration mode, the peer supports fast external fall-over.

Beginning with Cisco NX-OS Release 9.3(3), BGP prefix peers support graceful restarts.

With the additional BGP paths feature, if the number of paths advertised for a given prefix is the same before and after restart, the choice of path ID guarantees the final state and removal of stale paths. If fewer paths are advertised for a given prefix after a restart, stale paths can occur on the graceful restart helper peer.

Low Memory Handling

BGP reacts to low memory for the following conditions:

- Minor alert—BGP does not establish any new eBGP peers. BGP continues to establish new iBGP peers and confederate peers. Established peers remain, but reset peers are not re-established.
- Severe alert—BGP shuts down select established eBGP peers every two minutes until the memory alert becomes minor. For each eBGP peer, BGP calculates the ratio of total number of paths received to the number of paths selected as best paths. The peers with the highest ratio are selected to be shut down to reduce memory usage. You must clear a shutdown eBGP peer before you can bring the eBGP peer back up to avoid oscillation.

Note You can exempt important eBGP peers from this selection process.

- Critical alert—BGP gracefully shuts down all the established peers. You must clear a shutdown BGP peer before you can bring the BGP peer back up.

See the Tuning BGP section for more information on how to exempt a BGP peer from a shutdown due to a low memory condition.

Virtualization Support

You can configure one BGP instance. BGP supports virtual routing and forwarding (VRF) instances.

Enabling IP Forward on an Interface

To use RFC 5549, you must configure at least one IPv4 address. If you do not want to configure an IPv4 address, you must enable the IP forward feature to use RFC 5549.

SUMMARY STEPS

1. **configure terminal**
2. **interface** *type slot/port*
3. **ip forward**
4. (Optional) **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**interface** *type slot/port*
	Example:
	`switch(config)# interface ethernet 1/2`
	`switch(config-if)#`
		Enters interface configuration mode.

Step 3	**ip forward** **Example:** `switch(config-if)# ip forward`	Allows IPv4 traffic on the interface even when there is no IP address configuration on that interface.
Step 4	(Optional) **copy running-config startup-config** **Example:** `switch(config-if)# copy running-config startup-config`	Saves this configuration change.

Configuring BGP Session Templates

You can use BGP session templates to simplify the BGP configuration for multiple BGP peers with similar configuration needs. BGP templates allow you to reuse common configuration blocks. You configure BGP templates first and then apply these templates to BGP peers.

With BGP session templates, you can configure session attributes such as inheritance, passwords, timers, and security.

A peer-session template can inherit from one other peer-session template. You can configure the second template to inherit from a third template. The first template also inherits this third template. This indirect inheritance can continue for up to seven peer-session templates.

Any attributes configured for the neighbor take priority over any attributes inherited by that neighbor from a BGP template.

Before you begin

You must enable BGP (see the Enabling BGP section).

Note

- When editing a template, you can use the **no** form of a command at either the peer or template level to explicitly override a setting in a template. You must use the default form of the command to reset that attribute to the default state.
- When using BGP Peer Template, there is no check for the commands used inside template to verify if that command applies to iBGP/eBGP peer or not. For example if you create a template and add a command "Remove-private-as" inside a template and then assign this tempate to iBGP peer, then no error will be printed saying this command "Remove-private-as" does not apply to iBGP peer.

SUMMARY STEPS

1. **configure terminal**
2. **router bgp** *autonomous-system-number*
3. **template peer-session** *template-name*
4. (Optional) **password** *number password*
5. (Optional) **timers** *keepalive hold*
6. **exit**
7. **neighbor** *ip-address* **remote-as** *as-number*
8. **inherit peer-session** *template-name*
9. (Optional) **description** *text*
10. (Optional) **show bgp peer-session** *template-name*
11. (Optional) **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**router bgp** *autonomous-system-number*
	Example:
	`switch(config)# router bgp 65535`
	`switch(config-router)#`
		Enables BGP and assigns the autonomous system number to the local BGP speaker.

Step 3	**template peer-session** *template-name*
	Example:
	`switch(config-router)# template`
	`peer-session BaseSession`
	`switch(config-router-stmp)#`
		Enters peer-session template configuration mode.

	Command or Action	Purpose
Step 4	(Optional) **password** *number password* **Example:** `switch(config-router-stmp)# password 0 test`	Adds the clear text password test to the neighbor. The password is stored and displayed in type 3 encrypted form (3DES).
Step 5	(Optional) **timers** *keepalive hold* **Example:** `switch(config-router-stmp)# timers 30 90`	Adds the BGP keepalive and holdtimer values to the peer-session template. The default keepalive interval is 60. The default hold time is 180.

Step 6	**exit**
	Example:
	`switch(config-router-stmp)# exit`
	`switch(config-router)#`
		Exits peer-session template configuration mode.

Step 7	**neighbor** *ip-address* **remote-as** *as-number*
	Example:
	`switch(config-router)# neighbor 192.168.1.2 remote-as 65535`
	`switch(config-router-neighbor)#`
		Places the router in the neighbor configuration mode for BGP routing and configures the neighbor IP address.

Step 8	**inherit peer-session** *template-name*
	Example:
	`switch(config-router-neighbor)# inherit peer-session BaseSession`
	`switch(config-router-neighbor)#`
		Applies a peer-session template to the peer.

Step 9	(Optional) **description** *text*
	Example:
	`switch(config-router-neighbor)# description Peer Router A`
	`switch(config-router-neighbor)#`
		Adds a description for the neighbor.

Step 10	(Optional) **show bgp peer-session** *template-name* **Example:** `switch(config-router-neighbor)# show bgp peer-session BaseSession`	Displays the peer-policy template.
Step 11	(Optional) **copy running-config startup-config** **Example:** `switch(config-router-neighbor)# copy running-config startup-config`	Saves this configuration change. Use the **show bgp neighbor** command to see the template applied.

Example

This example shows how to configure a BGP peer-session template and apply it to a BGP peer:

```
switch# configure terminal
switch(config)# router bgp 65536
switch(config-router)# template peer-session BaseSession
switch(config-router-stmp)# timers 30 90
switch(config-router-stmp)# exit
switch(config-router)# neighbor 192.168.1.2 remote-as 65536
switch(config-router-neighbor)# inherit peer-session BaseSession
switch(config-router-neighbor)# description Peer Router A
switch(config-router-neighbor)# address-family ipv4 unicast
switch(config-router-neighbor-af)# copy running-config startup-config
```

Configuring BGP Peer-Policy Templates

You can configure a peer-policy template to define attributes for a particular address family. You assign a preference to each peer-policy template and these templates are inherited in the order specified, for up to five peer-policy templates in a neighbor address family.

Cisco NX-OS evaluates multiple peer policies for an address family using the preference value. The lowest preference value is evaluated first. Any attributes configured for the neighbor take priority over any attributes inherited by that neighbor from a BGP template.

Peer-policy templates can configure address family-specific attributes such as AS-path filter lists, prefix lists, route reflection, and soft reconfiguration.

Note Use the **show bgp neighbor** command to see the template applied. See the *Cisco Nexus 9000 Series NX-OS Unicast Routing Command Reference*, for details on all commands available in the template.

Before you begin

You must enable BGP (see the Enabling BGP section).

Note When editing a template, you can use the **no** form of a command at either the peer or template level to explicitly override a setting in a template. You must use the default form of the command to reset that attribute to the default state.

SUMMARY STEPS

1. **configure terminal**
2. **router bgp** *autonomous-system-number*
3. **template peer-session** *template-name*
4. (Optional) **advertise-active-only**
5. (Optional) **maximum-prefix** *number*
6. **exit**
7. **neighbor** *ip-address* **remote-as** *as-number*
8. **address-family** {**ipv4** | **ipv6**} {**multicast** | **unicast**}
9. **inherit peer-policy** *template-name preference*
10. (Optional) **show bgp peer-policy** *template-name*

11. (Optional) **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `switch# configure terminal`	Enters configuration mode.

Step 2	**router bgp** *autonomous-system-number*
	Example:
	`switch(config)# router bgp 65535`
	`switch(config-router)#`
		Enables BGP and assigns the autonomous system number to the local BGP speaker.

Step 3	**template peer-session** *template-name*
	Example:
	`switch(config-router)# template`
	`peer-policy BasePolicy`
	`switch(config-router-ptmp)#`
		Creates a peer-policy template.

Step 4	(Optional) **advertise-active-only**
	Example:
	`switch(config-router-ptmp)#`
	`advertise-active-only`
		Advertises only active routes to the peer.

Step 5	(Optional) **maximum-prefix** *number*
	Example:
	`switch(config-router-ptmp)#`
	`maximum-prefix 20`
		Sets the maximum number of prefixes allowed from this peer.

Step 6	**exit**
	Example:
	`switch(config-router-ptmp)# exit`
	`switch(config-router)#`
		Exits peer-policy template configuration mode.

Step 7	**neighbor** *ip-address* **remote-as** *as-number*
	Example:
	`switch(config-router)# neighbor`
	`192.168.1.2 remote-as 65535`
	`switch(config-router-neighbor)#`
		Places the router in the neighbor configuration mode for BGP routing and configures the neighbor IP address.

Step 8	**address-family** {**ipv4** | **ipv6**} {**multicast** | **unicast**}
	Example:
	`switch(config-router-neighbor)#`
	`address-family ipv4 unicast`
	`switch(config-router-neighbor-af)#`
		Enters global address family configuration mode for the address family specified.

	Command or Action	Purpose
Step 9	**inherit peer-policy** *template-name preference* **Example:** `switch(config-router-neighbor-af)# inherit peer-policy BasePolicy 1`	Applies a peer-policy template to the peer address family configuration and assigns the preference value for this peer policy.
Step 10	(Optional) **show bgp peer-policy** *template-name* **Example:** `switch(config-router-neighbor-af)# show bgp peer-policy BasePolicy`	Displays the peer-policy template.
Step 11	(Optional) **copy running-config startup-config** **Example:** `switch(config-router-neighbor-af)# copy running-config startup-config`	Saves this configuration change. Use the **show bgp neighbor** command to see the template applied.

Example

This example shows how to configure a BGP peer-policy template and apply it to a BGP peer:

```
switch# configure terminal
switch(config)# router bgp 65536
switch(config-router)# template peer-session BasePolicy
switch(config-router-ptmp)# maximum-prefix 20
switch(config-router-ptmp)# exit
switch(config-router)# neighbor 192.168.1.1 remote-as 65536
switch(config-router-neighbor)# address-family ipv4 unicast
switch(config-router-neighbor-af)# inherit peer-policy BasePolicy
switch(config-router-neighbor-af)# copy running-config startup-config
```

Configuring BGP Peer Templates

You can configure BGP peer templates to combine session and policy attributes in one reusable configuration block. Peer templates can also inherit peer-session or peer-policy templates. Any attributes configured for the neighbor take priority over any attributes inherited by that neighbor from a BGP template. You configure only one peer template for a neighbor, but that peer template can inherit peer-session and peer-policy templates.

Peer templates support session and address family attributes, such as eBGP multihop time-to-live, maximum prefix, next-hop self, and timers.

Before you begin

You must enable BGP (see the Enabling BGP section).

Note When editing a template, you can use the **no** form of a command at either the peer or template level to explicitly override a setting in a template. You must use the default form of the command to reset that attribute to the default state.

SUMMARY STEPS

1. **configure terminal**
2. **router bgp** *autonomous-system-number*
3. **template peer** *template-name*
4. (Optional) **inherit peer-session** *template-name*
5. (Optional) **address-family** {**ipv4**|**ipv6**} {**multicast**|**unicast**}
6. (Optional) **inherit peer-policy** *template-name*
7. **exit**
8. (Optional) **timers** *keepalive hold*
9. **exit**
10. **neighbor** *ip-address* **remote-as** *as-number*
11. **inherit peer** *template-name*
12. (Optional) **timers** *keepalive hold*
13. (Optional) **show bgp peer-template** *template-name*
14. (Optional) **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `switch# configure terminal`	Enters global configuration mode.
Step 2	**router bgp** *autonomous-system-number* **Example:** `switch(config)# router bgp 65535`	Enters BGP mode and assigns the autonomous system number to the local BGP speaker.
Step 3	**template peer** *template-name* **Example:** `switch(config-router)# template peer BasePeer`	Enters peer template configuration mode.
Step 4	(Optional) **inherit peer-session** *template-name* **Example:** `switch(config-router-neighbor)# inherit peer-session BaseSession`	Adds a peer-session template to the peer template.

Step 5	(Optional) **address-family** {**ipv4**|**ipv6**} {**multicast**|**unicast**}
	Example:
	`switch(config-router-neighbor)# address-family ipv4 unicast`
	`switch(config-router-neighbor-af)`
		Configures the global address family configuration mode for the specified address family.

	Command or Action	Purpose
Step 6	(Optional) **inherit peer-policy** *template-name* **Example:** `switch(config-router-neighbor-af)# inherit peer-policy BasePolicy 1`	Applies a peer-policy template to the neighbor address family configuration.
Step 7	**exit** **Example:** `switch(config-router-neighbor-af)# exit`	Exits BGP neighbor address family configuration mode.
Step 8	(Optional) **timers** *keepalive hold* **Example:** `switch(config-router-neighbor)# timers 45 100`	Adds the BGP timer values to the peer. These values override the timer values in the peer-session template, BaseSession.
Step 9	**exit** **Example:** `switch(config-router-neighbor)# exit`	Exits BGP neighbor configuration mode.

Step 10	**neighbor** *ip-address* **remote-as** *as-number*
	Example:
	`switch(config-router)# neighbor 192.168.1.2 remote-as 65535`
	`switch(config-router-neighbor)#`
		Places the router in neighbor configuration mode for BGP routing and configures the neighbor IP address.

Step 11	**inherit peer** *template-name* **Example:** `switch(config-router-neighbor)# inherit peer BasePeer`	Inherits the peer template.
Step 12	(Optional) **timers** *keepalive hold* **Example:** `switch(config-router-neighbor)# timers 60 120`	Adds the BGP timer values to this neighbor. These values override the timer values in the peer template and the peer-session template.
Step 13	(Optional) **show bgp peer-template** *template-name* **Example:** `switch(config-router-neighbor)# show bgp peer-template BasePeer`	Displays the peer template.
Step 14	(Optional) **copy running-config startup-config** **Example:** `switch(config-router-neighbor)# copy running-config startup-config`	Saves this configuration change. Use the **show bgp neighbor** command to see the template applied.

Example

This example shows how to configure a BGP peer template and apply it to a BGP peer:

```
switch# configure terminal
switch(config)# router bgp 65536
switch(config-router)# template peer BasePeer
switch(config-router-neighbor)# inherit peer-session BaseSession
switch(config-router-neighbor)# address-family ipv4 unicast
switch(config-router-neighbor-af)# inherit peer-policy BasePolicy 1
switch(config-router-neighbor-af)# exit
switch(config-router-neighbor)# exit
switch(config-router)# neighbor 192.168.1.2 remote-as 65536
switch(config-router-neighbor)# inherit peer BasePeer
switch(config-router-neighbor)# copy running-config startup-config
```

Configuring Prefix Peering

BGP supports the definition of a set of peers using a prefix for both IPv4 and IPv6. This feature allows you to not have to add each neighbor to the configuration.

When defining a prefix peering, you must specify the remote AS number with the prefix. BGP accepts any peer that connects from that prefix and autonomous system if the prefix peering does not exceed the configured maximum peers allowed.

When a BGP peer that is part of a prefix peering disconnects, Cisco NX-OS holds its peer structures for a defined prefix peer timeout value. An established peer can reset and reconnect without danger of being blocked because other peers have consumed all slots for that prefix peering.

SUMMARY STEPS

1. **timers prefix-peer-timeout** *value*
2. **maximum-peers** *value*

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**timers prefix-peer-timeout** *value* **Example:** `switch(config-router-neighbor)# timers prefix-peer-timeout 120`	Configures the BGP prefix peering timeout value in router configuration mode. The range is from 0 to 1200 seconds. The default value is 30. **Note** For prefix peers, set the prefix peer timeout to be greater than the configured graceful restart timer. If the prefix peer timeout is greater than the graceful restart timer, a peer's route is retained during its restart. If the prefix peer timeout is less than the graceful restart timer, the peer's route is purged by the prefix peer timeout, which may occur before the restart is complete.

	Command or Action	Purpose
Step 2	**maximum-peers** *value* **Example:** `switch(config-router-neighbor)# maximum-peers 120`	Configures the maximum number of peers for this prefix peering in neighbor configuration mode. The range is from 1 to 1000.

Example

This example shows how to configure a prefix peering that accepts up to 10 peers:

```
switch(config)# router bgp 65536
switch(config-router)# timers prefix-peer-timeout 120
switch(config-router)# neighbor 10.100.200.0/24 remote-as 65536
switch(config-router-neighbor)# maximum-peers 10
switch(config-router-neighbor)# address-family ipv4 unicast
switch(config-router-neighbor-af)#
```

Use the **show bgp ipv4 unicast neighbors** command to show the details of the configuration for that prefix peering with a list of the currently accepted instances and the counts of active, maximum concurrent, and total accepted peers.

Configuring BGP Interface Peering via IPv6 Link-Local for IPv4 and IPv6 Address Families

You can configure BGP Interface Peering via IPv6 Link-Local for IPv4 and IPv6 Address Families for automatic BGP neighbor discovery using unnumbered interfaces. Doing so allows you to set up BGP sessions using an interface name as a BGP peer (rather than interface-scoped addresses). This feature relies on ICMPv6 neighbor discovery (ND) route advertisement (RA) for automatic neighbor discovery and on RFC 5549 for sending IPv4 routes with IPv6 next hop.

Before you begin

You must enable BGP (see the Enabling BGP section).

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `switch# configure terminal`	Enters configuration mode.

Step 2	**router bgp** *autonomous-system-number*
	Example:
	`switch(config)# router bgp 65535`
	`switch(config-router)#`
		Enables BGP and assigns the autonomous system number to the local BGP speaker. The AS number can be a 16-bit integer or a 32-bit integer in the form of a higher 16-bit decimal number and a lower 16-bit decimal number in xx.xx format.

	Command or Action	Purpose

Step 3	**neighbor** *interface-name* **remote-as** {*as-number* | **route-map** *map-name*}
	
	Example:
	`switch(config-router)# neighbor Ethernet1/1 remote-as 65535`
	`switch(config-router-neighbor)#`
		Places the router in the neighbor configuration mode for BGP routing and configures the interface for BGP peering.
		
		Note
		You can specify only Ethernet interfaces, port-channel interfaces, subinterfaces, and breakout interfaces.
		
		Beginning with Cisco NX-OS Release 9.3(6), you can specify a route map, which can contain AS lists and ranges. See *Dynamic AS Numbers for Prefix Peers and Interface Peers* for more information about using dynamic AS numbers.
		
		interface-name can be a range if the configuration needs to be applied to more than one interface.

Step 4	**inherit peer** *template-name* **Example:** `switch(config-router-neighbor)# inherit peer PEER`	Inherits the peer template.

Step 5	**address-family** {**ipv4** | **ipv6**} **unicast**
	
	Example:
	`switch(config-router-neighbor)# address-family ipv4 unicast`
	`switch(config-router-neighbor-af)#`
		Enters global address family configuration mode for the address family specified.

Step 6	(Optional) **show bgp** {**ipv4** | **ipv6**} **unicast neighbors** *interface*
	
	Example:
	`switch(config-router-neighbor-af)# show bgp ipv4 unicast neighbors e1/25`
	
	Example:
	`switch(config-router-neighbor-af)# show bgp ipv6 unicast neighbors 3FFE:700:20:1::11`
		Displays information about BGP peers.

Step 7	(Optional) **show ip bgp neighbors** *interface-name* **Example:** `switch(config-router-neighbor-af)# show ip bgp neighbors Ethernet1/1`	Displays the interface used as a BGP peer.
Step 8	(Optional) **show ipv6 routers** [**interface** *interface*] **Example:** `switch(config-router-neighbor-af)# show ipv6 routers interface Ethernet1/1`	Displays the link-local address of remote IPv6 routers, which is learned through IPv6 ICMP router advertisement.
Step 9	(Optional) **copy running-config startup-config** **Example:** `switch(config-router-neighbor-af)# copy running-config startup-config`	Saves this configuration change.

Example

This example shows how to configure BGP Interface Peering via IPv6 Link-Local for IPv4 and IPv6 Address Families.

iBGP Interface Peering Configuration for Leaf 1:

```
switch# configure terminal
switch(config)# router bgp 65000
switch(config-router)# neighbor Ethernet1/1 remote-as 65000
switch(config-router-neighbor)# inherit peer PEER
switch(config-router-neighbor)# address-family ipv4 unicast
switch(config-router-neighbor)# address-family ipv6 unicast
switch(config-router-neighbor-af)# copy running-config startup-config
```

This example shows sample output for BGP Interface Peering via IPv6 Link-Local for IPv4 and IPv6 Address Families:

```
switch(config-router-neighbor)# show bgp ipv4 unicast neighbors e1/15.1
BGP neighbor is fe80::2, remote AS 100, ibgp link, Peer index 4
Peer is an instance of interface peering Ethernet1/15.1
BGP version 4, remote router ID 5.5.5.5
Neighbor previous state = OpenConfirm
BGP state = Established, up for 2d16h
Neighbor vrf: default
Peer is directly attached, interface Ethernet1/15.1
Last read 00:00:54, hold time = 180, keepalive interval is 60 seconds
Last written 00:00:08, keepalive timer expiry due 00:00:51
Received 3869 messages, 0 notifications, 0 bytes in queue
Sent 3871 messages, 0 notifications, 0(0) bytes in queue
Enhanced error processing: On
0 discarded attributes
Connections established 2, dropped 1
Last reset by peer 2d16h, due to session closed
Last error length received: 0
Reset error value received 0
Reset error received major: 104 minor: 0
Notification data received:
Last reset by us never, due to No error
Last error length sent: 0
Reset error value sent: 0
Reset error sent major: 0 minor: 0
--More--
```

Interface Configuration:

IPv6 needs to be enabled on the corresponding interface using one of the following commands:

- **ipv6 address** *ipv6-address*
- **ipv6 address use-link-local-only**
- **ipv6 link-local** *link-local-address*

```
switch# configure terminal
switch(config)# interface Ethernet1/1
switch(config-if)# ipv6 address use-link-local-only
```

Note If an IPv4 address is not configured on the interface, the **ip forward** command must be configured on the interface to enable IPv4 forwarding.

Note IPv6 ND timers can be tuned to speed up neighbor discovery and for BGP faster route convergence.

```
switch(config-if)# ipv6 nd ra-interval 4 min 3
switch(config-if)# ipv6 nd ra-lifetime 10
```

Note Beginning with Cisco NX-OS Release 9.3(6), for customer deployments with parallel links, the following command must be added in interface mode:

```
switch(config-if)# ipv6 link-local use-bia
```

The command makes IPv6 LLA unique across different interfaces.

Configuring BGP Authentication

You can configure BGP to authenticate route updates from peers using MD5 digests.

Alternatively, beginning with Cisco NX-OS Release 10.4(2)F, you can configure BGP to authenticate route updates from peers using TCP Authentication Option (TCP AO).

Beginning with Cisco NX-OS Release 10.3(3)F, Type-6 encryption for BGP password is supported on Cisco NX-OS switches. Following encryption types are supported:

- AES based encryption
- A configurable encryption-key called as primary-key is used for encryption and decryption of secrets.

To configure BGP to use MD5 digests or TCP AO, use the following command in neighbor configuration mode:

Before you begin

- Ensure the primary-key is configured using the **key config-key ascii** <*primary_key*> command on Cisco NX-OS switches.
- For Type-6 encryption to function properly, ensure **feature password encryption aes** is enabled on Cisco NX-OS switches.
- See Configuring TCP Authentication Option to configure and use TCP keychain authentication option for BGP neighbor session authentication.

SUMMARY STEPS

1. **key config-key ascii** <*primary_key*>
2. **configure terminal**

3. **feature password encryption aes**
4. **router bgp** *AS number*
5. **template peer***template name*
6. **password** {**0** | **3** | **7** | **6**} *string*
7. (Optional) **encryption re-encrypt obfuscated**
8. (Optional) **encryption delete type-6**
9. (Optional) **ao** <*Keychain-name*> [**include-tcp-options**]

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**key config-key ascii** <*primary_key*> **Example:** `switch# key config-key ascii 0123456789012345`	Configures the primary-key. **Note** • Enter this command only if the primary key is not configured. • If the primary key is already configured and if you enter this command, you are actually modifying the existing primary-key value. To modify to the new value, enter the existing primary-key value when prompted.
Step 2	**configure terminal** **Example:** `switch# configure terminal`	Enters global configuration mode.
Step 3	**feature password encryption aes** **Example:** `switch(config)# feature password encryption aes`	Enables the AES password encryption.
Step 4	**router bgp** *AS number* **Example:** `switch(config-router)# router bgp 1`	Enters to BGP router mode.
Step 5	**template peer***template name* **Example:** `switch(config-router-neighbor)# template peer abc`	Enters to BGP neighbor mode.
Step 6	**password** {**0** | **3** | **7** | **6**} *string* **Example:** `switch(config-router-neighbor)# password 6 JDYk5lJck2Vh7aM/yC2kc3yTrQAc/T2lalmKPC4P+Nljx/eR6wygnJWnHTpHwsCQ40e1P9utnk8I1QDu1sc3XYGTOA=`	Configures an MD5 password for BGP neighbor sessions. **Note** When you configure the Type-0/Type-3/Type-7 newly, if primary-key is configured and then if **feature password**

	Command or Action	Purpose
		encryption aes is enabled, the Type-0/3/7 is automatically encrypted to the Type-6 password.
Step 7	(Optional) **encryption re-encrypt obfuscated** **Example:** `switch# encryption re-encrypt obfuscated`	Encrypts the existing Type-0/Type-3/Type-7 password to Type-6 password.
Step 8	(Optional) **encryption delete type-6** **Example:** `switch# encryption delete type-6`	Deletes the Type-6 encrypted password.
Step 9	(Optional) **ao** <*Keychain-name*> [**include-tcp-options**]	Configures option to specify whether the TCP option headers (other than TCP AO option) will be included while computing the MAC digest of the packets.

Configuring TCP Authentication Option

This document describes how to configure TCP authentication option on Cisco NX-OS devices.

About TCP Authentication Option

With TCP Authentication Option (TCP-AO), defined in RFC 5925, you can protect long-lived TCP connections against replays using stronger Message Authentication Codes (MACs).

TCP-AO is the proposed replacement for TCP MD5, defined in RFC 2385. Unlike TCP MD5, TCP-AO is resistant to collision attacks and provides algorithmic agility and support for key management.

TCP-AO has the following distinct features:

- TCP-AO supports the use of stronger Message Authentication Codes (MACs) to enhance the security of long-lived TCP connections.
- TCP-AO protects against replays for long-lived TCP connections, and coordinates key changes between endpoints by providing a more explicit key management.

The TCP-AO feature deprecates TCP MD5. Cisco NX-OS devices will continue to support the TCP-MD5 option for legacy BGP peers. However, a configuration in which one end of the peering is configured with the TCP MD5 option and the other with the TCP-AO option is not supported

TCP-AO Key Chain

TCP-AO is based on traffic keys and Message Authentication Codes (MACs) generated using the keys and a MAC algorithm. The traffic keys are derived from master keys that you can configure in a TCP-AO key chain. Use the **key chain** *key-chain-name* **tcp** command in the global configuration mode to create a TCP-AO key chain and configure keys in the chain. The TCP-AO key chain must be configured on both the peers communicating via a TCP connection.

Keys in a TCP-AO key chain have the following configurable properties:

Configurable Property	Description
send-id	Key identifier of the TCP-AO option of the outgoing segment. The send identifier configured on a router must match the receive identifier configured on the peer.
recv-id	Key identifier compared with the TCP-AO key identifier of the incoming segment during authentication. The receive identifier configured on a router must match the send identifier configured on the peer.
cryptographic-algorithm	The MAC algorithm to be used to create MACs for outgoing segments. The algorithm can be one of the following: • AES-128-CMAC authentication algorithm • HMAC-SHA-1 authentication algorithm • HMAC-SHA-256 authentication algorithm
include-tcp-options	This flag indicates whether TCP options other than TCP-AO will be used to calculate MACs. With this flag enabled, the contents of all options along with a zero-filled authentication option, is used to calculate the MAC. When the flag is disabled, all options other than TCP-AO are excluded from MAC calculations. This flag is disabled by default. **Note** The configuration of this flag is overridden by the application configuration when the application configuration is available.
send-lifetime	This configuration determines the time for which a key is valid and can be used for TCP-AO-based authentication of TCP segments. When the lifetime of key elapses and the key expires, the next key with the youngest lifetime is selected.
key-string	The key string is a pre-shared master key configured on both peers and is used to derive the traffic keys.

TCP-AO Format

```
+------------+------------+------------+------------+
|  Kind=29   |   Length   |   KeyID    | RNextKeyID |
+------------+------------+------------+------------+
|                     MAC           ...
+-----------------------------------...

   ...-----------------+
   ...  MAC (con't)    |
   ...-----------------+
```

The fields of the TLV format are as follows:

- Kind: Indicates TCP-AO with a value of 29.
- Length: Indicates the length of the TCP-AO sequence.
- KeyID: The send identifier of the Master Key Tuple (MKT) that was used to generate the traffic keys.
- RNextKeyID: The receive identifier of the MKT that is ready to be used to authenticate received segments.
- MAC: The MAC computed for the TCP segment data and the prefixed pseudo header.

Master Key Tuples

Traffic keys are the keying material used to compute the message authentication codes of individual TCP segments.

Master Key Tuples (MKTs) enable you to derive unique traffic keys, and to include the keying material required to generate those traffic keys. MKTs indicate the parameters under which the traffic keys are configured. The parameters include whether TCP options are authenticated, and indicators of the algorithms used for traffic key derivation and MAC calculation.

Each MKT has the following two identifiers:

- **SendID**: The **SendID** identifier is inserted as the KeyID identifier of the TCP AO option of the outgoing segments.
- **RecvID**: The **RecvID** is matched against the TCP AO KeyID of the incoming segments.

TCP-AO Key Rollover

TCP-AO keys are valid for a defined duration configured using the send-lifetime. If send-lifetime is not configured the key is considered inactive. Key rollover is initiated based on the send lifetimes of keys.

TCP-AO coordinates the use of new MKTs using the RNextKeyID and KeyID field on the TCP-AO option field. For hitless key rollovers, new and old keys in keychain configurations need to have at least 15 minutes of overlap. This is required so that the TCP-AO has enough time to coordinate use of the new MKT.

When key rollover is initiated, one of the peer routers, say Router A, indicates that the rollover is necessary. To indicate that the rollover is necessary, Router A sets the RNextKeyID to the receive identifier (recv-id) of the new MKT to be used. On receiving the TCP segment, the peer router, say Router B, looks up the send identifier (send-id) in its database to find the MKT indicated by the RNextKeyID in the TCP-AO payload. If the key is available and valid, Router B sets the current key to the new MKT. After Router B has rolled over, Router A also sets the current key to the new Primary Key Tuples.

Key rollover is initiated with overlapping send-lifetimes and send-lifetime expiry

If you do not configure a new key that can be activated before the expiry of the current key, the key may time out and expire. Such an expiry can cause retransmissions with the peer router rejecting segments authenticated with the expired key. The connection may fail due to Retransmission Time Out (RTO). When new valid keys are configured and usable, the connection can be re-established.

Guidelines and Limitations

- The send-id and recv-id of each key in the key chain must be unique. Because send-id and recv-id must be chosen from the range 0 to 255, the TCP-AO key chain can have a maximum of 256 keys.
- Only one keychain can be associated with an application connection. Rollover is always performed within the keys in this keychain.

- If the key in use expires, expect segment loss until a new key that has a valid lifetime is configured on each side and keys rollover.
- All the following configurations must be done for a TCP-AO keychain key to be considered active: send-id, recv-id, key-string, send-lifetime and cryptographic-algorithm.
- The key chain software process will use the newest key (youngest key) based on the send-lifetime configuration. Or, whichever key was configured last if the same send-lifetime is configured for two different keys in the same key chain. Configuring two keys with identical send-lifetimes is not best practice or recommended.
- User MUST configure minimum 15 minutes overlapping time between the two overlapping keys.
- Modifying the configuration of a key in use such as key-string, send-id, recv-id, cryptographic-algorithm or send-lifetime will result in TCP connection flap.
- A keychain's configuration type must match the type it has been linked to within the client protocol. If an attempt is made to mismatch these types, a syslog message is generated to notify the user. For example: It is not supported if a keychain named keychain_abc is configured as a Macsec keychain but is associated as a TCP keychain with BGP. Similarly, the case where the keychain is first associated with the client (a process known as forward-referencing) and then configured as a different keychain type, is also not supported.

Configure TCP Key Chain and Keys

Before you begin

- Ensure that the key-string, send-lifetimes, cryptographic-algorithm, and ids of keys match on both peers.
- Ensure that the send-id on a router matches the recv-id on the peer router. We recommend using the same id for both the parameters unless there is a need to use separate key spaces.
- The send-id and recv-id of a key cannot be reused for another key in the same key chain.
- The key-string is encrypted and stored in the Type-6 format if the AES password encryption feature is enabled and a primary key is configured. Otherwise, the password will be stored in the Type-7 encrypted format.
- For more details, see Configuring a Primary Key and Enabling the AES Password Encryption Feature.

SUMMARY STEPS

1. **configure terminal**
2. **key chain** *name* **tcp**
3. **key** *key-ID*
4. **send-id** *send-ID*
5. **recv-id** *recv-ID*
6. **key-string** *[encryption-type] text-string*
7. **[no] cryptographic-algorithm {HMAC-SHA-1 | HMAC-SHA-256 | AES-128-CMAC }**
8. **send-lifetime [local]** *start-time* **duration** [duration-value | infinite | end-time]
9. (Optional) **include-tcp-options**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `switch# configure terminal`	Enters global configuration mode.
Step 2	**key chain** *name* **tcp** **Example:** `switch(config)# key chain bgp-keys tcp`	Enters keychain configuration mode for the keychain that you specified.
Step 3	**key** *key-ID* **Example:** `switch(config-tcpkeychain)# key 13`	Enters key configuration mode for the key that you specified. The *key-ID* argument must be a whole number between 0 and 65535.
Step 4	**send-id** *send-ID* **Example:** `switch(config-tcpkeychain-tcpkey)# send-id 2`	Specifies the send identifier for the key. The send-ID must be in the range from 0 to 255 and unique value per key chain.
Step 5	**recv-id** *recv-ID* **Example:** `switch(config-tcpkeychain-tcpkey)# recv-id 2`	Specifies the recieve identifier for the key. The recv-ID must be in the range from 0 to 255 and unique value per key chain.
Step 6	**key-string** *[encryption-type] text-string* **Example:** `switch(config-tcpkeychain-tcpkey)# key-string 0 AS3cureStr1ng`	Configures the text string for the key. The text-string argument is alphanumeric, case-sensitive, and supports special characters. The encryption-type argument can be one of the following values: • 0—The text-string argument that you enter is unencrypted text. This is the default. • 6—Beginning with Cisco NX-OS Release 10.3(3)F, the Cisco proprietary (Type-6 encrypted) method is supported on Cisco Nexus 9000 Series platform switches. • 7—The text-string argument that you enter is encrypted. The encryption method is a Cisco proprietary method. This option is useful when you are entering a text string based on the encrypted output of a **show key chain** command that you ran on another Cisco NX-OS device. The **key-string** command has limitations on using the following special characters in the *text-string*:

	Command or Action	Purpose
		<table><tr><th>Special Character</th><th>Description</th><th>Comments</th></tr><tr><td>|</td><td>Vertical bar or pipe</td><td>Unsupported at start of key-string</td></tr><tr><td>&gt;</td><td>Greater than</td><td>Unsupported at start of key-string</td></tr><tr><td>\</td><td>Backslash</td><td>Unsupported start or end of a key-string</td></tr><tr><td>(</td><td>Left parenthesis</td><td>Unsupported at start of key-string</td></tr><tr><td>'</td><td>Apostrophe</td><td>Unsupported at start of key-string</td></tr><tr><td>"</td><td>Quotation mark</td><td>Unsupported at start of key-string</td></tr><tr><td>?</td><td>Question mark</td><td>Supported. However, press **Ctrl-V** before entering a question mark (?).</td></tr></table> For more information on the special characters usage in commands, see Understanding the Command-Line Interface section.

Step 7	**[no] cryptographic-algorithm {HMAC-SHA-1 | HMAC-SHA-256 | AES-128-CMAC }**
	 Example:
	 `switch(config-tcpkeychain-tcpkey)# cryptographic-algorithm HMAC-SHA-1`
		Specifies the algorithm to be used to compute MACs for TCP segments. You can configure only one cryptographic algorithm per key.

Step 8	**send-lifetime [local]** *start-time* **duration** [duration-value | infinite | end-time] **Example:** `switch(config-tcpkeychain-tcpkey)# send-lifetime local 01:01:01 Jan 01 2023 01:01:01 Jan 10 2023`	Configures a send lifetime for the key. By default, the device treats the start-time and end-time arguments as UTC. If you specify the **local** keyword, the device treats these times as local times. The start-time argument is the time of day and date that the key becomes active. You can specify the end of the send lifetime with one of the following options: • **duration** duration-value —The length of the lifetime in seconds. The maximum length is 2147483646 seconds (approximately 68 years). • **infinite**—The send lifetime of the key never expires. • end-time —The end-time argument is the time of day and date that the key becomes inactive.

	Command or Action	Purpose
Step 9	(Optional) **include-tcp-options** **Example:** `switch(config-tcpkeychain-tcpkey)# include-tcp-options`	An optional configuration to specify if the full 'TCP Options" part of the TCP header (other than TCP AO option) needs to be included while computing the 'MAC' digest of the packets.

Verifying the TCP Keychain

Command	Purpose
show key chain *[name] [detail]*	Displays the keychains configured on the device.

```
switch# show key chain
Key-Chain bgp_keys tcp
  Key 2 -- text 7 "070e234f"
    send-id 2
    recv-id 2
    cryptographic-algorithm AES_128_CMAC
    send lifetime UTC (08:17:00 May 29 2023)-(08:21:00 May 29 2023)
    include-tcp-options
  Key 3 -- text 7 "070c2058"
    send-id 3
    recv-id 4
    cryptographic-algorithm HMAC-SHA-1
    send lifetime UTC (08:20:00 May 29 2023)-(always valid) [active]
    include-tcp-options
  Key 12 -- text ""
    send lifetime UTC (08:20:00 May 29 2023)-(always valid)
```

Note [active] indicates that the key is valid and active otherwise the key is inactive. In the above example only key 3 is active and usable.

The **show key chain detail** command will explicitly display any active and inactive key(s). In the case of Type 6 encryption, the show key chain detail command will display if the type 6 key-string is decryptable or not. It will also display the newest (youngest) active send key that the client is currently using to authenticate packets.

```
switch# show key chain detail
Key-Chain bgp_keys tcp
  Key 1 -- text 6 "JDYk9k4kmaciqaH6Eu2+9C0tmCRl9k7JAMYs/fXGbW1lmHP88PAA=="
    Type6 Decryptable: yes
    send-id 1
    recv-id 1
    cryptographic-algorithm HMAC-SHA-1
    send lifetime local (18:15:42 May 15 2023)-(always valid) [active]
    include-tcp-options
    accept-ao-mismatch
  Key 2 -- text 6 "JDYkB+Fs8u3ujRDpFSu4tH6H7iTS45JJA6sKeGsBD0L3HjGDeg9AA=="
    Type6 Decryptable: yes
    send-id 2
    recv-id 2
    cryptographic-algorithm AES_128_CMAC
    send lifetime local (17:10:47 May 15 2023)-(18:15:42 May 15 2023) [inactive]

  youngest active send key: 1
```

Configuration Example for a TCP Keychain

This example shows how to configure a TCP keychain named bgp_keys. Each key text string is encrypted. The keys have overlapping lifetime configurations:

```
key chain bgp_keys tcp
  key 1
    send-id 1
    recv-id 1
    key-string 7 070e234f
    send-lifetime 01:00:00 Oct 10 2023 01:00:00 Oct 11 2023
    cryptographic-algorithm AES-128-CMAC
  key 2
    send-id 2
    recv-id 2
    key-string 7 075e731f
    send-lifetime 00:45:00 Oct 11 2023 01:00:00 Oct 12 2023
    cryptographic-algorithm HMAC-SHA-256
    include-tcp-options
```

Resource Public Key Infrastructure (RPKI)

RPKI is a globally distributed database that contains information mapping BGP (internet) prefixes to their authorized origin-AS numbers. To validate the origin-AS of BGP paths, routers running BGP can connect to RPKI caches.

The RPKI-Cache-to-Router connectivity can be many-to-many, one RPKI cache can provide origin-AS validation data to multiple routers and one router can be connected to multiple RPKI caches. A router connects to RPKI caches to download information to build a special RPKI database that can be used by BGP to validate the origin-AS numbers for the internet routing table.

The RPKI database is a set of Route-Origin-Attestation (ROA) objects aggregated from the different RPKI caches to which BGP connects. ROA objects provide a mapping between a BGP prefix-block, and an AS number authorized to originate that block.

Beginning with Cisco NX-OS Release 10.6(1)F, users can configure origin-AS validation feature on an eBGP router of an AS and use Origin Validation State Extended Community to signal validation state to the eBGP peers under their own administration.

RPKI Configuration

RPKI configuration is categorized as:

- commands for connecting to RPKI Caches.
- commands for marking incoming prefixes with RPKI validation state.
- commands for using RPKI validation state in BGP best-path computation.
- commands for dropping out or manipulating prefixes with specific validation states using route-map.

Commands for connecting to RPKI caches

RPKI cache configuration is done in a new rpki-cache submode under the router-bgp submode. This is like configuring BGP peers under the default VRF. The submode is entered by using the "rpki cache <IP address>" command. When you enter the submode, various parameters for the RPKI cache can be configured.

```
router bgp 100
 rpki cache 147.28.0.11
    description        A description to identify the cache
    shutdown           Shutdown the cache
    transport tcp port Transport port on which cache is listening
    vrf                Vrf in which RPKI cache is reachable
    refresh-interval   Specify periodic wait time between cache poll attempts
    retry-interval     Specify wait time before retrying failed serial or reset query
   expiry-interval    Specify how long to use current data while unable to perform successful
 query
```

Note Unless transport TCP port is explicitly configured, BGP will connect to RPKI cache on RPKI-RTR port 323.

Unless explicitly configured, all intervals will be determined as suggested by the RPKI Cache in End of Data PDU.

Commands for marking incoming prefixes with RPKI validation state

There are knobs that control the behavior of RPKI prefix validation processing. These knobs can be configured at the address-family level.

- **origin-as validate** - Configured at the address-family level enables eBGP path validation against ROA database. By default, this is disabled.

Note This command has no bearing on iBGP paths. The iBGP paths are not validated against ROA database. The only way to mark path validation state on iBGP paths is receiving the BGP Prefix Origin Validation State Extended Community, and is done by default without configuring any command.

- **origin-as validate signal ibgp** - Configured at the address-family level enables the iBGP signalling of validity state through BGP Prefix Origin Validation State Extended Community.
- **origin-as validate signal ebgp** - When configured at the address-family level, enables the eBGP signaling of validity state through BGP Prefix Origin Validation State Extended Community to all eBGP peers.

  When configured at the neighbor address-family level, enables the eBGP signaling of validity state through BGP Prefix Origin Validation State Extended Community to that specific eBGP peer.
- **origin-as validate accept ebgp** - Configured at the address-family level, enables the acceptance of validation state from eBGP peers through BGP Prefix Origin Validation State Extended Community.

Commands for using RPKI validation state in BGP best-path-computation

There are commands to control the behavior of RPKI prefix validation processing. These commands can be configured at the address-family level.

- **bestpath origin-as use-validity** - Configured at the address-family level enables the validity states of BGP paths to affect the path's preference in the BGP bestpath process. By default, this is disabled.
- **bestpath origin-as allow invalid** - Configured at the address-family level allows all "invalid" paths to be considered for BGP bestpath computation (all such paths are not bestpath candidates if best-path origin-as validate is configured). By default, this is disabled.

Commands for dropping out or manipulating prefixes with specific validation states using route-map

The following is the command for dropping out or manipulating prefixes with specific validation states using route-map:

```
route-map sample1 permit 10
  match rpki {not-found | invalid | valid}
```

The parameters of the match rpki command are described as follows:

- `not-found` - This origin-AS is unknown in the RPKI database.
- `invalid` - This is an invalid origin-AS in the RPKI database.

  `valid` - This is a valid origin-AS in the RPKI database.

This match clause is relevant for inbound route-maps only.

For iBGP learnt paths, the incoming BGP Prefix Origin Validation State Extended Community in the update will be compared against this route-map clause.

For eBGP learnt paths, the validation state obtained by ROA database lookup will be compared against this route-map clause.

While prefixes marked as validation-state invalid are rendered ineffective by not being considered for best-path computation in BGP, an administrator may decide to drop such prefixes altogether to save system memory. The following inbound route-map is recommended for this purpose:

```
route-map sample deny 10
match rpki invalid
route-map sample permit 20
```

RPKI Show Commands

To display RPKI configuration information, perform one of the following tasks:

Command	Purpose
show bgp rpki summary	Displays an overview of RPKI statistics including the number of RPKI caches.

Command	Purpose
show bgp rpki table {**ipv4** | **ipv6**} {**IP address**/**masklength**}	Displays information about the current RPKI ROA database. With no options specified, the command shows the IPv4 ROA database. With the IPv6 option (show bgp rpki table ipv6), the command shows the IPv6 ROA database. ROAs that are received from a cache that is temporarily down (due to connectivity issues, for example) are displayed with (*). These ROAs will be removed from the RPKI database if the cache session does not establish within the purge-time for that cache. If an ROA prefix-block is specified after the table show command (for example, show bgp rpki table 67.21.36.0/24 max 24), then that specific ROA entry is displayed in detail, if the ROA exists. **Note** One ROA (IP address/min-max) can have multiple origin ASs and can be sourced from multiple caches.
show bgp rpki cache {**IP address**}	Displays a summary listing of all the caches that are configured and their parameters, such as **show bgp summary**. If a cache IP address is specified with the previous command, then detailed information is shown for that cache.
show bgp {**ipv4 unicast** | **ipv6 unicast**} **origin-as validity-state** {**valid** | **invalid** | **unknown**}	Displays information about BGP. This command has new options to filter the BGP table output based on path (validation_state). Specify a validity state (valid, invalid, or unknown) with this command to filter the relevant information from the BGP table, and only the BGP paths matching that validity-state are displayed.

RPKI Clear Commands

The following is the RPKI Clear command:

- **clear bgp rpki cache *** - This command resets the transport sessions of all configured RPKI caches and immediately purges the RPKI database of all IPv4 and IPv6 ROAs received from all caches.

RPKI Debug and Event History Commands

The following are the RPKI Debug and Event History commands:

- **debug bgp rpki** - This command turns on debugging for all RPKI related operations excluding prefix-validation. This includes debugging events such as RPKI cache connectivity, protocol state-machine for the RPKI caches, and RPKI database events such as ROA insertion or deletion.

- **sh bgp event-history rpki** - This command dumps high level information about RPKI.

Resetting a BGP Session

If you modify a route policy for BGP, you must reset the associated BGP peer sessions. If the BGP peers do not support route refresh, you can configure a soft reconfiguration for inbound policy changes. Cisco NX-OS automatically attempts a soft reset for the session.

To configure soft reconfiguration inbound, use the following command in neighbor address-family configuration mode:

SUMMARY STEPS

1. **soft-reconfiguration inbound**
2. **clear bgp ipv4** {**unicast** | **multicast** *ip-address* **soft** {**in** | **out**}
3. (Optional) **clear bgp** {**ipv4** | **ipv6** } {**unicast** | **multicast** *ip-address* **soft** {**in** | **out**}
4. **clear bgp** {**ipv4** | **ipv6**} {**unicast** | **multicast**} *ip-address* **soft** (**in** | **out**)

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**soft-reconfiguration inbound** **Example:** `switch(config-router-neighbor-af)# soft-reconfiguration inbound`	Enables soft reconfiguration to store the inbound BGP route updates. This command triggers an automatic soft clear or refresh of BGP neighbor sessions.

Step 2	**clear bgp ipv4** {**unicast** | **multicast** *ip-address* **soft** {**in** | **out**}
	Example:
	`switch# clear bgp ip unicast 192.0.2.1 soft in`
		This command in any mode resets the BGP session without tearing down the TCP session.

Step 3	(Optional) **clear bgp** {**ipv4** | **ipv6** } {**unicast** | **multicast** *ip-address* **soft** {**in** | **out**}
	Example:
	`switch# clear bgp ip unicast 192.0.2.1 soft in`
		Resets the BGP session without tearing down the TCP session.

Step 4	**clear bgp** {**ipv4** | **ipv6**} {**unicast** | **multicast**} *ip-address* **soft** (**in** | **out**) **Example:** `switch# clear bgp ip unicast 192.0.2.1 soft in`	Resets the BGP session without tearing down the TCP session.

Modifying the Next-Hop Address

You can modify the next-hop address used in a route advertisement in the following ways:

- Disable next-hop calculation and use the local BGP speaker address as the next-hop address.
- Set the next-hop address as a third-party address. Use this feature in situations where the original next-hop address is on the same subnet as the peer that the route is being sent to. Using this feature saves an extra hop during forwarding.

To modify the next-hop address, use the following commands in address-family configuration mode:

SUMMARY STEPS

1. **next-hop-self**
2. **next-hop-third-party**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**next-hop-self** **Example:** `switch(config-router-neighbor-af)# next-hop-self`	Uses the local BGP speaker address as the next-hop address in route updates. This command triggers an automatic soft clear or refresh of BGP neighbor sessions.
Step 2	**next-hop-third-party** **Example:** `switch(config-router-neighbor-af)# next-hop-third-party`	Sets the next-hop address as a third-party address. Use this command for single-hop eBGP peers that do not have **next-hop-self** configured.

Configuring BGP Next-Hop Address Tracking

BGP next-hop address tracking is enabled by default and cannot be disabled.

You can modify the delay interval between RIB checks to increase the performance of BGP next-hop tracking.

To modify the BGP next-hop address tracking, use the following commands in address-family configuration mode:

SUMMARY STEPS

1. **nexthop trigger-delay** {**critical** | **non-critical**} *milliseconds*

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**nexthop trigger-delay** {**critical** | **non-critical**} *milliseconds* **Example:** `switch(config-router-af)# nexthop trigger-delay critical 5000`	Specifies the next-hop address tracking delay timer for critical next-hop reachability routes and for noncritical routes. The range is from 1 to 4294967295 milliseconds. The critical timer default is 3000. The noncritical timer default is 10000.

Configuring Next-Hop Filtering

BGP next-hop filtering allows you to specify that when a next-hop address is checked with the RIB, the underlying route for that next-hop address is passed through the route map. If the route map rejects the route, the next-hop address is treated as unreachable.

BGP marks all next hops that are rejected by the route policy as invalid and does not calculate the best path for the routes that use the invalid next-hop address.

To configure BGP next-hop filtering, use the following command in address-family configuration mode:

SUMMARY STEPS

1. **nexthop route-map** *name*

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**nexthop route-map** *name* **Example:** `switch(config-router-af)# nexthop route-map nextHopLimits`	Specifies a route map to match the BGP next-hop route to. The name can be any case-sensitive, alphanumeric string up to 63 characters.

Configuring Next-Hop Resolution via Default Route

BGP next-hop resolution allows you to specify if the IP default route is used for BGP next-hop resolution.

To configure BGP next-hop resolution, use the following command in router configuration mode:

SUMMARY STEPS

1. [**no**] **nexthop suppress-default-resolution**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	[**no**] **nexthop suppress-default-resolution** **Example:** `switch(config-router)# nexthop suppress-default-resolution`	Prevents resolution of BGP next hop through the IP default route. When this command is enabled: • The output of the **show bgp process detail** command includes the following line: Use default route for nexthop resolution: No • The output of the **show routing clients bgp** command includes the following line: Owned rnh will never resolve to 0.0.0.0/0

Controlling Reflected Routes Through Next-Hop-Self

NX-OS enables controlling the iBGP routes being sent to a specific peer through the **next-hop-self** [all] arguments. By using these arguments, you can selectively change the next-hop of routes even if the route is reflected.

Command	Purpose
next-hop-self [all] **Example**: `switch(config-router-af)# next-hop-self all`	Uses the local BGP speaker address as the next-hop address in route updates. The all keyword is optional. If you specify all, all routes are sent to the peer with next-hop-self. If you do not specify all, the next hops of reflected routes are not changed.

Shrinking Next-Hop Groups When A Session Goes Down

You can configure BGP to shrink ECMP groups in an accelerated way when a session goes down.

This feature applies to the following BGP path failure events:

- Any single or multiple Layer 3 link failures
- Line card failures
- BFD failure detections for BGP neighbors
- Administrative shutdown of BGP neighbors (using the shutdown command)

The accelerated handling of the first two events (Layer 3 link failures and line card failures) is enabled by default and does not require a configuration command to be enabled.

To configure the accelerated handling of the last two events, use the following command in router configuration mode:

SUMMARY STEPS

1. **neighbor-down fib-accelerate**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**neighbor-down fib-accelerate** **Example:** `switch(config-router)# neighbor-down fib-accelerate`	Withdraws the corresponding next hop from all next-hop groups (ECMP groups and single next-hop routes) whenever a BGP session goes down. **Note** This command applies to both IPv4 and IPv6 routes.

Disabling Capabilities Negotiation

You can disable capabilities negotiations to interoperate with older BGP peers that do not support capabilities negotiation.

To disable capabilities negotiation, use the following command in neighbor configuration mode:

SUMMARY STEPS

1. **dont-capability-negotiate**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**dont-capability-negotiate** **Example:** `switch(config-router-neighbor)# dont-capability-negotiate`	Disables capabilities negotiation. You must manually reset the BGP sessions after configuring this command.

Disabling Policy Batching

In BGP deployments where prefixes have unique attributes, BGP tries to identify routes with similar attributes to bundle in the same BGP update message. To avoid the overhead of this additional BGP processing, you can disable batching.

Cisco recommends that you disable policy batching for BGP deployments that have a large number of routes with unique next hops.

To disable policy batching, use the following command in router configuration mode:

SUMMARY STEPS

1. **disable-policy-batching**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**disable-policy-batching** **Example:** `switch(config-router)# disable-policy-batching`	Disables the batching evaluation of prefix advertisements to all peers.

Configuring BGP Additional Paths

BGP supports sending and receiving multiple paths per prefix and advertising such paths.

Advertising the Capability of Sending and Receiving Additional Paths

You can configure BGP to advertise the capability of sending and receiving additional paths to and from the BGP peers. To do so, use the following commands in neighbor address-family configuration mode:

SUMMARY STEPS

1. [**no**] **capability additional-paths send** [**disable**]
2. [**no**] **capability additional-paths receive** [**disable**]
3. **show bgp neighbor**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	[**no**] **capability additional-paths send** [**disable**] **Example:** `switch(config-router-neighbor-af)# capability addtional-paths send`	Advertises the capability to send additional paths to the BGP peer. The **disable** option disables the advertising capability of sending additional paths. The **no** form of this command disables the capability of sending additional paths.

	Command or Action	Purpose
Step 2	[**no**] **capability additional-paths receive** [**disable**] **Example:** `switch(config-router-neighbor-af)# capability addtional-paths receive`	Advertises the capability to receive additional paths from the BGP peer. The **disable** option disables the advertising capability of receiving additional paths. The **no** form of this command disables the capability of receiving additional paths.
Step 3	**show bgp neighbor** **Example:** `switch(config-router-neighbor-af)# show bgp neighbor`	Displays whether the local peer has advertised the additional paths send or receive capability to the remote peer.

Example

This example shows how to configure BGP to advertise the capability to send and receive additional paths to and from the BGP peer:

```
switch# configure terminal
switch(config)# router bgp 100
switch(config-router)# neighbor 10.131.31.2 remote-as 100
switch(config-router-neighbor)# address-family ipv4 unicast
switch(config-router-neighbor-af)# capability additional-paths send
switch(config-router-neighbor-af)# capability additional-paths receive
```

Configuring the Sending and Receiving of Additional Paths

You can configure the capability of sending and receiving additional paths to and from the BGP peers. To do so, use the following commands in address-family configuration mode:

SUMMARY STEPS

1. [**no**] **additional-paths send**
2. [**no**] **additional-paths receive**
3. **show bgp neighbor**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	[**no**] **additional-paths send** **Example:** `switch(config-router-af)# additional-paths send`	Enables the send capability of additional paths for all of the neighbors under this address family for which the capability has not been disabled. The **no** form of this command disables the send capability.

	Command or Action	Purpose
Step 2	[**no**] **additional-paths receive** **Example:** `switch(config-router-af)# additional-paths receive`	Enables the receive capability of additional paths for all of the neighbors under this address family for which the capability has not been disabled. The **no** form of this command disables the receive capability.
Step 3	**show bgp neighbor** **Example:** `switch(config-router-af)# show bgp neighbor`	Displays whether the local peer as advertised the additional paths send or receive capability to the remote peer.

Example

This example shows how to enable the additional paths send and receive capability for all neighbors under the specified address family for which this capability has not been disabled:

```
switch# configure terminal
switch(config)# router bgp 100
switch(config-router)# address-family ipv4 unicast
switch(config-router-af)# additional-paths send
switch(config-router-af)# additional-paths receive
```

Configuring Advertised Paths

You can specify the paths that are advertised for BGP. To do so, use the following commands in route-map configuration mode:

SUMMARY STEPS

1. [**no**] **set ip next-hop unchanged**
2. [**no**] **set path-selection { all | backup | best2 | multipaths}** | advertise
3. **show bgp** {**ipv4** | **ipv6**} **unicast** [*ip-address* | *ipv6-prefix*] [**vrf** *vrf-name*]

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	[**no**] **set ip next-hop unchanged** **Example:** `switch(config-route-map)# set ip next-hop unchanged`	Specifies and unchanged next-hop IP address.
Step 2	[**no**] **set path-selection { all | backup | best2 | multipaths}** | advertise **Example:**	Specifies that all paths be advertised for a given prefix. You can use one of the following options: • all—Advertises all available valid paths.

	Command or Action	Purpose
	`switch(config-route-map)# set path-selection all advertise`	• backup—Advertises paths marked as backup paths. This option requires that backup paths be enabled using the additional-path install backup command. • best2—Advertises the second best path, which is the best path of the remaining available paths, except the already calculated best path. • multipaths—Advertises all multipaths. This option requires that multipaths be enabled using the maximum-paths command. **Note** If there are no multipaths, the backup and best2 options are the same. If there are multipaths, best2 is the first path on the list of multipaths while backup is the best path of all available paths, except the calculated best path and multipaths. The **no** form of this command specifies that only the best path be advertised.
Step 3	**show bgp** {**ipv4** | **ipv6**} **unicast** [*ip-address* | *ipv6-prefix*] [**vrf** *vrf-name*] **Example:** `switch(config-route-map)# show bgp ipv4 unicast`	Displays the path ID for the additional paths of a prefix and advertisement information for these paths.

Example

This example show how to specify that all paths be advertised for the prefix list p1:

```
switch# configure terminal
switch(config)# route-map PATH_SELECTION_RMAP
switch(config-route-map)# match ip address prefix-list p1
switch(config-route-map)# set path-selection all advertise
```

Configuring Additional Path Selection

You can configure the capability fo selecting additional paths for a prefix. To do so, use the following commands in address-family configuration mode:

SUMMARY STEPS

1. [**no**] **additional-paths selection route-map** *map-name*
2. **show bgp** {**ipv4** | **ipv6**} **unicast** [*ip-address* | *ipv6-prefix*] [**vrf** *vrf-name*]

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	[**no**] **additional-paths selection route-map** *map-name* **Example:** `switch(config-router-af)# additional paths selection route-map map1`	Configures the capability of selecting additional paths for a prefix. The **no** form of this command disables the additional paths selection capability.
Step 2	**show bgp** {**ipv4** | **ipv6**} **unicast** [*ip-address* | *ipv6-prefix*] [**vrf** *vrf-name*] **Example:** `switch(config-route-af)# show bgp ipv4 unicast`	Displays the path ID for the additional paths of a prefix and advertisement information for these paths.

Example

This example shows how to configure additional paths selection under the specified address family:

```
switch# configure terminal
switch(config)# router bgp 100
switch(config-router)# address-family ipv4 unicast
switch(config-router-af)# additional-paths selection route-map PATH_SELECTION_RMAP
```

Configuring eBGP

Disabling eBGP Single-Hop Checking

You can configure eBGP to disable checking whether a single-hop eBGP peer is directly connected to the local router. Use this option for configuring a single-hop loopback eBGP session between directly connected switches.

To disable checking whether or not a single-hop eBGP peer is directly connected, use the following command in neighbor configuration mode:

SUMMARY STEPS

1. **disable-connected-check**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**disable-connected-check** **Example:** `switch(config-router-neighbor)# disable-connected-check`	Disables checking whether or not a single-hop eBGP peer is directly connected. You must manually reset the BGP sessions after using this command.

Configuring TTL Security Hops

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*
6. **ttl-security hops** *hop-count*
7. **end**
8. **show running-config**
9. **show ip bgp neighbors** *[ip-address]*

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `switch(config)# enable`	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	**trace** *[protocol] destination* **Example:** `switch(config)# trace ip 10.1.1.1`	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.
Step 3	**configure terminal** **Example:** `switch(config)# configure terminal`	Enters global configuration mode.
Step 4	**router bgp** *autonomous-system-number* **Example:** `switch(config)# router bgp 65000`	Enters router configuration mode, and creates a BGP routing process.
Step 5	**neighbor** *ip-address* **Example:** `switch(config)# neighbor 10.1.1.1`	Configures the neighbor IP address.
Step 6	**ttl-security hops** *hop-count* **Example:** `switch(config)# ttl-security hops 2`	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.
Step 7	**end** **Example:**	Exits router configuration mode and enters privileged EXEC mode.

	Command or Action	Purpose
	`switch(config)# end`	
Step 8	**show running-config** **Example:** `switch(config)# show running-config | begin bgp`	(Optional) Displays the contents of the currently running configuration file. The output of this command displays the configuration of the neighbor ttl-security command for each peer under the BGP configuration section of output. That section includes the neighbor address and the configured hop count. **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 9	**show ip bgp neighbors** *[ip-address]* **Example:** `switch(config)# show ip bgp neighbors 10.4.9.5`	(Optional) Displays information about the TCP and BGP connections to neighbors. This command displays "External BGP neighbor may be up to number hops away" when the BGP Support for TTL Security Check feature is enabled. The number value represents the hop count. It is a number from 1 to 254. **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.

Configuring eBGP Multihop

You can configure the eBGP time-to-live (TTL) value to support eBGP multihop. In some situations, an eBGP peer is not directly connected to another eBGP peer and requires multiple hops to reach the remote eBGP peer. You can configure the eBGP TTL value for a neighbor session to allow these multihop sessions.

Note This configuration is not supported for BGP interface peering.

To configure eBGP multihop, use the following command in neighbor configuration mode:

SUMMARY STEPS

1. **ebgp-multihop** *ttl-value*

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**ebgp-multihop** *ttl-value* **Example:** `switch(config-router-neighbor)# ebgp-multihop 5`	Configures the eBGP TTL value for eBGP multihop. The range is from 2 to 255. You must manually reset the BGP sessions after using this command.

Disabling a Fast External Fallover

By default, the Cisco Nexus 7000 Series device supports fast external fallover for neighbors in all VRFs and address-families (IPv4 or IPv6).

Be default, the Cisco NX-OS device supports fast external fallover for neighbors in all VRFs and address families (IPv4 or IPv6). Typically, when a BGP router loses connectivity to a directly connected eBGP peer, BGP triggers a fast external fallover by resetting the eBGP session to the peer. You can disable this fast external fallover to limit the instability caused by link flaps.

To disable fast external fallover, use the following command in router configuration mode:

SUMMARY STEPS

1. **no fast-external-fallover**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**no fast-external-fallover** **Example:** `switch(config-router)# no fast-external-fallover`	Disables a fast external fallover for eBGP peers. This command is enabled by default.

Limiting the AS-path Attribute

You can configure eBGP to discard routes that have a high number of AS numbers in the AS-path attribute.

To discard routes that have a high number of AS numbers in the AS-path attribute, use the following command in router configuration mode:

SUMMARY STEPS

1. **maxas-limit** *number*

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**maxas-limit** *number* **Example:** `switch(config-router)# maxas-limit 50`	Discards eBGP routes that have a number of AS-path segments that exceed the specified limit. The range is from 1 to 512.

Configuring Local AS Support

The local-AS feature allows a router to appear to be a member of a second autonomous system (AS), in addition to its real AS. Local AS allows two ISPs to merge without modifying peering arrangements. Routers in the merged ISP become members of the new autonomous system but continue to use their old AS numbers for their customers.

This feature can only be used for true eBGP peers. You cannot use this feature for two peers that are members of different confederation subautonomous systems.

Furthermore, the remote peer's ASN configured with the remote-as command cannot be identical to the local device's ASN configured with the local-as command.

To configure eBGP local AS support, use the following command in neighbor configuration mode:

SUMMARY STEPS

1. **local-as** *number* [**no-prepend** [**replace-as** [**dual-as**]]]

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**local-as** *number* [**no-prepend** [**replace-as** [**dual-as**]]] **Example:** `switch(config-router-neighbor)# local-as 1.1`	Configures eBGP to prepend the local AS *number* to the AS_PATH attribute. The AS *number* can be a 16-bit integer or a 32-bit integer in the form of a higher 16-bit decimal number and a lower 16-bit decimal number in xx.xx format.

Example

This example shows how to configure local AS support on a VRF:

```
switch# configure terminal
switch(config)# router bgp 1
switch(config-router)# vrf test
switch(config-router-vrf)# local-as 1
switch(config-router-vrf)# show running-config bgp
```

Configuring AS Confederations

To configure an AS confederation, you must specify a confederation identifier. To the outside world, the group of autonomous systems within the AS confederation 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:

SUMMARY STEPS

1. **confederation identifier** *as-number*
2. **bgp confederation peers** *as-number* [*as-number2...*]

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**confederation identifier** *as-number* **Example:** `switch(config-router)# confederation identifier 4000`	In router configuration mode, this command configures a BGP confederation identifier. The command triggers an automatic notification and session reset for the BGP neighbor sessions.
Step 2	**bgp confederation peers** *as-number* [*as-number2...*] **Example:** `switch(config-router)# bgp confederation peers 5 33 44`	In router configuration mode, this command configures the autonomous systems that belong to the AS confederation. The command specifies a list of autonomous systems that belong to the confederation and it triggers an automatic notification and session reset for the BGP neighbor sessions.

Configuring Route Reflector

You can configure iBGP peers as route reflector clients to the local BGP speaker, which acts as the route reflector. Together, a route reflector and its clients form a cluster. A cluster of clients usually has a single route reflector. In such instances, the cluster is identified by the router ID of the route reflector. To increase redundancy and avoid a single point of failure in the network, you can configure a cluster with more than one route reflector. You must configure all route reflectors in the cluster with the same 4-byte cluster ID so that a route reflector can recognize updates from route reflectors in the same cluster.

Before you begin

You must enable BGP.

SUMMARY STEPS

1. **configure terminal**
2. **router bgp** *as-number*
3. **cluster-id** *cluster-id*
4. **address-family** {**ipv4** | **ipv6**} {**unicast** | **multicast**}

5. (Optional) **client-to-client reflection**
6. **exit**
7. **neighbor** *ip-address* **remote-as** *as-number*
8. **address-family** {**ipv4** | **ipv6**} {**unicast** | **multicast**}
9. **route-reflector-client**
10. (Optional) **show bgp** {**ipv4** | **ipv6**} {**unicast** | **multicast**} **neighbors**
11. (Optional) **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `switch# configure terminal`	Enters global configuration mode.

Step 2	**router bgp** *as-number*
	Example:
	`switch(config)# router bgp 65535`
	`switch(config-router)#`
		Enters BGP mode and assigns the autonomous system number to the local BGP speaker.

Step 3	**cluster-id** *cluster-id* **Example:** `switch(config-router)# cluster-id 192.0.2.1`	Configures the local router as one of the route reflectors that serve the cluster. You specify a cluster ID to identify the cluster. This command triggers an automatic soft clear or refresh of BGP neighbor sessions.

Step 4	**address-family** {**ipv4** | **ipv6**} {**unicast** | **multicast**}
	Example:
	`switch(config-router)# address-family ipv4 unicast`
	`switch(config-router-af)#`
		Enters router address family configuration mode for the specified address family.

Step 5	(Optional) **client-to-client reflection** **Example:** `switch(config-router-af)# client-to-client reflection`	Configures client-to-client route reflection. This feature is enabled by default. This command triggers an automatic soft clear or refresh of BGP neighbor sessions.

Step 6	**exit**
	Example:
	`switch(config-router-af)# exit`
	`switch(config-router)#`
		Exits router address configuration mode.

Step 7	**neighbor** *ip-address* **remote-as** *as-number* **Example:**	Configures the IP address and AS number for a remote BGP peer.

	Command or Action	Purpose

	`switch(config-router)# neighbor 192.0.2.10 remote-as 65535`
	`switch(config-router-neighbor)#`	

Step 8	**address-family** {**ipv4** | **ipv6**} {**unicast** | **multicast**}
	Example:
	`switch(config-router-neighbor)# address-family ipv4 unicast`
	`switch(config-router-neighbor-af)#`
		Enters neighbor address family configuration mode for the unicast IPv4 address family.

Step 9	**route-reflector-client** **Example:** `switch(config-router-neighbor-af)# route-reflector-client`	Configures the device as a BGP route reflector and configures the neighbor as its client. This command triggers an automatic notification and session reset for the BGP neighbor sessions.
Step 10	(Optional) **show bgp** {**ipv4** | **ipv6**} {**unicast** | **multicast**} **neighbors** **Example:** `switch(config-router-neighbor-af)# show bgp ipv4 unicast neighbors`	Displays the BGP peers.
Step 11	(Optional) **copy running-config startup-config** **Example:** `switch(config-router-neighbor-af)# copy running-config startup-config`	Saves this configuration change.

Example

This example shows how to configure the router as a route reflector and add one neighbor as a client:

```
switch(config)# router bgp 65536
switch(config-router)# neighbor 192.0.2.10 remote-as 65536
switch(config-router-neighbor)# address-family ip unicast
switch(config-router-neighbor-af)# route-reflector-client
switch(config-router-neighbor-af)# copy running-config startup-config
```

Configuring Next-Hops on Reflected Routes Using an Outbound Route-Map

You can change the next-hop on reflected routes on a BGP route reflector using an outbound route-map. You can configure the outbound route-map to specify the peer's local address as the next-hop address.

Note The **next-hop-self** command does not enable this functionality for routes being reflected to clients by a route reflector. This functionality can only be enabled using an outbound route-map.

Before you begin

You must enable BGP (see the Enabling BGP section).

Ensure that you are in the correct VDC (or use the **switchto vdc** command).

You must enter the **set next-hop** command to configure an address family-specific next-hop address. For example, for the IPv6 address family, you must enter the **set ipv6 next-hop peer-address** command.

- When setting IPv4 next-hops using route-maps—If **set ip next-hop peer-address** matches the route-map, the next-hop is set to the peer's local address. If no next-hop is set in the route-map, the next-hop is set to the one stored in the path.
- When setting IPv6 next-hops using route-maps—If **set ipv6 next-hop peer-address** matches the route-map, the next-hop is set as follows:
    - For IPv6 peers, the next-hop is set to the peer's local IPv6 address.
    - For IPv4 peers, if **update-source** is configured, the next-hop is set to the source interface's IPv6 address, if any. If no IPv6 address is configured, no next-hop is set
    - For IPv4 peers, if **update-source** is not configured, the next-hop is set to the outgoing interface's IPv6 address, if any. If no IPv6 address is configured, no next-hop is set.

SUMMARY STEPS

1. **configure terminal**
2. **router bgp** *as-number*
3. **neighbor** *ip-address* **remote-as** *as-number*
4. (Optional) **update-source** *interface number*
5. **address-family** {**ipv4** | **ipv6**} {**unicast** | **multicast**}
6. **route-reflector-client**
7. **route-map** *map-name* **out**
8. (Optional) **show bgp** {**ipv4** | **ipv6**} {**unicast** | **multicast**} [**ip-address** | **ipv6-prefix**] **route-map** *map-name* [**vrf** *vrf-name*]
9. (Optional) **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**router bgp** *as-number*
	Example:
	`switch(config)# router bgp 200`
	`switch(config-router)#`
		Enters BGP mode and assigns the autonomous system number to the local BGP speaker.

Step 3	**neighbor** *ip-address* **remote-as** *as-number* **Example:**	Configures the IP address and AS number for a remote BGP peer.

	Command or Action	Purpose

	`switch(config-router)# neighbor 192.0.2.12 remote-as 200`
	`switch(config-router-neighbor)#`	

Step 4	(Optional) **update-source** *interface number* **Example:** `switch(config-router-neighbor)# update-source loopback 300`	Specifies and updates the source of the BGP session.

Step 5	**address-family** {**ipv4** | **ipv6**} {**unicast** | **multicast**}
	Example:
	`switch(config-router-neighbor)# address-family ipv4 unicast`
	`switch(config-router-neighbor-af)#`
		Enters router address family configuration mode for the specified address family.

Step 6	**route-reflector-client** **Example:** `switch(config-router-neighbor-af)# route-reflector-client`	Configures the device as a BGP route reflector and configures the neighbor as its client. This command triggers an automatic notification and session reset for the BGP neighbor sessions.
Step 7	**route-map** *map-name* **out** **Example:** `switch(config-router-neighbor-af)# route-map setrrnh out`	Applies the configured BGP policy to outgoing routes.
Step 8	(Optional) **show bgp** {**ipv4** | **ipv6**} {**unicast** | **multicast**} [**ip-address** | **ipv6-prefix**] **route-map** *map-name* [**vrf** *vrf-name*] **Example:** `switch(config-router-neighbor-af)# show bgp ipv4 unicast route-map setrrnh`	Displays the BGP routes that match the route map.
Step 9	(Optional) **copy running-config startup-config** **Example:** `switch(config-router-neighbor-af)# copy running-config startup-config`	Saves this configuration change.

Example

This example shows how to configure the next-hop on reflected routes on a BGP route reflector using an outbound route-map:

```
switch(config)# interface loopback 300
switch(config-if)# ip address 192.0.2.11/32
switch(config-if)# ipv6 address 2001::a0c:1a65/64
switch(config-if)# ip router ospf 1 area 0.0.0.0
switch(config-if)# exit
switch(config)# route-map setrrnh permit 10
switch(config-route-map)# set ip next-hop peer-address
switch(config-route-map)# exit
switch(config)# route-map setrrnhv6 permit 10
switch(config-route-map)# set ipv6 next-hop peer-address
switch(config-route-map)# exit
switch(config)# router bgp 200
switch(config-router)# neighbor 192.0.2.12 remote-as 200
switch(config-router-neighbor)# update-source loopback 300
switch(config-router-neighbor)# address-family ipv4 unicast
switch(config-router-neighbor-af)# route-reflector-client
switch(config-router-neighbor-af)# route-map setrrnh out
switch(config-router-neighbor-af)# exit
switch(config-router-neighbor)# address-family ipv6 unicast
switch(config-router-neighbor-af)# route-reflector-client
switch(config-router-neighbor-af)# route-map setrrnhv6 out
```

Configuring Route Dampening

You can configure route dampening to minimize route flaps propagating through your iBGP network.

To configure route dampening, use the following command in address-family or VRF address family configuration mode:

SUMMARY STEPS

1. **dampening** [{*half-life reuse-limit suppress-limit max-suppress-time* | **route-map** *map-name*}]

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**dampening** [{*half-life reuse-limit suppress-limit max-suppress-time* | **route-map** *map-name*}] **Example:** `switch(config-router-af)# dampening route-map bgpDamp`	Disables capabilities negotiation. The parameter values are as follows: • *half-life*—The range is from 1 to 45. • *resuse-limit*—The range is from 1 to 20000. • *suppress-limit*—The range is from 1 to 20000. • *max-suppress-time*—The range is from 1 to 255.

Configuring Load Sharing and ECMP

You can configure the maximum number of paths that BGP adds to the route table for equal-cost multipath (ECMP) load balancing.

To configure the maximum number of paths, use the following command in router address-family configuration mode:

SUMMARY STEPS

1. **maximum-paths** [**ibgp**] *maxpaths*

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**maximum-paths** [**ibgp**] *maxpaths* **Example:** `switch(config-router-af)# maximum-paths 8`	Configures the maximum number of equal-cost paths for load sharing. The default is 1.

Unequal Cost Multipath (UCMP) over BGP

UCMP is also known as Weighted ECMP. It is a mechanism that allows multiple routes to the same destination with different weights per next-hop and load-balances the routed traffic over those multiple next-hops. The basic UCMP works for most of the customers' requirements. The load entropy is the best way to maximize the link usage efficiency.

Often, the application distribution in the network can be unbalanced. The new clusters roll in at different over-subscription rates than the old clusters. The new clusters have powerful servers than the old clusters and they are capable of handling more load per CPU. As the network is not perfect, some control over routing behavior is needed. You can configure Weighted ECMP over BGP for balancing the traffic load and for administering control over the routing behavior.

Note The Link-Bandwidth Extended Community must be advertised across eBGP sessions, although it is defined as a non-transitive attribute.

Next-hop-self must strip the Link-Bandwidth Extended Community from advertisements.

Enabling UCMP over BGP

The solution for the unequal distribution of the resources and sub-optimal traffic distribution use-cases is to configure Weighted ECMP over BGP. You can inject the routes (from the host or the controller) and signal a weight for each instance. You can then aggregate the weights across the infrastructure and deliver the traffic in the direct proportion to the application deployment distribution.

Guidelines and Limitations for UCMP over BGP

- BGP uses the Link-Bandwidth Extended Community defined in the draft-ietf-idr-link-bandwidth-06.txt to implement the weighted ECMP feature. The Link-Bandwidth Extended Community is advertised across eBGP sessions, although it's defined as a non-transitive attribute, as long as next-hop is unchanged.
- You can accept Link-Bandwidth Extended Community from both iBGP and eBGP peers.
- For weights programming, the Link-Bandwidth Extended Community has the link bandwidth encoded in bytes/second, as a four byte floating point integer, that is normalized between 0 and 1000 before downloading to RIB.
- The hardware ECMP width is fixed as 64 in size.

Configuring Maximum Prefixes

You can configure the maximum number of prefixes that BGP can receive from a BGP peer. If the number of prefixes exceeds this value, you can optionally configure BGP to generate a warning message or tear down the BGP session to the peer.

To configure the maximum allowed prefixes for a BGP peer, use the following command in neighbor address-family configuration mode:

SUMMARY STEPS

1. **maximum-prefix** *maximum* [*threshold*] [**restart** *time* | **warning-only**]

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**maximum-prefix** *maximum* [*threshold*] [**restart** *time* | **warning-only**] **Example:** `switch(config-router-neighbor-af)# maximum-prefix 12`	Configures the maximum number of prefixes from a peer. The parameter ranges are as follows: • *maximum*—The range is from 1 to 300000. • *threshold*—The range is from 1 to 100 percent. The default is 75 percent. • *time*—The range is from 1 to 65535 minutes. This command triggers an automatic notification and session reset for the BGP neighbor sessions if the prefix is exceeded.

Configuring DSCP

You can configure a differentiated services code point (DSCP) for a neighbor. You can specify a DSCP value for locally originated packets for IPv4 or IPv6.

To configure the DSCP value, use the following command in neighbor configuration mode:

SUMMARY STEPS

1. **dscp** *dscp_value*

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**dscp** *dscp_value* **Example:**	Sets the differentiated services code point (DSCP) value for the neighbor. The DSCP value can be a number from 0 to 63, or it can be one of the following keywords: **ef**, **af11**,

	Command or Action	Purpose

	`switch(config-router-neighbor)# dscp 63`
	Below is an example of the corresponding **show** command:
	`show ipv6 bgp neighbors`
	`BGP neighbor is 10.1.1.1, remote AS 0, unknown link, Peer index 4`
	`  BGP version 4, remote router ID 0.0.0.0`
	`  BGP state = Idle, down for 00:13:34, retry in 0.000000`
	`  DSCP (DiffServ CodePoint): 0`
	`  Last read never, hold time = 180, keepalive interval is 60 seconds`
		af12, **af13**, **af21**, **af22**, **af23**, **af31**, **af32**, **af33**, **af41**, **af42**, **af43**, **cs1**, **cs2**, **cs3**, **cs4**, **cs5**, **cs6**, or **cs7**.
		The default value is cs6.

Configuring Dynamic Capability

You can configure dynamic capability for a BGP peer.

To configure dynamic capability, use the following command in neighbor configuration mode:

SUMMARY STEPS

1. **dynamic-capability**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**dynamic-capability** **Example:** `switch(config-router-neighbor)# dynamic-capability`	Enables dynamic capability. This command triggers an automatic notification and session reset for the BGP neighbor sessions.

Configuring Aggregate Addresses

You can configure aggregate address entries in the BGP route table.

To configure an aggregate address, use the following command in router address-family configuration mode:

SUMMARY STEPS

1. **aggregate-address** *ip-prefix/length* [**as-set**] [**summary-only**] [**advertise-map** *map-name*] [**attribute-map** *map-name*] [**suppress-map** *map-name*]

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**aggregate-address** *ip-prefix/length* [**as-set**] [**summary-only**] [**advertise-map** *map-name*] [**attribute-map** *map-name*] [**suppress-map** *map-name*] **Example:** `switch(config-router-af)# aggregate-address 192.0.2.0/8 as-set`	Creates an aggregate address. The path advertised for this route is an autonomous system set that consists of all elements contained in all paths that are being summarized: • The **as-set** keyword generates autonomous system set path information and community information from contributing paths. • The **summary-only** keyword filters all more specific routes from updates. • The **advertise-map** keyword and argument specify the route map used to select attribute information from selected routes. • The **attribute-map** keyword and argument specify the route map used to select attribute information from the aggregate. • The **suppress-map** keyword and argument conditionally filter more specific routes. If you specify the **suppress-map** option while performing a BGP route aggregation, you can set the community attribute for a BGP route update. This option enables you to set community attributes on the more-specific routes. • The **suppress-map** keyword and argument conditionally filter more specific routes. If you specify the **suppress-map** option while performing a BGP route aggregation, you can either suppress certain more-specific routes from being advertised to its peers, or decide to advertise the more-specific routes with some community attributes set on them, depending upon the suppress-map route-map configuration. A route-map configured with only match clauses will suppress the more-specific routes that satisfy the match criteria. However, if a route-map is configured with match and set clauses, then the routes satisfying the match criteria will be advertised with the appropriate attributes as modified by the route-map. The second option enables you to set community attributes on the more-specific routes.

Suppressing BGP Routes

You can configure Cisco NX-OS to advertise newly learned BGP routes only after these routes are confirmed by the Forwarding Information Base (FIB) and programmed in the hardware. After the routes are programmed, subsequent changes to these routes do not require this hardware-programming check.

To suppress BGP routes, use the following command in router configuration mode:

SUMMARY STEPS

1. **suppress-fib-pending**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**suppress-fib-pending** **Example:** `switch(config-router)# suppress-fib-pending`	Suppresses newly learned BGP routes (IPv4 or IPv6) from being advertised to downstream BGP neighbors until the routes have been programmed in the hardware.

Configuring BGP Conditional Advertisement

You can configure BGP conditional advertisement to limit the routes that BGP propagates. You define the following two route maps:

- Advertise map—Specifies the conditions that the route must match before BGP considers the conditional advertisement. This route map can contain any appropriate match statements.
- Exist map or nonexist map—Defines the prefix that must exist in the BGP table before BGP propagates a route that matches the advertise map. The nonexist map defines the prefix that must not exist in the BGP table before BGP propagates a route that matches the advertise map. BGP processes only the permit statements in the prefix list match statements in these route maps.
- Nexus does not support any other BGP Attribute change operation (example prepend AS Path) with Conditional Route Advertisements. It is used to control which routes are advertised based on exist/non-exist map configuration.

If the route does not pass the condition, BGP withdraws the route if it exists in the BGP table.

Before you begin

You must enable BGP(see the Enabling BGP section).

SUMMARY STEPS

1. **configure terminal**
2. **router bgp** *as-number*
3. **neighbor** *ip-address* **remote-as** *as-number*

4. **address-family** {**ipv4** | **ipv6**} {**unicast** | **multicast**}
5. **advertise-map** *adv-map* {**exist-map** *exist-rmap*|**non-exist-map** *nonexist-rmap*}
6. (Optional) **show bgp** {**ipv4** | **ipv6**} {**unicast** | **multicast**} **neighbors**
7. (Optional) **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters configuration mode.

Step 2	**router bgp** *as-number*
	Example:
	`switch(config)# router bgp 65535`
	`switch(config-router)#`
		Enters BGP mode and assigns the autonomous system number to the local BGP speaker.

Step 3	**neighbor** *ip-address* **remote-as** *as-number*
	Example:
	`switch(config-router)# neighbor`
	`192.168.1.2 remote-as 65534`
	`switch(config-router-neighbor)#`
		Places the router in neighbor configuration mode for BGP routing and configures the neighbor IP address.

Step 4	**address-family** {**ipv4** | **ipv6**} {**unicast** | **multicast**}
	Example:
	`switch(config-router-neighbor)#`
	`address-family ipv4 multicast`
	`switch(config-router-neighbor-af)#`
		Enters address family configuration mode.

Step 5	**advertise-map** *adv-map* {**exist-map** *exist-rmap*|**non-exist-map** *nonexist-rmap*}
	Example:
	`switch(config-router-neighbor-af)#`
	`advertise-map advertise exist-map exist`
		Configures BGP to conditionally advertise routes based on the two configured route maps:
		• *adv-map*—Specifies a route map with **match** statements that the route must pass before BGP passes the route to the next route map. The *adv-map* is a case-sensitive, alphanumeric string up to 63 characters.
		• *exist-rmap*—Specifies a route map with match statements for a prefix list. A prefix in the BGP table must match a prefix in the prefix list before BGP advertises the route. The *exist-rmap* is a case-sensitive, alphanumeric string up to 63 characters.
		• *nonexist-rmap*—Specifies a route map with match statements for a prefix list. A prefix in the BGP table must not match a prefix in the prefix list before BGP

	Command or Action	Purpose
		advertises the route. The *nonexist-rmap* is a case-sensitive, alphanumeric string up to 63 characters. **Note** For BGP conditional advertisement feature, ensure that the "le" or "ge" statements are not used on prefix-list when associated to exist or nonexist map.
Step 6	(Optional) **show bgp** {**ipv4** | **ipv6**} {**unicast** | **multicast**} **neighbors** **Example:** `switch(config-router-neighbor-af)# show ip bgp neighbor`	Displays information about BGP and the configured conditional advertisement route maps.
Step 7	(Optional) **copy running-config startup-config** **Example:** `switch(config-router-neighbor-af)# copy running-config startup-config`	Saves this configuration change.

Example

This example shows how to configure BGP conditional advertisement:

```
switch# configure terminal
switch(config)# router bgp 65536
switch(config-router)# neighbor 192.0.2.2 remote-as 65537
switch(config-router-neighbor)# address-family ipv4 unicast
switch(config-router-neighbor-af)# advertise-map advertise exist-map exist
switch(config-router-neighbor-af)# exit
switch(config-router-neighbor)# exit
switch(config-router)# exit
switch(config)# route-map advertise
switch(config-route-map)# match as-path pathList
switch(config-route-map)# exit
switch(config)# route-map exit
switch(config-route-map)# match ip address prefix-list plist
switch(config-route-map)# exit
switch(config)# ip prefix-list plist permit 209.165.201.0/27
```

Configuring Route Redistribution

You can configure BGP to accept routing information from another routing protocol and redistribute that information through the BGP network. Optionally, you can assign a default route for redistributed routes.

Before you begin

Ensure that you have enabled the BGP feature

- You must enable BGP (see the Enabling BGP section).
- Ensure that you are in the correct VDC (or use the **switchto vdc** command).

You must enable BGP.

SUMMARY STEPS

1. **configure terminal**
2. **router bgp** *as-number*
3. **address-family ipv4** {**unicast** | **multicast**}
4. **address-family** {**ipv4** | **ipv6** } {**unicast** | **multicast**}
5. **address-family** {**ipv4** | **ipv6**} {**unicast** | **multicast**}
6. **redistribute** {**direct**| {**eigrp** |**ospf** | **ospfv3** |**rip**} *instance-tag* | **static**} **route-map** *map-name*
7. **redistribute** {**direct** | {**eigrp** | **isis** | **ospf** | **ospfv3** | **rip**} *instance-tag* | **static** | **icmpv6**} **route-map** *map-name*
8. (Optional) **default-metric** *value*
9. (Optional) **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**router bgp** *as-number*
	Example:
	`switch(config)# router bgp 65535`
	`switch(config-router)#`
		Enters BGP mode and assigns the autonomous system number to the local BGP speaker.

Step 3	**address-family ipv4** {**unicast** | **multicast**}
	Example:
	`switch(config-router)# address-family`
	`ipv4 unicast`
	`switch(config-router-af)#`
		Enters address family configuration mode.

Step 4	**address-family** {**ipv4** | **ipv6** } {**unicast** | **multicast**}
	Example:
	`switch(config-router)# address-family`
	`vpnv4 unicast`
	`switch(config-router-af)#`
		Enters address family configuration mode.

Step 5	**address-family** {**ipv4** | **ipv6**} {**unicast** | **multicast**}
	Example:
	`switch(config-router)# address-family`
	`ipv4 unicast`
	`switch(config-router-af)#`
		Enters address-family configuration mode.

	Command or Action	Purpose
Step 6	**redistribute** {**direct**| {**eigrp** |**ospf** | **ospfv3** |**rip**} *instance-tag* | **static**} **route-map** *map-name* **Example:** `switch(config-router-af)# redistribute eigrp 201 route-map Eigrpmap`	Redistributes routes from other protocols into BGP.
Step 7	**redistribute** {**direct** | {**eigrp** | **isis** | **ospf** | **ospfv3** | **rip**} *instance-tag* | **static** | **icmpv6**} **route-map** *map-name* **Example:** `switch(config-router-af)# redistribute eigrp 201 route-map Eigrpmap`	Redistributes routes from other protocols into BGP. Beginning with Cisco NX-OS Release 10.3(3)F, the keyword **icmpv6** is supported to redistribute icmpv6 routes from other protocols into BGP.
Step 8	(Optional) **default-metric** *value* **Example:** `switch(config-router-af)# default-metric 33`	Generates a default route into BGP.
Step 9	(Optional) **copy running-config startup-config** **Example:** `switch(config-router-af)# copy running-config startup-config`	Saves this configuration change.

Example

This example shows how to redistribute EIGRP into BGP:

```
switch# configure terminal
switch(config)# router bgp 65536
switch(config-router)# address-family ipv4 unicast
switch(config-router-af)# redistribute eigrp 201 route-map Eigrpmap
switch(config-router-af)# copy running-config startup-config
```

DMZ Link Bandwidth

The DMZ Link Bandwidth feature is used to enable traffic load balancing towards a BGP learnt route reachable via multiple autonomous system exit links. The load balancing is done proportional to the bandwidth of these links.

Link Bandwidth Extended Community is used to carry the bandwidth of the link between two directly connected (single hop) eBGP peers. A nexus device will attach this extended community to BGP routes received from a directly connected eBGP neighbor if the dmz-link-bandwidth command is configured under that neighbor's address-family mode. This extended community is then propagated to iBGP peers when extended community exchange is enabled with the send-community extended or send-community both command. This attribute is used as a load sharing value relative to other paths in forwarding.

In addition, user may want to forcefully change the Link Bandwidth Extended Communtiy for routes received from a BGP peer. They may also only want to set this extended community for only a subset of routes received from the peer. They can achieve that by configuring an inbound route-map towards the peer and configure 'set extcommunity bandwidth <1-4000000>' under it.

Guidelines and Limitations

BGP DMZ Link Bandwidth

Consider the following guidelines and limitations before configuring the Link Bandwidth feature:

- The **dmz-link-bandwidth** command can be configured only under IPv4 unicast and IPv6 unicast address families under a BGP neighbor.
- It will only attach the Link Bandwidth Extended Community to routes received from directly connected BGP neighbors. It will not do so for BGP multi-hop neighbors.
- It can be configured under both global mode and VRF mode.
- BGP multipath load balancing must be configured under the address-family using **maximum-paths** command for this feature to be enabled.
- BGP extended community exchange must be enabled between iBGP neighbors to which the Link Bandwidth Extended Community is to be advertised.
- Link Bandwidth Extended Community will be seamlessly carried to routes leaked from one VRF to another VRF.

Configuring BGP DMZ Link Bandwidth

Beginning with Cisco NX-OS Release 10.5(1)F, you can configure this feature.

SUMMARY STEPS

1. **configure terminal**
2. **router bgp** *as-number*
3. **address-family [ipv4|ipv6] unicast**
4. **maximum-paths** *max-path*
5. **template peer** *peer-template-name*
6. **address-family [ipv4 | ipv6] unicast**
7. **dmz-link-bandwidth**
8. **neighbor** *neighbor*
9. **remote-as** *remote-as*
10. **address-family [ipv4 | ipv6] unicast**
11. **dmz-link-bandwidth**
12. **route-map** *name* **permit** *route*
13. **set extcommunity bandwidth <1-4000000>**
14. **neighbor** *neighbor* **address-family [ipv4 | ipv6] unicast route-map** *name* **in**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `switch# configure terminal`	Enters global configuration mode.
Step 2	**router bgp** *as-number* **Example:** `switch# configure terminal`	Enters router configuration mode to create or configure a BGP routing process.
Step 3	**address-family [ipv4|ipv6] unicast** **Example:** `switch(config)# address-family ipv4 unicast`	Configures address family IPv4 or IPv6 unicast.
Step 4	**maximum-paths** *max-path* **Example:** `switch(config)# maximum-paths 10`	Enable BGP multi-path under address-family.
Step 5	**template peer** *peer-template-name* **Example:** `switch(config)# template peer host_peer`	Enters template mode and configures peer parameter.
Step 6	**address-family [ipv4 | ipv6] unicast** **Example:** `switch(config)# address-family ipv4 unicast`	Configures the address family for IPv4 or IPv6.
Step 7	**dmz-link-bandwidth** **Example:** `switch(config)# dmz-link-bandwidth`	Configures BGP to consider load balancing some traffic towards this directly connected peer by attaching link bandwidth extended community to routes received from it.

Step 8	**neighbor** *neighbor*
	Example:
	`switch(config)# neighbor 1.1.1.1`
	`or`
	`switch(config)# neighbor 11::1`
		Configure BGP neighbor.

Step 9	**remote-as** *remote-as* **Example:** `switch(config)# remote-as 100`	Specify Autonomous System Number of the neighbor .

	Command or Action	Purpose
Step 10	**address-family [ipv4 | ipv6] unicast** **Example:** `switch(config)# address-family ipv4 unicast`	Configures the address family IPv4 or IPv6 unicast.
Step 11	**dmz-link-bandwidth** **Example:** `switch(config)# dmz-link-bandwidth`	Configures BGP to consider load balancing some traffic towards this directly connected peer by attaching link bandwidth extended community to routes received from it.
Step 12	**route-map** *name* **permit** *route* **Example:** `switch(config)# route-map change_link_bandwidth permit 10`	Confgure route-map.
Step 13	**set extcommunity bandwidth <1-4000000>** **Example:** `switch(config-route-map)# set extcommunity bandwidth 1000`	Configure route-map to set link bandwidth extended community.

Step 14	**neighbor** *neighbor* **address-family [ipv4 | ipv6] unicast route-map** *name* **in**
	Example:
	`switch(config-router)# neighbor 1.1.1.1`
	`switch (config-router-neighbor)# address-family ipv4 unicast`
	`switch(config-router-neighbor-af)# route-map change_link_bandwidth in`
		Configure neighbor to be attached to an inbound route-map.

Configuration Examples for BGP DMZ Link Bandwidth

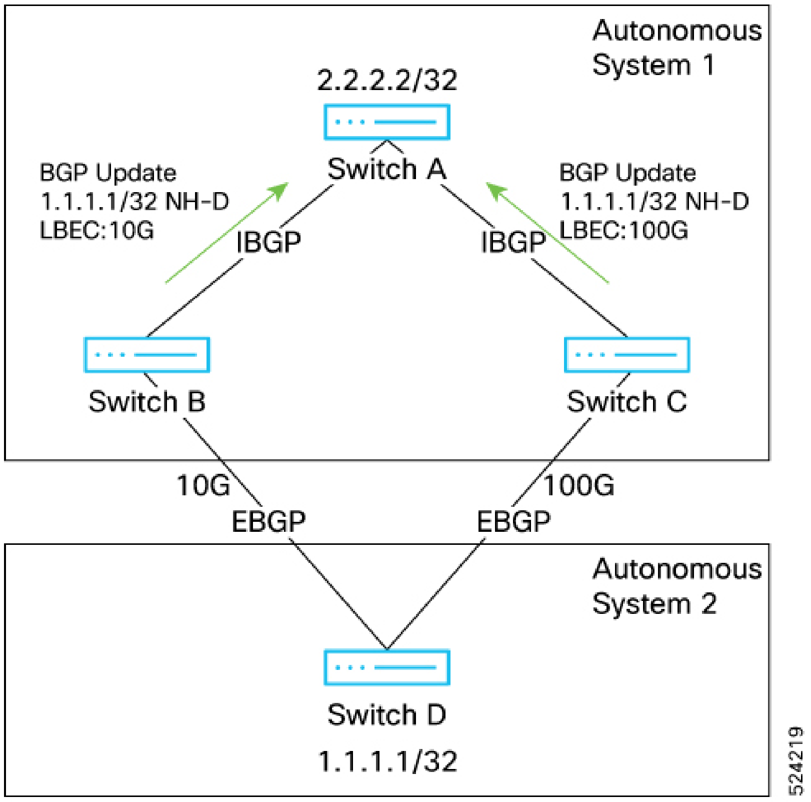
In the following example, AS 1 is attached to AS 2 through two unequal bandwidth links. B-D link is 10G and C-D link is 100G. B-D link is 10G and C-D link is 100G. A-B and A-C connected by IBGP session. B-D and C-D connected by EBGP Session.

If you want traffic to be proportionally load balanced according to these link bandwidths that is A should send 10 times the outgoing traffic to C as compared to B, configure dmz-link-bandwidth command on B and C towards EBGP neighbor D. B will package B-D bandwidth into Link Bandwidth Extended Community (LBEC) and attach it to the BGP path for route entry 1.1.1.1/32. Similarly, C will package C-D bandwidth into LBEC and attach it to the BGP path for route entry 1.1.1.1/32.

B and C will advertise the route to iBGP peer A along with LBEC.

On A, BGP will program forwarding with hash 10/110 for NH-B and 100/110 for NH-C.

Figure 7: DMZ Link Bandwidth Configuration



Switch B to D and B to A Configuration

```
router bgp 1
 neighbor D
    address-family ipv4|v6 unicast
      dmz-link-bandwidth
  neighbor A
    address-family ipv4|v6 unicast
       send-community extended
```

Switch C to D and C to A Configuration

```
router bgp 1
 neighbor D
    address-family ipv4|v6 unicast
      dmz-link-bandwidth
  neighbor A
    address-family ipv4|v6 unicast
       send-community extended
```

Switch A Control Plane and Data Plane State

BGP table state:

```
1.1.1.1/32
```

```
  NH-B    LBEC: 10G
  NH-C    LBEC: 100G
```

Forwarding state:

```
1.1.1.1/32
  NH-B   hash 10:110
  NH-C   hash 100:110
```

Configuring Unequal Cost Multipath (UCMP) Using Link Bandwidth Extended Community

Before you begin

See Configuring BGP DMZ Link Bandwidth. That feature must be first configured at edge devices for this feature to work. This means that at the edge devices, the Link Bandwidth Extended Community must be attached to a BGP route received from a directly connected ebgp peer by either configuring **dmz-link-bandwidth** command or by configuring an inbound route-map with **set extcommunity link-bandwidth <1-4000000>**command. Until that happens, none of the functionality described in this section will work.

Beginning with Cisco NX-OS Release 10.5(1)F, a BGP speaker has the ability to convey to its directly connected BGP neighbor the cumulative bandwidth available from itself to a BGP learnt route if the command 'link-bandwidth cumulative' is configured under the neighbor's address-family mode. It does that by leveraging the Link Bandwidth Extended Community. It will advertise the BGP route with the value n inserted in this extended community, where n = min (Sum of bandwidth obtained from Link Bandwidth Extended Community of all available multi-paths, Bandwidth of link towards the neighbor to which advertisement is being sent).

Guidelines and Limitations

Consider the following guidelines and limitations before configuring the BGP UCMP feature:

- The **link-bandwidth cumulative** command can be configured only under IPv4 unicast and IPv6 unicast address families under a BGP neighbor.
- It will only take effect to towards directly connected BGP neighbors.
- This command will only take effect if all of the available multi-paths have the Link Bandwidth Extended Community.
- It can be configured under both global mode and vrf mode.
- Link Bandwidth Extended Community will be seamlessly carried to routes leaked from one VRF to another VRF.

SUMMARY STEPS

1. **configure terminal**
2. **router bgp** *as-number*
3. **neighbor** *neighbor*
4. **remote-as** *remote-as*
5. **address-family [ipv4 | ipv6] unicast**
6. **send-community extended**
7. **link-bandwidth cumulative**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `switch# configure terminal`	Enters global configuration mode.
Step 2	**router bgp** *as-number* **Example:** `switch(config)# router bgp 120`	Enters router configuration mode to create or configure a BGP routing process.

Step 3	**neighbor** *neighbor*
	Example:
	`switch(config)# neighbor 1.1.1.1`
	`or`
	`switch(config)# neighbor 11::1`
		Configure BGP neighbor.

Step 4	**remote-as** *remote-as* **Example:** `switch(config)# remote-as 100`	Specify Autonomous System Number of the neighbor.
Step 5	**address-family [ipv4 | ipv6] unicast** **Example:** `switch(config)# address-family ipv4 unicast`	Configures the address family IPv4 or IPv6 unicast.
Step 6	**send-community extended** **Example:** `switch(config)# send-community extended`	Configures sending of BGP extended community towards this neighbor.
Step 7	**link-bandwidth cumulative** **Example:** `switch(config)# link-bandwidth cumulative`	Sends cumulative link bandwidth towards the neighbor. This configuration doesn’t advertise the cumulative link bandwidth to the neighbor if any of the multi-paths doesn’t have the link bandwidth extended community.

Configuration Example

Configuration Example

In the following figures:

- Single hop directly connected ebgp devices in 4 clos layers.
- All links are 100G, except B-D and B-E, which are 10G. This means traffic from B to destination 1.1.1.1 is bottle necked at a 20G link bandwidth.

- User wants end-to-end traffic load balancing should account for this lower link bandwidth.
- On each device in Layer T1, configure command **dmz-link-bandwidth** towards every BGP neighbor in Layer T0.
- On each device in Layer T1, configure command **link-bandwidth cumulative** towards every BGP peer in layer T2.
- On each device in Layer T2, configure command **link-bandwidth cumulative** towards every BGP peer in layer T1 and T3.
- On each device in Layer T3, configure command **link-bandwidth cumulative** towards every BGP peer in layer T2.
- Command **dmz-link-bandwidth** will cause switch D to package the bandwidth of link D-F into Link Bandwidth Extended Community (LBEC) and attach it to the corresponding BGP path for route entry 1.1.1.1/32.
- Command **dmz-link-bandwidth** will cause switch E package the bandwidth of link E-F into LBEC and attach it to the corresponding BGP path for route entry 1.1.1.1/32.
- Command **link-bandwidth cumulative** will cause switches A, B, C, D, and E to insert bandwidth **n** into LBEC while advertising BGP update to the peers under which it is configured.
- The value **n** is calculated by using the formula min(Sum of LBEC of all multi-paths, bandwidth towards peer where update is to be advertised.)
- Propagation of LBEC in BGP update will cause forwarding on all devices to be programmed with proportional hashes
- LBEC will be dynamically recalculated in case of link failures.

Figure 8: Configuration Example 1

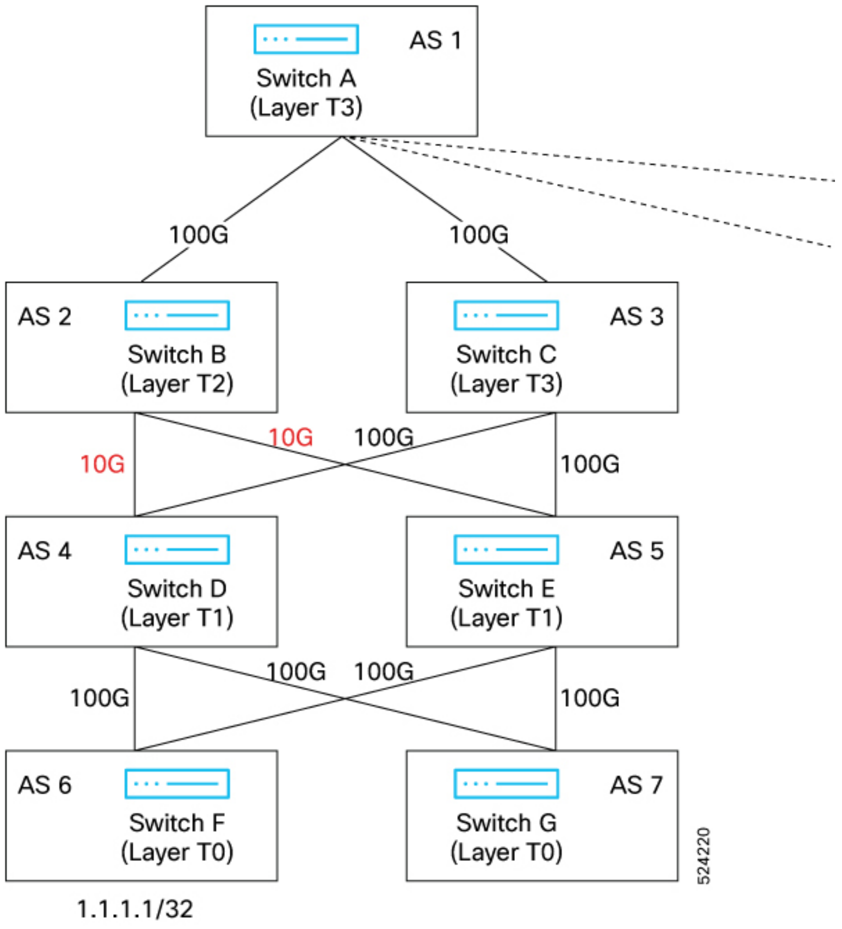
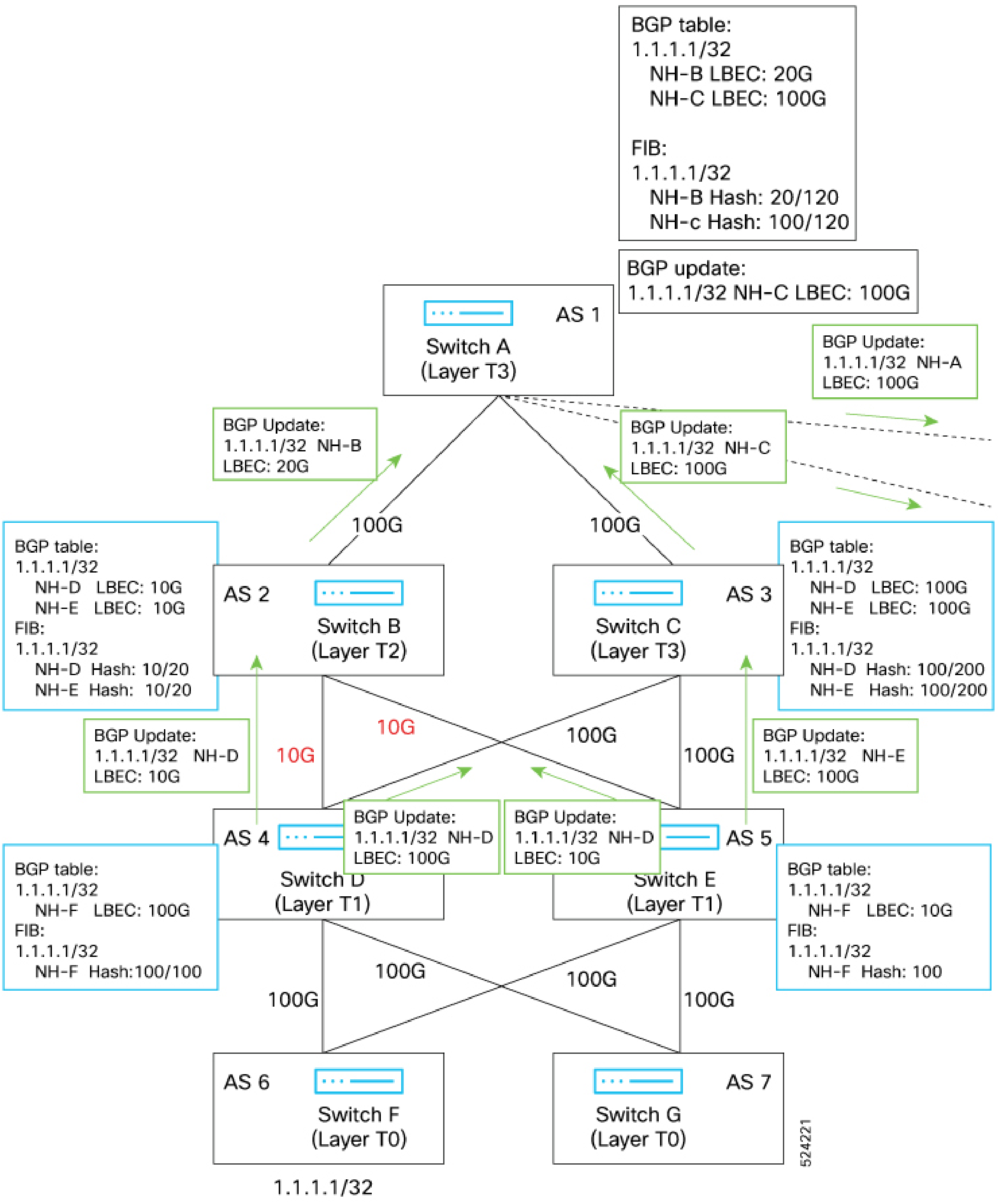


Figure 9: Configuration Example 2



Configuring A to B and C

```
router bgp 1
neighbor B
    address-family ipv4|v6 unicast
```

```
       link-bandwidth cumulative
       send-community extended
  neighbor C
    address-family ipv4|v6 unicast
       link-bandwidth cumulative
       send-community extended
  neighbor B’
    address-family ipv4|v6 unicast
       link-bandwidth cumulative
       send-community extended
  neighbor C’
    address-family ipv4|v6 unicast
       link-bandwidth cumulative
       send-community extended
```

Configuring B to D, A, and E

```
router bgp 1
neighbor B
    address-family ipv4|v6 unicast
       link-bandwidth cumulative
       send-community extended
  neighbor C
    address-family ipv4|v6 unicast
       link-bandwidth cumulative
       send-community extended
  neighbor B’
    address-family ipv4|v6 unicast
       link-bandwidth cumulative
       send-community extended
  neighbor C’
    address-family ipv4|v6 unicast
       link-bandwidth cumulative
       send-community extended
```

Configuring C to A, D, and E

```
router bgp 3
  neighbor A
    address-family ipv4|v6 unicast
       link-bandwidth cumulative
       send-community extended
  neighbor D
    address-family ipv4|v6 unicast
       link-bandwidth cumulative
       send-community extended
  neighbor E
    address-family ipv4|v6 unicast
       link-bandwidth cumulative
       send-community extended
```

Configuring D to F, B, and C

```
router bgp 4
  neighbor F
    address-family ipv4|v6 unicast
      dmz-link-bandwidth
  neighbor B
    address-family ipv4|v6 unicast
       link-bandwidth cumulative
       send-community extended
neighbor C
```

```
    address-family ipv4|v6 unicast
       link-bandwidth cumulative
       send-community extended
```

Configuring E to F, B, and C

```
router bgp 5
  neighbor F
    address-family ipv4|v6 unicast
      dmz-link-bandwidth
  neighbor B
    address-family ipv4|v6 unicast
       link-bandwidth cumulative
       send-community extended
neighbor C
    address-family ipv4|v6 unicast
       link-bandwidth cumulative
       send-community extended
```

Verifying Configuration

Use the following commands to verify configuration:

- Use the following command to see if the dmz-link-bandwidth command is enabled towards a peer

```
show bgp ipv4 unicast neighbors 192.168.11.2 | i i link
         dmz-link-bandwidth is enabled
```

- Use the following command to see if the link-bandwidth cumulative command is enabled towards a peer

```
show bgp ipv4 unicast neighbors 10.1.1.2 | i i link
         link-bandwidth cumulative is enabled
```

- Use the following command to confirm if BGP path has Link Bandwidth Extended Community

```
show bgp ipv4 unicast 1.1.1.1/32
BGP routing table information for VRF default, address family IPv4 Unicast
BGP routing table entry for 1.1.1.1/32, version 403 Paths: (1 available, best #1) Flags:
 (0x8000001a) (high32 0x002000) on xmit-list, is in urib, is best urib route, is in HW

Advertised path-id 1 Path type: external, path is valid, is best path, no labeled
nexthop, in rib

AS-Path: 10 33299 51178 47751 {27016} , path sourced external to AS 192.168.11.2 (metric
 0) from 192.168.11.2 (192.168.11.2) Origin EGP, MED 2219, localpref 100, weight 0
Community: 1:1 Extcommunity: LB:1:125000000

Path type: external, path is valid, is multi-path, no labeled nexthop, in rib
AS-Path: 10 33299 51178 47751 {27016} , path sourced external to AS 192.168.11.3 (metric
 0) from 192.168.11.2 (192.168.11.2) Origin EGP, MED 2219, localpref 100, weight 0
Community: 1:1 Extcommunity: LB:1:250000000
```

- Use the following command to confirm if routing table has the hashing ratios

```
 show ip route 1.1.1.1/32 detail

100.1.1.1/32, ubest/mbest: 1/0 *via 192.168.11.2, [20/2219], 00:14:22, bgp-1, bw:333,
external, tag 10 client-specific data: 10 recursive next hop: 192.168.11.2/32 extended
 route information: BGP origin AS 0 BGP peer AS 10
100.1.1.2/32, ubest/mbest: 1/0 *via 192.168.11.3, [20/2219], 00:14:22, bgp-1, bw:666,
external, tag 10 client-specific data: 10 recursive next hop: 192.168.11.3/32 extended
 route information: BGP origin AS 0 BGP peer AS 10
```

Advertising the Default Route

You can configure BGP to advertise the default route (network 0.0.0.0).

Before you begin

You must enable BGP (see the Enabling BGP section).

SUMMARY STEPS

1. **configure terminal**
2. **route-map allow permit**
3. **exit**
4. **ip route** *ip-address network-mask* **null** *null-interface-number*
5. **router bgp** *as-number*
6. **address-family** {**ipv4** | **ipv6**} **unicast**
7. **default-information originate**
8. **redistribute static route-map allow**
9. (Optional) **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**route-map allow permit**
	
	Example:
	`switch(config)# route-map allow permit`
	`switch(config-route-map)#`
		Enters router map configuration mode and defines the conditions for redistributing routes.

Step 3	**exit**
	
	Example:
	`switch(config-route-map)# exit`
	`switch(config)#`
		Exits router map configuration mode.

Step 4	**ip route** *ip-address network-mask* **null** *null-interface-number* **Example:** `switch(config)# ip route 192.0.2.1 255.255.255.0 null 0`	Configures the IP address.
Step 5	**router bgp** *as-number* **Example:**	Enters BGP mode and assigns the AS number to the local BGP speaker.

	Command or Action	Purpose

	`switch(config)# router bgp 65535`
	`switch(config-router)#`	

Step 6	**address-family** {**ipv4** | **ipv6**} **unicast**
	Example:
	`switch(config-router)# address-family ipv4 unicast`
	`switch(config-router-af)#`
		Enters address-family configuration mode.

Step 7	**default-information originate** **Example:** `switch(config-router-af)# default-information originate`	Advertises the default route.
Step 8	**redistribute static route-map allow** **Example:** `switch(config-router-af)# redistribute static route-map allow`	Redistributes the default route.
Step 9	(Optional) **copy running-config startup-config** **Example:** `switch(config-router-af)# copy running-config startup-config`	Saves this configuration change.

Configuring BGP Attribute Filtering and Error Handling

Beginning with Cisco NX-OS Release 9.3(3), you can configure BGP attribute filtering and error handling to provide an increased level of security. The following features are available and implemented in the following order:

- **Path attribute treat-as-withdraw:** Allows you to treat-as-withdraw a BGP update from a specific neighbor if the update contains a specified attribute type. The prefixes contained in the update are removed from the routing table.
- **Path attribute discard:** Allows you to remove specific path attributes in a BGP update from a specific neighbor.
- **Enhanced attribute error handling:** Prevents peer sessions from flapping due to a malformed update.

Attribute types 1, 2, 3, 4, 5, 8, 14, 15, and 16 cannot be configured for path attribute treat-as-withdraw and path attribute discard. Attribute type 9 (Originator) and type 10 (Cluster-id) can be configured for eBGP neighbors only.

Treating as Withdraw Path Attributes from a BGP Update Message

To "treat-as-withdraw" BGP updates that contain specific path attributes, use the following command in router neighbor configuration mode:

Procedure

	Command or Action	Purpose

Step 1	[**no**] **path-attribute treat-as-withdraw** [*value* | **range** *start end*] **in**
	Example:
	`switch#(config-router)# neighbor 10.20.30.40`
	`switch(config-router-neighbor)# path-attribute treat-as-withdraw 100 in`
	Example:
	`switch#(config-router)# neighbor 10.20.30.40`
	`switch(config-router-neighbor)# path-attribute treat-as-withdraw range 21 255 in`
		Treats as withdraw any incoming BGP update messages that contain the specified path attribute or range of path attributes and triggers an inbound route refresh to ensure that the routing table is up to date. Any prefixes in a BGP update that are treat-as-withdraw are removed from the BGP routing table.
		This command is also supported for BGP template peers and BGP template peer sessions.

Discarding Path Attributes from a BGP Update Message

To discard BGP updates that contain specific path attributes, use the following command in router neighbor configuration mode:

Procedure

	Command or Action	Purpose

Step 1	[**no**] **path-attribute discard** [*value* | **range** *start end*] **in**
	Example:
	`switch#(config-router)# neighbor 10.20.30.40`
	`switch(config-router-neighbor)# path-attribute discard 100 in`
	Example:
	`switch#(config-router)# neighbor 10.20.30.40`
	`switch(config-router-neighbor)# path-attribute discard range 100 255 in`
		Drops specified path attributes in BGP update messages for the specified neighbor and triggers an inbound route refresh to ensure that the routing table is up to date. You can configure a specific attribute or an entire range of unwanted attributes.
		This command is also supported for BGP template peers and BGP template peer sessions.
		Note
		When the same path attribute is configured for both discard and treat-as-withdaw, treat-as-withdraw has a higher priority.

Enabling or Disabling Enhanced Attribute Error Handling

BGP enhanced attribute error handling is enabled by default but can be disabled. This feature, which complies with RFC 7606, prevents peer sessions from flapping due to a malformed update. The default behavior applies to both eBGP and iBGP peers.

To disable or reenable enhanced error handling, use the following command in router configuration mode:

Procedure

	Command or Action	Purpose

Step 1	[**no**] **enhanced-error**
	Example:
	`switch(config)# router bgp 1000`
	`switch(config-router)# enhanced-error`
		Enables or disables BGP enhanced attribute error handling.

Displaying Discarded or Unknown Path Attributes

To display information about discarded or unknown path attributes, perform one of the following tasks:

Command	Purpose
show bgp {**ipv4** | **ipv6**} **unicast path-attribute discard**]	Displays all prefixes for which an attribute has been discarded.
show bgp {**ipv4** | **ipv6**} **unicast path-attribute unknown**]	Displays all prefixes that have an unknown attribute.
show bgp {**ipv4** | **ipv6**} **unicast** *ip-address*	Displays the unknown attributes and discarded attributes associated with a prefix.

The following example shows the prefixes for which an attribute has been discarded:

```
switch# show bgp ipv4 unicast path-attribute discard
Network            Next Hop
1.1.1.1/32         20.1.1.1
1.1.1.2/32         20.1.1.1
1.1.1.3/32         20.1.1.1
```

The following example shows the prefixes that have an unknown attribute:

```
switch# show bgp ipv4 unicast path-attribute unknown
Network            Next Hop
2.2.2.2/32         20.1.1.1
2.2.2.3/32         20.1.1.1
```

The following example shows the unknown attributes and discarded attributes associated with a prefix:

```
switch# show bgp ipv4 unicast 2.2.2.2
BGP routing table entry for 2.2.2.2/32, version 6241
Paths: (1 available, best #1, table default)
  Not advertised to any peer
  Refresh Epoch 1
  1000
    20.1.1.1 from 20.1.1.1 (20.1.1.1)
      Origin IGP, localpref 100, valid, external, best
      unknown transitive attribute: flag 0xE0 type 0x62 length 0x64
        value 0000 0000 0100 0000 0200 0000 0300 0000
              0400 0000 0500 0000 0600 0000 0700 0000
              0800 0000 0900 0000 0A00 0000 0B00 0000
              0C00 0000 0D00 0000 0E00 0000 0F00 0000
              1000 0000 1100 0000 1200 0000 1300 0000
              1400 0000 1500 0000 1600 0000 1700 0000
              1800 0000
      rx pathid: 0, tx pathid: 0x0
      Updated on Jul 20 2019 07:50:43 PST
```

Tuning BGP

You can tune BGP characteristics through a series of optional parameters.

To tune BGP, use the following optional commands in router configuration mode:

Command	Purpose
bestpath [**always-compare-med** | **as-pathmultipath-relax** | **compare-routerid** |**cost-community ignore** | **igp-metric ignore** |**med** {**confed** |**missing-as-worst**| **non-deterministic**}] **Example:** `switch(config-router)# bestpath always-compare-med`	Modifies the best-path algorithm. The optional parameters are as follows: • **always-compare-med** —Compares MED on paths from different autonomous systems. • **as-path multipath-relax** — Allows load sharing across the providers with different (but equal-length) AS paths. Without this option, the AS paths must be identical for load sharing. When configured, BGP selects the best path with the lowest MED among potential multipaths, even if they come from different ASNs. • **compare-routerid** —Compares the router IDs for identical eBGP paths. • **cost-community ignore** —Ignores the cost community for BGP best-path calculations. • **igp-metric ignore** —Ignores the Interior Gateway Protocol (IGP) metric for next hop during best-path selection. This option is supported beginning with Cisco NX-OS Release 9.2(2). • **med confed** —Forces bestpath to do a MED comparison only between paths originated within a confederation. • **med missing-as-worst** —Treats a missing MED as the highest MED. • **med non-deterministic** —Does not always pick the best MED path from among the paths from the same autonomous system.

Command	Purpose
enforce-first-as **Example:** `switch(config-router)# enforce-first-as`	Enforces the neighbor autonomous system to be the first AS number listed in the AS_path attribute for eBGP.
log-neighbor-changes **Example:** `switch(config-router)# log-neighbor-changes`	Generates a system message when any neighbor changes state. **Note** To suppress neighbor status change messages for a specific neighbor, you can use the **log-neighbor-changes disable** command in router address-family configuration mode.
router-id *id* **Example:** `switch(config-router)# router-id 10.165.20.1`	Manually configures the router ID for this BGP speaker.
timers [*prefix-peer-wait* | *bgp holdtime* | **prefix-peer-timeout** *timeout* | **bestpath-limit** *bestpath-timeout*] **Example:** `switch(config-router)# timers bestpath-limit 300`	Sets BGP timer values. The optional parameters are as follows: • *prefix-peer-wait* —Wait timer for a prefix peer. The range is from 0 to 1200 seconds. The default value is 90. • *bgp* —BGP session keepalive time. The range is from 0 to 3600 seconds. The default value is 60. • *holdtime* —Different bgp keepalive and holdtimes. The range is from 0 to 3600 seconds The default value is 60. • *timeout* —Prefix peer timeout value. The range is from 0 to 1200 seconds. The default value is 30. • *bestpath-timeout* —Bestpath timeout in seconds. The default value is 300. When a high-scale BGP setup is expected, the timeout value needs to be set between 480 and 1200, based on the scale. You must manually reset the BGP sessions after configuring this command.

To tune BGP, use the following optional commands in router address-family configuration mode:

Command	Purpose
distance *ebgp-distance ibgp-distance local-distance* **Example:** `switch(config-router-af)# distance 20 100 200`	Sets the administrative distance for BGP. The range is from 1 to 255. The defaults are as follows: • *ebgp-distance* —20. • *ibgp-distance* —200. • *local-distance* —220. Local-distance is the administrative distance used for aggregate discard routes when they are installed in the RIB. After you enter the value for the external administrative distance, you must enter the value for the administrative distance for the internal routes or/and the value for the administrative distance for the local routes depending on your requirement; so that the internal/local routes are also considered in the route administration.
log-neighbor-changes [**disable**] **Example:** `switch(config-router-af)# log-neighbor-changes disable`	Generates a system message when this specific neighbor changes state. The **disable** option suppresses neighbor status changes messages for this specific neighbor.

To tune BGP, use the following optional commands in neighbor configuration mode:

Command	Purpose
description *string* **Example:** `switch(config-router-neighbor)# description main site`	Sets a descriptive string for this BGP peer. The string can be up to 80 alphanumeric characters.
low-memory exempt **Example:** `switch(config-router-neighbor)# low-memory exempt`	Exempts this BGP neighbor from a possible shutdown due to a low memory condition.
transport connection-mode passive **Example:** `switch(config-router-neighbor)# transport connection-mode passive`	Allows a passive connection setup only. This BGP speaker does not initiate a TCP connection to a BGP peer. You must manually reset the BGP sessions after configuring this command.

Command	Purpose
[**no** | **default**] **remove-private-as** [**all** |**replace-as**] **Example:** `switch(config-router-neighbor)# remove-private-as`	Removes private AS numbers from outbound route updates to an eBGP peer. This command triggers an automatic soft clear or refresh of BGP neighbor sessions. The optional parameters are as follows: • **no** —Disables the command. • **default** —Moves the command to its default mode. • **all** —Removes all private-as numbers from the AS-path value. • **replace-as** —Replaces all private AS numbers with the replace-as AS-path value. See the *Guidelines and Limitations for BGP* section for additional information on this command.
update-source *interface-type number* **Example:** `switch(config-router-neighbor)# update-source ethernet 2/1`	Configures the BGP speaker to use the source IP address of the configured interface for BGP sessions to the peer. This command triggers an automatic notification and session reset for the BGP neighbor sessions. Single-hop iBGP peers support fast external fallover when **update-source** is configured.

To tune BGP, use the following optional commands in neighbor address-family configuration mode:

Command	Purpose
allowas in **Example:** `switch(config-router-neighbor-af)# allowas in`	Allows routes that have their own AS in the AS path to be installed in the BRIB.
default-originate [**route-map** *map-name*] **Example:** `switch(config-router-neighbor-af)# default-originate`	Generates a default route to the BGP peer.
disable-peer-as-check **Example:** `switch(config-router-neighbor-af)# disable-peer-as-check`	Disables peer AS-number checking while the device advertises routes learned from one node to another node in the same AS path.

Command	Purpose

filter-list *list-name* {**in** | **out**}
Example:
`switch(config-router-neighbor-af)# filter-list BGPFilter in`
	Applies an AS_path filter list to this BGP peer for inbound or outbound route updates. This command triggers an automatic soft clear or refresh of BGP neighbor sessions.

prefix-list *list-name* {**in** | **out**}
Example:
`switch(config-router-neighbor-af)# prefix-list PrefixFilter in`
	Applies a prefix list to this BGP peer for inbound or outbound route updates. This command triggers an automatic soft clear or refresh of BGP neighbor sessions.

send-community **Example:** `switch(config-router-neighbor-af)# send-community`	Sends the community attribute to this BGP peer. This command triggers an automatic soft clear or refresh of BGP neighbor sessions.
send-community extended **Example:** `switch(config-router-neighbor-af)# send-community extended`	Sends the extended community attribute to this BGP peer. This command triggers an automatic soft clear or refresh of BGP neighbor sessions.
suppress-inactive **Example:** `switch(config-router-neighbor-af)# suppress-inactive`	Advertises the best (active) routes only to the BGP peer. This command triggers an automatic soft clear or refresh of BGP neighbor sessions.
[no | default] as-override **Example:** `switch(config-router-neighbor-af)# as-override`	**no** - (Optional) Disables the command. **default** - (Optional) Moves the command to its default mode. **as-override** - While sending updates to eBGP peer, replaces in the *path* attribute all occurrences of the peer's AS number with the local AS number.

Configuring Policy-Based Administrative Distance

You can configure a distance for external BGP (eBGP) and internal BGP (iBGP) routes that match a policy described in the configured route map. The distance configured in the route map is downloaded to the unicast RIB along with the matching routes. BGP uses the best path to determine the administrative distance when downloading next hops in the unicast RIB table. If there is no match or a deny clause in the policy, BGP uses the distance configured in the distance command or the default distance for routes.

The policy-based administrative distance feature is useful when there are two or more different routes to the same destination from two different routing protocols.

Before you begin

You must enable BGP.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **ip prefix-list** *name* **seq** *number* **permit** *prefix-length*
3. switch(config)# **route-map** *map-tag* **permit** *sequence-number*
4. switch(config-route-map)# **match ip address prefix-list** *prefix-list-name*
5. switch(config-route-map)# **set distance** *value1 value2 value3*
6. switch(config-route-map)# **exit**
7. switch(config)# **router bgp** *as-number*
8. switch(config-router)# **address-family** {**ipv4** | **ipv6** | **vpnv4** | **vpnv6**} **unicast**
9. switch(config-router-af)# **table-map** *map-name*
10. (Optional) switch(config-router-af)# **show forwarding distribution**
11. (Optional) switch(config)# **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	switch# **configure terminal**	Enters global configuration mode.
Step 2	switch(config)# **ip prefix-list** *name* **seq** *number* **permit** *prefix-length*	Creates a prefix list to match IP packets or routes with the permit keyword.
Step 3	switch(config)# **route-map** *map-tag* **permit** *sequence-number*	Creates a route map and enters route-map configuration mode with the permit keyword. If the match criteria for the route is met in the policy, the packet is policy routed.
Step 4	switch(config-route-map)# **match ip address prefix-list** *prefix-list-name*	Matches IPv4 network routes based on a prefix list. The prefix-list name can be any alphanumeric string up to 63 characters.
Step 5	switch(config-route-map)# **set distance** *value1 value2 value3*	Specifies the administrative distance for interior BGP (iBGP) or exterior BGP (eBGP) routes and BGP routes originated in the local autonomous system. The range is from 1 to 255. After you enter the value for the external administrative distance, you must enter the value for the administrative distance for the internal routes or/and the value for the administrative distance for the local routes depending on your requirement; so that the internal/local routes are also considered in the route administration.
Step 6	switch(config-route-map)# **exit**	Exits route-map configuration mode.
Step 7	switch(config)# **router bgp** *as-number*	Enters BGP mode and assigns the AS number to the local BGP speaker.
Step 8	switch(config-router)# **address-family** {**ipv4** | **ipv6** | **vpnv4** | **vpnv6**} **unicast**	Enters address family configuration mode.

	Command or Action	Purpose
Step 9	switch(config-router-af)# **table-map** *map-name*	Configures the selective administrative distance for a route map for BGP routes before forwarding them to the RIB table. The table-map name can be any alphanumeric string up to 63 characters. **Note** You can also configure the **table-map** command under the VRF address-family configuration mode.
Step 10	(Optional) switch(config-router-af)# **show forwarding distribution**	Displays forwarding information distribution.
Step 11	(Optional) switch(config)# **copy running-config startup-config**	Saves the change persistently through reboots and restarts by copying the running configuration to the startup configuration.

Configuring Multiprotocol BGP

You can configure MP-BGP to support multiple address families, including IPv4 and IPv6 unicast and multicast routes.

Before you begin

- You must enable BGP (see the Enabling BGP section).

You must enable BGP.

SUMMARY STEPS

1. **configure terminal**
2. **router bgp** *as-number*
3. **neighbor** *ip-address* **remote-as** *as-number*
4. switch(config-router-neighbor)# **address-family ipv4** {**unicast** | **multicast**}
5. switch(config-router-neighbor)# **address-family** {**ipv4** | **ipv6** } {**unicast** | **multicast**}
6. **address-family** {**ipv4** | **ipv6**} {**unicast** | **multicast**}
7. (Optional) **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

	Command or Action	Purpose

Step 2	**router bgp** *as-number*
	Example:
	`switch(config)# router bgp 65535`
	`switch(config-router)#`
		Enters BGP mode and assigns the autonomous system number to the local BGP speaker.

Step 3	**neighbor** *ip-address* **remote-as** *as-number*
	Example:
	`switch(config-router)# neighbor 192.168.1.2 remote-as 65534`
	`switch(config-router-neighbor)#`
		Places the router in neighbor configuration mode for BGP routing and configures the neighbor IP address.

Step 4	switch(config-router-neighbor)# **address-family ipv4** {**unicast** | **multicast**}	Enters address family configuration mode.
Step 5	switch(config-router-neighbor)# **address-family** {**ipv4** | **ipv6** } {**unicast** | **multicast**}	Enters address family configuration mode.

Step 6	**address-family** {**ipv4** | **ipv6**} {**unicast** | **multicast**}
	Example:
	`switch(config-router-neighbor)# address-family ipv4 multicast`
	`switch(config-router-neighbor-af)#`
		Enters address family configuration mode.

Step 7	(Optional) **copy running-config startup-config** **Example:** `switch(config-router-neighbor-af)# copy running-config startup-config`	Saves this configuration change.

Example

This example shows how to enable advertising and receiving IPv4 routes for multicast RPF for a neighbor:

```
switch# configure terminal
switch(config)# interface ethernet 2/1
switch(config-if)# ipv4 address 2001:0DB8::1
switch(config-if)# router bgp 65536
switch(config-router)# neighbor 192.168.1.2 remote-as 35537
switch(config-router-neighbor)# address-family ipv4 multicast
switch(config-router-neighbor-af)# exit
switch(config-router-neighbor)# address-family ipv4 multicast
switch(config-router-neighbor-af)# copy running-config startup-config
```

This example shows how to enable advertising and receiving IPv4 and IPv6 routes for multicast RPF for a neighbor:

```
switch# configure terminal
switch(config)# interface ethernet 2/1
switch(config-if)# ipv6 address 2001:0DB8::1
switch(config-if)# router bgp 65536
switch(config-router)# neighbor 192.168.1.2 remote-as 35537
switch(config-router-neighbor)# address-family ipv4 multicast
switch(config-router-neighbor-af)# exit
switch(config-router-neighbor)# address-family ipv6 multicast
switch(config-router-neighbor-af)# copy running-config startup-config
```

Configuring BMP

Beginning with Cisco NX-OS Release 7.0(3)I5(2), you can configure BMP on the device.

Before you begin

You must enable BGP (see the Enabling BGP section).

SUMMARY STEPS

1. **configure terminal**
2. **router bgp as-number**
3. **bmp server** *server-number*
4. **address ip-address port-number port-number**
5. **description** *string*
6. **initial-refresh** { *skip* | *delay time*}
7. **initial-delay** *time*
8. **stats-reporting-period** *time*
9. shutdown
10. **vrf** *vrf-name*
11. **update-source** <*interface-name*>
12. **neighbor ip-address**
13. **remote-as** *as-number*
14. **bmp-activate-server** *server-number*
15. (Optional) **show bgp bmp** *server [server-number] [detail]*
16. (Optional) **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `switch# configure terminal`	Enters global configuration mode.
Step 2	**router bgp as-number** **Example:** `switch(config)# router bgp 200`	Enters BGP mode and assigns the autonomous system number to the local BGP speaker.

	Command or Action	Purpose
Step 3	**bmp server** *server-number* **Example:** `switch(config-router-bmp)# bmp-server 1`	Configures the BMP server to which BGP should send information. The server number is used as a key. **Note** You can configure up to two BMP servers.
Step 4	**address ip-address port-number port-number** **Example:** `switch(config-router-bmp)# address 10.1.1.1 port-number 2000`	Configures the IPv4 or IPv6 address of the host and the port number on which the BMP speaker connects to the BMP server.
Step 5	**description** *string* **Example:** `switch(config-router-bmp)# description BMPserver1`	Configures the BMP server description. You can enter up to 256 alphanumeric characters.

Step 6	**initial-refresh** { *skip* | *delay time*}
	Example:
	`switch(config-router-bmp)# initial-refresh delay 100`
		Configures the option to send a route refresh when BGP is converged and the BMP server connection is established later.
		The skip option specifies to not send a route refresh if the BMP server connection comes up later.
		The delay option specifies the time in seconds after which the route refresh should be sent. The range is from 30 to 720 seconds, and the default value is 30 seconds.

Step 7	**initial-delay** *time* **Example:** `switch(config-router-bmp)# initial-delay 120`	Configures the delay after which a connection is attempted to the BMP server. The range is from 30 to 720 seconds, and the default value is 45 seconds.
Step 8	**stats-reporting-period** *time* **Example:** `switch(config-router-bmp)# stats-reporting-period 50`	Configures the time interval in which the BMP server receives the statistics report from BGP neighbors. The range is from 30 to 720 seconds, and the default is disabled.
Step 9	shutdown **Example:** `switch(config-router-bmp)# shutdown`	Disables the connection to the BMP server.
Step 10	**vrf** *vrf-name* **Example:** `switch(config-router-bmp)# vrf BMP`	Selects vrf in which BMP server is reachable.
Step 11	**update-source** <*interface-name*> **Example:** `switch(config-router-bmp)# update-source ethernet4/2`	Selects local interface to be used for establishing BMP server connection.

	Command or Action	Purpose
Step 12	**neighbor ip-address** **Example:** `switch(config-router-bmp)# neighbor 192.168.1.2`	Enters neighbor configuration mode for BGP routing and configures the neighbor IP address.
Step 13	**remote-as** *as-number* **Example:** `switch(config-router-neighbor)# remote-as 65535`	Configures the AS number for a remote BGP peer.
Step 14	**bmp-activate-server** *server-number* **Example:** `switch(config-router-neighbor)# bmp-activate-server 1`	Configures the BMP server to which a neighbor's information should be sent.
Step 15	(Optional) **show bgp bmp** *server [server-number] [detail]* **Example:** `switch(config-router-neighbor)# show bgp bmp server`	Displays BMP server information.
Step 16	(Optional) **copy running-config startup-config** **Example:** `switch(config-router-neighbor)# copy running-config startup-config`	Saves this configuration change.

BGP Local Route Leaking

About BGP Local Route Leaking

Beginning with release 9.3(1), NX-OS BGP supports leaking imported VPN routes between:

- The VPN route table and default VRF route table
- The VPN route table and VRF-lite route table
- Border leaf (BL) switch route tables for leaf-to-leaf connectivity

This feature enables the propagation of routes between the route tables. You can control route leaking for a VRF by configuring an import or export map, which now includes an option to allow or prevent incoming locally originated routes and specify whether they should be advertised. Local route leaking is bidirectional, so routes that are locally originated can be leaked from a VRF out to a BGP VPN, and routes that are imported from the BGP VPN can be leaked into a VRF.

Note NX-OS supports a similar feature called centralized route leaking. For information, see Configuring Layer 3 Virtualization.

Guidelines and Limitations for BGP Local Route Leaking

The following are the guidelines and limitations for the BGP local route leaking feature:

- The following Cisco hardware supports this feature:
    - Cisco Nexus 9332C, 9364C, 9300-EX, 9300-FX/FXP/FX2/FX3, and 9300-GX platform switches, and Cisco Nexus 9500 platform switches with 9700-EX/FX line cards
    - Cisco Nexus 9500 platform switches with -R line cards
- When using route-targets, the same route-targets might have duplicated paths pointing to the same remote path, which can negatively impact the switch's memory and performance. Be careful when using route targets.
- Be careful when using local route leaking in a leaf-to-leaf case, where border-leaf routers (BLs) are leaking between the same VRFs. This scenario is more prone to routing loops. We recommend using inbound route-maps to exclude the imported routes from other BLs.
- After a remote path gets withdrawn, it can take up to 20 seconds more for BGP to completely clean up the path.

Configuring Routes Imported from a VPN to Leak into the Default VRF

You can configure a VRF to allow routes that are imported from a BGP VPN to be exported to the default VRF. Use this procedure for a non-default VRF.

Before you begin

If you have not already enabled BGP, enable it now (**feature bgp**).

SUMMARY STEPS

1. **config terminal**
2. **vrf context** *vrf-name*
3. **address-family** *address-family sub family*
4. **export vrf default [***prefix-limit***] map***route-map* **allow-vpn**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**config terminal**
	Example:
	`switch-1# config terminal`
	`Enter configuration commands, one per line. End with CNTL/Z.`
	`switch-1(config)#`
		Enters global configuration mode.

	Command or Action	Purpose

Step 2	**vrf context** *vrf-name*
	Example:
	`switch-1(config)# vrf context vpn1`
	`switch-1(config-vrf)#`
		Creates a new VRF and enters VRF configuration mode. The name can be any case-sensitive, alphanumeric string up to 32 characters.

Step 3	**address-family** *address-family sub family*
	Example:
	`switch-1(config-vrf)# address-family ipv4 unicast`
	`switch-1(config-vrf-af-ipv4)#`	

Step 4	**export vrf default [***prefix-limit***] map***route-map* **allow-vpn**
	Example:
	`switch-1(config-vrf-af-ipv4)# export vrf default map vpnmap1 allow-vpn`
	`switch-1(config-vrf-af-ipv4)#`
		Configures the current VRF to allow routes that are imported from a BGP VPN to be exported to the default VRF.

Configuring Routes Leaked from the Default-VRF to Export to a VPN

You can configure a VRF to allow routes leaked from the default VRF to be exported to a BGP VPN. Use this procedure for a non-default VRF.

Before you begin

If you have not already enabled BGP, enable it now (**feature bgp**).

SUMMARY STEPS

1. **config terminal**
2. **vrf context** *vrf-name*
3. **address-family** *address-family sub family*
4. **import vrf default [***prefix-limt***] map***route-map* **advertise-vpn**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**config terminal**
	Example:
	`switch-1# config terminal`
	`Enter configuration commands, one per line. End with CNTL/Z.`
	`switch-1(config)#`
		Enters global configuration mode.

	Command or Action	Purpose

Step 2	**vrf context** *vrf-name*
	Example:
	`switch-1(config)# vrf context vpn1`
	`switch-1(config-vrf)#`
		Creates a new VRF and enters VRF configuration mode. The name can be any case-sensitive, alphanumeric string up to 32 characters.

Step 3	**address-family** *address-family sub family*
	Example:
	`switch-1(config-vrf)# address-family ipv4 unicast`
	`switch-1(config-vrf-af-ipv4)#`	

Step 4	**import vrf default [***prefix-limt***] map***route-map* **advertise-vpn**
	Example:
	`switch-1(config-vrf-af-ipv4)# import vrf map vpnmap1 advertise-vpn`
	`switch-1(config-vrf-af-ipv4)#`
		Configures the current VRF to allow routes imported from the default VRF to be exported to a BGP VPN.

Configuring Routes Imported from a VPN to Export to a VRF

You can configure a VRF to allow VPN imported routes to be exported to another VRF. Use this procedure for non-default VRFs.

Before you begin

If you have not already enabled BGP, enable it now (**feature bgp**).

SUMMARY STEPS

1. **config terminal**
2. **vrf context** *vrf-name*
3. **address-family** *address-family sub family*
4. **export vrf allow-vpn**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**config terminal**
	Example:
	`switch-1# config terminal`
	`Enter configuration commands, one per line. End with CNTL/Z.`
	`switch-1(config)#`
		Enters global configuration mode.

	Command or Action	Purpose

Step 2	**vrf context** *vrf-name*
	Example:
	`switch-1(config)# vrf context vpn1`
	`switch-1(config-vrf)#`
		Creates a new VRF and enters VRF configuration mode. The name can be any case-sensitive, alphanumeric string up to 32 characters.

Step 3	**address-family** *address-family sub family*
	Example:
	`switch-1(config-vrf)# address-family ipv4 unicast`
	`switch-1(config-vrf-af-ipv4)#`	

Step 4	**export vrf allow-vpn**
	Example:
	`switch-1(config-vrf-af-ipv4)# export vrf allow-vpn`
	`nxosv2(config-vrf-af-ipv4)#`
		Configures a VRF to allow routes imported from a BGP VPM to be exported to a non-default VRF.

Configuring Routes Imported from a VRF to Export to a VPN

You can configure a VRF to allow routes imported from another VRF to be exported to a BGP VPN. Use this procedure for non-default VRFs.

Before you begin

If you have not already enabled BGP, enable it now (**feature bgp**).

SUMMARY STEPS

1. **config terminal**
2. **vrf context** *vrf-name*
3. **address-family** *address-family sub family*
4. **import vrf advertise-vpn**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**config terminal**
	Example:
	`switch-1# config terminal`
	`Enter configuration commands, one per line. End with CNTL/Z.`
	`switch-1(config)#`
		Enters global configuration mode.

	Command or Action	Purpose

Step 2	**vrf context** *vrf-name*
	Example:
	`switch-1(config)# vrf context vpn1`
	`switch-1(config-vrf)#`
		Creates a new VRF and enters VRF configuration mode. The name can be any case-sensitive, alphanumeric string up to 32 characters.

Step 3	**address-family** *address-family sub family*
	Example:
	`switch-1(config-vrf)# address-family ipv4 unicast`
	`switch-1(config-vrf-af-ipv4)#`	

Step 4	**import vrf advertise-vpn**
	Example:
	`switch-1(config-vrf-af-ipv4)# import vrf advertise-vpn`
	`nxosv2(config-vrf-af-ipv4)#`
		Configures the current VRF to allow routes that are imported from another VRF to be exported to a BGP VPN.

Configuration Examples

The following show sample configurations for the BGP local route leaking feature.

Configuring BGP VPN to Default VRF Reachability

In this example, the configuration enables route re-importation through an intermediate VRF, called VRF_A, which is between the VPN and the default VRF.

```
vrf context VRF_A
   address-family ipv4 unicast
   route-target both auto evpn
   import vrf default map MAP_1 advertise-vpn
   export vrf default map MAP_1 allow-vpn
```

Route re-importation is enabled by using the **advertise-vpn** option to control importing routes from the VPN into VRF_A, and **allow-vpn** for the export map to control exporting VPN-imported routes from VRF_A out to the default VRF. Configuration occurs on the intermediate VRF.

Configuring VPN to VRF-Lite Reachability

In this example, the VPN connects to a tenant VRF, called VRF_A. VRF_A connects a VRF-Lite, called VRF-B. The configuration enables VPN imported routes to be leaked from VRF_A to VRF_B.

```
vrf context VRF_A
   address-family ipv4 unicast
   route-target both auto
   route-target both auto evpn
   route-target import 3:3
   route-target export 2:2
   import vrf advertise-vpn
   export vrf allow-vpn
vrf context VRF_B
   address-family ipv4 unicast
   route-target both 1:1
   route-target import 2:2
   route-target export 3:3
```

Route leaking between the two is enabled by using the **allow-vpn** in an export map configured in VRF_A (tenant). The export map in VRF_A allows route imported from the VPN to be leaked into the VRF_B. Routes processed by the export map have the **route-mapexport** and **export-map** attributes added to the route's set of route targets. The import map uses **advertise-vpn** which enables routes that are imported from the VRF-Lite for be exported out to the VPN.

After a route leaks between the VRFs, it is reoriginated and its route targets are replaced by the route target export and export map attributes specified by the new VRF's configuration.

Leaf-to-Leaf Reachability

In this example, two VPNs exist and two VRFs exist. VPN_1 is connected to VRF_A and VPN_2 is connected to VRF_B. Both VRFs are route distinguishers (RDs).

```
vrf context VRF_A
   address-family ipv4 unicast
   route-target both auto
   route-target both auto evpn
   route-target import 3:3
   route-target export 2:2
   import vrf advertise-vpn
   export vrf allow-vpn
vrf context VRF_B
   address-family ipv4 unicast
   route-target both 1:1
   route-target import 2:2
   route-target export 3:3
   import vrf advertise-vpn
   export vrf allow-vpn
```

Route leaking between the two is enabled by **allow-vpn** in an export map configured in VRF_A and VRF_B. VPN imported routes have **route-mapexport** and **export-map** attributes added to the route's set of route targets. An import map map uses the advertise-vpn option which enables routes that are imported from each VRF to be exported out to the VPN.

After a route leaks between the VRFs, it is reoriginated and its route targets are replaced by the route target export and export map attributes specified by the new VRF's configuration.

Leaf-to-Leaf with Loop Prevention

In the leaf-to-leaf configuration, you can inadvertently cause loops between the BLs that are leaking between the same VRFs unless you are careful with your route maps:

- You can use an inbound route map in each BL to deny updates from every other BL.
- If a BL originates a route, a standard community can be applied, which enables other BLs to accept the routes. This community is then stripped in the receiving BL.

In the following example, VTEPs 3.3.3.3, 4.4.4.4 and 5.5.5.5 are the BLs.

```
ip prefix-list BL_PREFIX_LIST seq 5 permit 3.3.3.3/32
ip prefix-list BL_PREFIX_LIST seq 10 permit 4.4.4.4/32
ip prefix-list BL_PREFIX_LIST seq 20 permit 5.5.5.5/32
ip community-list standard BL_COMMUNITY seq 10 permit 123:123
route-map INBOUND_MAP permit 5
  match community BL_COMMUNITY
  set community none
route-map INBOUND_MAP deny 10
  match ip next-hop prefix-list BL_PREFIX_LIST
route-map INBOUND_MAP permit 20
```

```
route-map OUTBOUND_SET_COMM permit 10
  match evpn route-type 2 mac-ip
  set community 123:123
route-map SET_COMM permit 10
  set community 123:123
route-map allow permit 10

vrf context vni100
  vni 100
  address-family ipv4 unicast
    route-target import 2:2
    route-target export 1:1
    route-target both auto
    route-target both auto evpn
    import vrf advertise-vpn
    export vrf allow-vpn

vrf context vni200
  vni 200
  address-family ipv4 unicast
    route-target import 1:1
    route-target export 2:2
    route-target both auto
    route-target both auto evpn
    import vrf advertise-vpn
    export vrf allow-vpn

router bgp 100
  template peer rr
    remote-as 100
    update-source loopback0
    address-family l2vpn evpn
      send-community
      send-community extended
      route-map INBOUND_MAP in
      route-map OUTBOUND_SET_COMM out
  neighbor 101.101.101.101
    inherit peer rr
  neighbor 102.102.102.102
    inherit peer rr
  vrf vni100
    address-family ipv4 unicast
      network 3.3.3.100/32 route-map SET_COMM
  vrf vni200
    address-family ipv4 unicast
      network 3.3.3.200/32 route-map SET_COMM
```

In this example, the tenant VRFs for the border leaf (BL) router can leak traffic by enabling extra import export flows, and the route targets in the route maps determine where the routes are imported from or exported to.

Multipath in a VRF

In this example, a VPN has multiple incoming paths. This configuration enables route leaking through an intermediate VRF, called VRF_A, which is between the VPN and another VRF, named VRF_B. Assume that multipathing is enabled in VRF_A.

```
vrf context VRF_A
   address-family ipv4 unicast
   route-target both auto evpn
   route-target export 3:3
   export vrf allow-vpn
vrf context VRF_B
```

```
   address-family ipv4 unicast
   route-target import 3:3
```

Route leaking is enabled by **allow-vpn** in the export map configured in VRF_A. When two paths for a given prefix are learnt from a VPN and imported into VRF_A, two different paths exist in VRF_B with the same source RD (VRF_A's local RD). Each route is distinguished by the original source RD (remote RD).

Path Duplication

In this example, the configuration enables a single VPN path to be imported into both VRF_A and VRF_B. Because VRF_A is configured with **export vrf allow-vpn**, VRF_A also leaks its routes into VRF_B. VRF_B then has two paths with same source RD (VRF_A's local RD), each one distinguished by the original source RD (remote RD).

```
vrf context VRF_A
   address-family ipv4 unicast
      route-target import 1:1 evpn
      route-target export 1:1 evpn
      route-target export 2:2
      export vrf allow-vpn
vrf context VRF_B
   address-family ipv4 unicast
     route-target import 1:1 evpn
     route-target import 2:2
```

This configuration creates a situation in which multipathing does not exist.

Displaying BGP Local Route Leaking Information

The following show commands contain information for the BGP local route leaking feature.

Command	Action
show bgp vrf *vrf-name* **process**	For a default or non-default VRF, shows the enabled state (Yes or No) of the **import advertise-vpn** and **export allow-vpn** options.
show bgp vrf *vrf-name* **ipv4 unicast** *prefix*	Shows information about imported paths, including a list of destinations a route has been imported from.

BGP Graceful Shutdown

About BGP Graceful Shutdown

Beginning with release 9.3(1), BGP supports the graceful shutdown feature. This BGP feature works with the BGP **shutdown** command to:

- Dramatically decrease the network convergence time when a router or link is taken offline.
- Reduce or eliminate dropped packets that are in transit when a router or link is taken offline.

Despite the name, BGP graceful shutdown does not actually cause a shutdown. Instead, it alerts connected routers that a router or link will be going down soon.

The graceful shutdown feature uses the GRACEFUL_SHUTDOWN well-known community (0xFFFF0000 or 65535:0), which is identified by IANA and the IETF through RFC 8326. This well-known community can be attached to any routes, and it is processed like any other attribute of a route.

Because this feature announces that a router or link will be going down, the feature is useful in preparation of maintenance windows or planned outages. Use this feature before shutting down BGP to limit the impact on traffic.

Graceful Shutdown Aware and Activate

BGP routers can control the preference of all routes with the GRACEFUL_SHUTDOWN community through the concept of GRACEFUL SHUTDOWN awareness. Graceful shutdown awareness is enabled by default, which enables the receiving peers to deprefer incoming routes carrying the GRACEFUL_SHUTDOWN community. Although not a typical use case, you can disable and reenable graceful shutdown awareness through the **graceful-shutdown aware** command.

Graceful shutdown aware is applicable only at the BGP global context. For information about contexts, see Graceful Shutdown Contexts, on page 138. The aware option operates with another option, the **activate** option, which you can assign to a route map for more granular control over graceful shutdown routes.

Interaction of the Graceful Shutdown Aware and Activate Options

When a graceful shutdown is activated, the GRACEFUL_SHUTDOWN community is appended to route updates only when you specify the **activate** keyword. At this point, new route updates that contain the community are generated and transmitted. When the **graceful-shutdown aware** command is configured, all routers that receive the community then deprefer (lower the route preference of) the routes in the update. Without the **graceful-shutdown aware** command, BGP does not deprefer routes with the GRACEFUL_SHUTDOWN community.

After the feature is activated and the routers are aware of graceful shutdown, BGP still considers the routes with the GRACEFUL_SHUTDOWN community as valid. However, those routes are given the lowest priority in the best-path calculation. If alternate paths are available, new best paths are chosen, and convergence occurs to accommodate the router or link that will soon go down.

Graceful Shutdown Contexts

BGP graceful shutdown feature has two contexts that determine what the feature affects and what functionality is available.

Context	Affects	Commands
Global	The entire switch and all routes processed by it. For example, readvertise all routes with the GRACEFUL_SHUTDOWN community.	**graceful-shutdown activate [route-map** *route-map***]** **graceful-shutdown aware**
Peer	A BGP peer or a link between neighbors. For example, advertise only one link between peers with GRACEFUL_SHUTDOWN community.	**graceful-shutdown activate [route-map** *route-map***]**

Graceful Shutdown with Route Maps

Graceful shutdown works with the route policy manager (RPM) feature to control how the switch's BGP router transmits and receives routes with the GRACEFUL_SHUTDOWN community. Route maps can process route updates with the community in the inbound and outbound directions. Typically, route maps are not required. However, if needed, you can use them to customize the control of graceful shutdown routes.

Normal Inbound Route Maps

Normal inbound route maps affect routes that are incoming to the BGP router. Normal inbound route maps are not commonly used with the graceful shutdown feature because routers are aware of graceful shutdown by default.

Cisco Nexus switches running Cisco NX-OS Release 9.3(1) and later do not require an inbound route map for the graceful shutdown feature. Cisco NX-OS Release 9.3(1) and later have implicit inbound route maps that automatically deprefer any routes that have the GRACEFUL_SHUTDOWN community if the BGP router is graceful shutdown aware.

Normal inbound route maps can be configured to match against the well-known GRACEFUL_SHUTDOWN community. Although these inbound route maps are not common, there are some cases where they are used:

- If switches are running a Cisco NX-OS release earlier than 9.3(1), they do not have the implicit inbound route map present in NX-OS 9.3(1). To use the graceful shutdown feature on these switches, you must create a graceful shutdown inbound route map. The route map must match inbound routes with the well-known GRACEFUL_SHUTDOWN community, permit them, and deprefer them. If an inbound route map is needed, create it on the BGP peer that is running a version of NX-OS earlier than 9.3(1) and is receiving the graceful shutdown routes.
- If you want to disable graceful shutdown aware, but still want the router to act on incoming routes with GRACEFUL_SHUTDOWN community from some BGP neighbors, you can configure an inbound route map under the respective peers.

Normal Outbound Route Maps

Normal outbound route maps control forwarding the routes that a BGP router sends. Normal outbound route maps can affect the graceful shutdown feature. For example, you can configure an outbound route map to match on the GRACEFUL_SHUTDOWN community and set attributes, and it takes precedence over any graceful shutdown outbound route maps.

Graceful Shutdown Outbound Route Maps

Outbound Graceful shutdown route maps are specific type of outbound route map for the graceful shutdown feature. They are optional, but they are useful when you already have a community list that is associated with a route map. The typical graceful shutdown outbound route map contains only `set` clauses to set or modify certain attributes.

You can use outbound route maps in the following ways:

- For customers that already have existing outbound route maps, you can add a new entry with a higher sequence number, match on the GRACEFUL_SHUTDOWN well-known community, and add any attributes that you want.
- You can also use a graceful shutdown outbound route map with the **graceful-shutdown activate route-map** *name* option. This is the typical use case.

This route map requires no match clauses, so the route map matches on all routes being sent to the neighbor.

Route Map Precedence

When multiple route maps are present on the same router, the following order of precedence is applied to determine how routes with the community are processed:Consider the following example. Assume you have a standard outbound route map name Red that sets a local-preference of 60. Also, assume you have a peer graceful-shutdown route map that is named Blue that sets local-pref to 30. When the route update is processed, the local preference will be set to 60 because Red overwrites Blue.

- Normal outbound route maps take precedence over peer graceful shutdown maps.
- Peer graceful shutdown maps take precedence over global graceful shutdown maps.

Guidelines and Limitations

The following are limitations and guidelines for BGP global shutdown:

- Graceful shutdown feature can only help avoid traffic loss when alternative routes exist in the network for the affected routers. If the router has no alternate routes, routes carrying the GRACEFUL_SHUTDOWN community are the only ones available, and therefore, are used in the best-path calculation. This situation defeats the purpose of the feature.
- Configuring a BGP send community is required to send the GRACEFUL_SHUTDOWN community.
- For route maps:
  - When global route maps and neighbor route maps are configured, the per-neighbor route maps take precedence.
  - Outbound route maps take precedence over any global route maps configured for graceful shutdown.
  - Outbound route maps take precedence over any peer route maps configured for graceful shutdown.
  - To add the graceful shutdown functionality to legacy (existing) inbound route maps, follow this order:
    1. Add the graceful shutdown match clause to the top of the route map by setting a low sequence number for the clause (for example, sequence number 0).
    2. Add a continue statement after the graceful shutdown clause. If you omit the continue statement, route-map processing stops when it matches the graceful shutdown clause, any other clauses with higher sequence numbers (for example, 1 and higher) are not processed.

Graceful Shutdown Task Overview

To use the graceful shutdown feature, you typically enable graceful-shutdown aware on all Cisco Nexus switches and leave the feature enabled. When a BGP router must be taken offline, you configure graceful-shutdown activate on it.

The following details document the best practice for using the graceful shutdown feature.

To bring the router or link down:

1. Configure the Graceful Shutdown feature.

2. Watch the neighbor for the best path.
3. When the best path is recalculated, issue the **shutdown** command to disable BGP.
4. Perform the work that required you to shut down the router or link.

To bring the router or link back online:

1. When you finish the work that required the shutdown, reenable BGP (**no shutdown**).
2. Disable the graceful shutdown feature (**no graceful-shutdown activate** in config router mode).

Configuring Graceful Shutdown on a Link

This task enables you to configure graceful shutdown on a specific link between two BGP routers.

Before you begin

If you have not already enabled BGP, enable it now (**feature bgp**).

SUMMARY STEPS

1. **config terminal**
2. **router bgp** *autonomous-system-number*
3. **neighbor {** *ipv4-address*|*ipv6-address* **} remote-as** *as-number*
4. **graceful-shutdown activate [route-map** *map-name***]**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**config terminal**
	
	Example:
	`switch-1# configure terminal`
	`switch-1(config)#`
		Enters global configuration mode.

Step 2	**router bgp** *autonomous-system-number*
	
	Example:
	`switch-1(config)# router bgp 110`
	`switch-1(config-router)#`
		Enters router configuration mode to create or configure a BGP routing process.

Step 3	**neighbor {** *ipv4-address*|*ipv6-address* **} remote-as** *as-number*
	
	Example:
	`switch-1(config-router)# neighbor 10.0.0.3 remote-as 200`
	`switch-1(config-router-neighbor)#`
		Configures the autonomous system (AS) to which the neighbor belongs.

	Command or Action	Purpose

Step 4	**graceful-shutdown activate [route-map** *map-name***]**
	Example:
	`switch-1(config-router-neighbor)# graceful-shutdown activate route-map gshutPeer`
	`switch-1(config-router-neighbor)#`
		Configures graceful shutdown on the link to the neighbor. Also, advertises the routes with the well-known GRACEFUL_SHUTDOWN community and applies the route map to the outbound route updates.
		The routes are advertised with the graceful-shutdown community by default. In this example, routes are advertised to the neighbor with the Graceful-shutdown community with a route-map named gshutPeer.
		The devices receiving the gshut community look at the communities of the route and optionally use the communities to apply routing policy.

Filtering BGP Routes and Setting Local Preference Based On GRACEFUL_SHUTDOWN Communities

Switches that are not yet running 9.3(1) do not have an inbound route map that matches against the GRACEFUL_SHUTDOWN community name. Therefore, they have no way of identifying and depreferring the correct routes.

For switches running a release of NX-OS that is earlier than 9.3(1), you must configure an inbound route map that matches on the community value for graceful shutdown (65535:0) and deprefers routes.

If your switch is running 9.3(1) or later, you do not need to configure an inbound route map.

SUMMARY STEPS

1. **configure terminal**
2. **ip community list standard** *community-list-name* **seq** *sequence-number* **{ permit | deny }** *value*
3. **route map** *map-tag* **{deny | permit}** *sequence-number*
4. **match community** *community-list-name*
5. **set local-preference** *local-pref-value*
6. **exit**
7. **router bgp** *community-list-name*
8. **neighbor {** *ipv4-address|ipv6-address* **}**
9. **address-family {** *address-family sub family* **}**
10. **send community**
11. **route map** *map-tag* **in**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch-1# configure terminal`
	`switch-1<config)#`
		Enters global configuration mode.

	Command or Action	Purpose

Step 2	**ip community list standard** *community-list-name* **seq** *sequence-number* **{ permit | deny }** *value*
	Example:
	`switch-1(config)# ip community-list standard GSHUT seq 10 permit 65535:0`
	`switch-1(config)#`
		Configures a community list and permits or denies routes that have the well-known graceful shutdown community value.

Step 3	**route map** *map-tag* **{deny | permit}** *sequence-number*
	Example:
	`switch-1(config)# route-map RM_GSHUT permit 10`
	`switch-1(config-route-map)#`
		Configures a route map as sequence 10 and permits routes that have the GRACEFUL_SHUTDOWN community.

Step 4	**match community** *community-list-name*
	Example:
	`switch-1(config-route-map)# match community GSHUT`
	`switch-1(config-route-map)#`
		Configures that routes that match the IP community list GSHUT are processed by Route Policy Manager (RPM).

Step 5	**set local-preference** *local-pref-value*
	Example:
	`switch-1(config-route-map)# set local-preference 10`
	`switch-1(config-route-map)#`
		Configures that the routes that match the IP community list GSHUT will be given a specified local preference.

Step 6	**exit**
	Example:
	`switch-1(config-route-map)# exit`
	`switch-1(config)#`
		Leaves route map configuration and returns to global configuration mode.

Step 7	**router bgp** *community-list-name*
	Example:
	`switch-1(config)# router bgp 100`
	`switch-1(config-router)#`
		Enters router configuration mode and creates a BGP instance.

Step 8	**neighbor {** *ipv4-address|ipv6-address* **}**
	Example:
	`switch-1(config-router)# neighbor 10.0.0.3`
	`switch-1(config-router-neighbor)#`
		Enters route BGP neighbor mode for a specified neighbor.

Step 9	**address-family {** *address-family sub family* **}**
	Example:
	`nxosv2(config-router-neighbor)# address-family ipv4 unicast`
	`nxosv2(config-router-neighbor-af)#`
		Puts the neighbor into address family (AF) configuration mode.

Step 10	**send community** **Example:**	Enables BGP community exchange with the neighbor.

	Command or Action	Purpose

	`nxosv2(config-router-neighbor-af)# send-community`
	`nxosv2(config-router-neighbor-af)#`	

Step 11	**route map** *map-tag* **in**
	Example:
	`nxosv2(config-router-neighbor-af)# route-map RM_GSHUT in`
	`nxosv2(config-router-neighbor-af)#`
		Applies the route map to incoming routes from the neighbor. In this example, the route map that is named RM_GSHUT permits routes with the GRACEFUL_SHUTDOWN community from the neighbor.

Configuring Graceful Shutdown for All BGP Neighbors

You can manually apply the GRACEFUL_SHUTDOWN well-known community to all the neighbors of a graceful shutdown initiator.

You can configure graceful shutdown at the global level for all BGP neighbors.

Before you begin

If you have not already enabled BGP, enable it now (**feature bgp**).

SUMMARY STEPS

1. **configure terminal**
2. **router bgp** *autonomous-system-number*
3. **graceful-shutdown activate [route-map** *map-name***]**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch-1# configure terminal`
	`switch-1(config)#`
		Enters global configuration mode.

Step 2	**router bgp** *autonomous-system-number*
	Example:
	`switch-1(config)# router bgp 110`
	`switch-1(config-router)#`
		Enters router configuration mode to create or configure a BGP routing process.

Step 3	**graceful-shutdown activate [route-map** *map-name***]**
	Example:
	`switch-1(config-router-neighbor)# graceful-shutdown activate route-map gshutPeer`
	`switch-1(config-router-neighbor)#`
		Configures graceful shutdown route map for the links to all neighbors. Also, advertises all routes with the well-known GRACEFUL_SHUTDOWN community and applies the route map to the outbound route updates.
		The routes are advertised with the GRACEFUL_SHUTDOWN community by default. In this example, routes are advertised to all neighbors with the

	Command or Action	Purpose
		community with a route-map named gshutPeer. The route map should contain only set clauses. The devices receiving the GRACEFUL_SHUTDOWN community look at the communities of the route and optionally use the communities to apply routing policy.

Controlling the Preference for All Routes with the GRACEFUL_SHUTDOWN Community

Cisco NX-OS enables lowering the preference of incoming routes that have the GRACEFUL_SHUTDOWN community. When **graceful shutdown aware** is enabled, BGP considers routes carrying the community as the lowest preference during best path calculation. By default, lowering the preference is enabled, but you can selectively disable this option.

Whenever you enable or disable this option, you trigger a BGP best-path calculation. This option gives you the flexibility to control the behavior of the BGP best-path calculation for the graceful shutdown well-known community.

Before you begin

If you have not enabled BGP, enable it now (**feature bgp**).

SUMMARY STEPS

1. **configure terminal**
2. **router bgp** *autonoums-system*
3. (Optional) **no graceful-shutdown aware**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	
	Example:
	`switch-1(config)# config terminal`
	`switch-1(config)#`
		Enters global configuration mode.

Step 2	**router bgp** *autonoums-system*
	
	Example:
	`switch-1(config)# router bgp 100`
	`switch-1(config-router)#`
		Enters router configuration mode and configures a BGP routing process.

Step 3	(Optional) **no graceful-shutdown aware**
	
	Example:
	`switch-1(config-router)# no graceful-shutdown aware`
	`switch-1(config-router)#`
		For this BGP router, do not give lower preference for all routes that have the GRACEFUL_SHUTDOWN community. The default action is to deprefer routes when the graceful shutdown aware feature is disabled, so using the **no** form of the command is optional for not depreferring graceful shutdown routes.

Preventing Sending the GRACEFUL_SHUTDOWN Community to a Peer

If you no longer need the GRACEFUL_SHUTDOWN community that is appended as a route attribute to outbound route updates, you can remove the community, which no longer sends it to a specified neighbor. One use case would be when a router is at an autonomous system boundary, and you do not want the graceful shutdown functionality to propagate outside of an autonomous system boundary.

To prevent sending the GRACEFUL_SHUTDOWN to a peer, you can disable the send community option or strip the community from the outbound route map.

Choose either of the following methods:

- Disable the send-community in the running config.

  Example:

  ```
  nxosv2(config-router-neighbor-af)# no send-community standard
  nxosv2(config-router-neighbor-af)#
  ```

  If you use this option, the GRACEFUL_SHUTDOWN community is still received by the switch, but it is not sent to the downstream neighbor through the outbound route map. All standard communities are not sent either.

- Delete the GRACEFUL_SHUTDOWN community through an outbound route map by following these steps:

  1. Create an IP community list matches the GRACEFUL_SHUTDOWN community.
  2. Create an outbound route map to match against the GRACEFUL_SHUTDOWN community.
  3. Use a **set community-list delete** clause to strip GRACEFUL_SHUTDOWN community.

  If you use this option, the community list matches and permits the GRACEFUL_SHUTDOWN community, then the outbound route map matches against the community and then deletes it from the outbound route map. All other communities pass through the outbound route map without issue.

Displaying Graceful Shutdown Information

Information about the graceful shutdown feature is available through the following **show** commands.

Command	Action
show ip bgp community-list graceful-shutdown	Shows all entires in the BGP routing table that have the GRACEFUL_SHUTDOWN community.
show running-config bgp	Shows the running BGP configuration.
show running-config bgp all	Shows all information for the running BGP configuration including information about the graceful shutdown feature.

Command	Action
show bgp *address-family* **neighbors** *neighbor-address*	When the feature is configured for the peer, shows the following: • The state of the graceful-shutdown-activate feature for the specified neighbor • The name of any graceful shutdown route map configured for the specified neighbor
show bgp process	Shows different information depending on the context. When the graceful-shutdown-activate option is configured in peer context, shows the enabled or disabled state for the feature through `graceful-shutdown-active`. When the graceful-shutdown-activate option is configured in global context and has a graceful-shutdown route map, shows the enabled state of the feature through the following: • `graceful-shutdown-active` • `graceful-shutdown-aware` • `graceful-shutdown route-map`
show ip bgp *address*	For the specified address, shows the BGP routing table information, including the following: • The state of the specified address as the best path • Whether the specified address is part of the GRACEFUL_SHUTDOWN community

Graceful Shutdown Configuration Examples

These examples show some configurations for using the graceful shutdown feature.

Configuring Graceful Shutdown for a BGP Link

The following example shows how to configure graceful shutdown while setting a local preference and a community:

- Configuring graceful shutdown activate for the link to the specified neighbor
- Adding the GRACEFUL_SHUTDOWN community to the routes
- Setting a route map named gshutPeer with only set clauses for outbound routes with the community.

```
router bgp 100
    neighbor 20.0.0.3 remote-as 200
         graceful-shutdown activate route-map gshutPeer
         address-family ipv4 unicast
              send-community
route-map gshutPeer permit 10
    set local-preference 0
    set community 200:30
```

Configuring Graceful Shutdown for All-Neighbor BGP Links

The following example shows:

- Configuring graceful shutdown activate for all the links connecting the local router and all its neighbors.
- Adding the GRACEFUL_SHUTDOWN community to the routes.
- Setting a route map that is named gshutAall with only set clauses for all outbound routes.

```
router bgp 200
   graceful-shutdown activate route-map gshutAll

route-map gshutAll permit 10
   set as-path prepend 10 100 110
   set community 100:80

route-map Red permit 10
   set local-pref 20

router bgp 100
   graceful-shutdown activate route-map gshutAll
      router-id 2.2.2.2
         address-family ipv4 unicast
         network 2.2.2.2/32
         neighbor 1.1.1.1 remote-as 100
         update-source loopback0
         address-family ipv4 unicast
            send-community
         neighbor 20.0.0.3 remote-as 200
         address-family ipv4 unicast
            send-community
               route-map Red out
```

In this example, the `gshutAll` route-map takes effect for neighbor 1.1.1.1, but not neighbor 20.0.0.3, because the outbound route-map `Red` configured under neighbor 20.0.0.3 takes precedence instead.

Configuring Graceful Shutdown Under a Peer-Template

This example configures the graceful shutdown feature under a peer-session template, which is inherited by a neighbor.

```
router bgp 200
   template peer-session p1
      graceful-shutdown activate route-map gshut_out
   neighbor 1.1.1.1 remote-as 100
      inherit peer-session p1
      address-family ipv4 unicast
         send-community
```

Filtering BGP Routes and Setting Local Preference Based on GRACEFUL_SHUTDOWN Community Using and Inbound Route Map

This example shows how to use a community list to filter the incoming routes that have the GRACEFUL_SHUTDOWN community. This configuration is useful for legacy switches that are not running Cisco NX-OS 9.3(1) as a minimum version.

The following example shows:

- An IP Community List that permits routes that have the GRACEFUL_SHUTDOWN community.
- A route map that is named RM_GSHUT that permits routes based on a standard community list named GSHUT.
- The route map also sets the preference for the routes it processes to 0 so that those routes are given lower preference for best path calculation when the router goes offline. The route map is applied to incoming IPv4 routes from the neighbor (20.0.0.2).

```
ip community-list standard GSHUT permit 65535:0

route-map RM_GSHUT permit 10
   match community GSHUT
   set local-preference 0

router bgp 200
   neighbor 20.0.0.2 remote-as 100
      address-family ipv4 unicast
         send-community
         route-map RM_GSHUT in
```

Configuring a Graceful Restart

You can configure a graceful restart and enable the graceful restart helper feature for BGP.

Note Cisco NX-OS Release 10.1(1) supports a higher number of BFD sessions. If BGP sessions are associated with BFD, the BGP **restart-time** may need to be increased to maintain peer connection during ISSU.

Note From the perspective of BGP Graceful Restart, if there are idle peers during a node restart, they can potentially cause traffic loss during an ISSU because they may delay the establishment of the first best-path. It is recommended to either bring all these idle neighbors up, or configure 'shutdown' under each of them, or remove them entirely from the configuration.

Before you begin

You must enable BGP (see the "Enabling BGP" section).

Create the VRFs.

SUMMARY STEPS

1. **configure terminal**
2. **router bgp** *as-number*
3. (Optional) **timers prefix-peer-timeout** *timeout*
4. **graceful-restart**
5. **graceful-restart** {**restart-time** *time*|**stalepath-time** *time*}
6. **graceful-restart-helper**
7. (Optional) **show running-config bgp**

8. (Optional) **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters configuration mode.

Step 2	**router bgp** *as-number*
	Example:
	`switch(config)# router bgp 65535`
	`switch(config-router)#`
		Creates a new BGP process with the configured autonomous system number.

Step 3	(Optional) **timers prefix-peer-timeout** *timeout* **Example:** `switch(config-router)# timers prefix-peer-timeout 20`	Configures the timeout value (in seconds) for BGP prefix peers. The default value is 90 seconds. **Note** This command is supported beginning with Cisco NX-OS Release 9.3(3).
Step 4	**graceful-restart** **Example:** `switch(config-router)# graceful-restart`	Enables a graceful restart and the graceful restart helper functionality. This command is enabled by default. This command triggers an automatic notification and session reset for the BGP neighbor sessions.

Step 5	**graceful-restart** {**restart-time** *time*|**stalepath-time** *time*}
	Example:
	`switch(config-router)# graceful-restart restart-time 300`
		Configures the graceful restart timers.
		The optional parameters are as follows:
		• **restart-time**—Maximum time for a restart sent to the BGP peer. The range is from 1 to 3600 seconds. The default is 120.
		Note
		Cisco NX-OS Release 10.1(1) supports a higher number of BFD sessions. If BGP sessions are associated with BFD, the BGP **restart-time** may need to be increased to maintain peer connection during ISSU.
		• **stalepath-time**—Maximum time that BGP keeps the stale routes from the restarting BGP peer. The range is from 1 to 3600 seconds. The default is 300.
		In NX-OS software release 10.2(1), a manual reset of a BGP session is needed for the BGP session to advertise Graceful Restart capabilities. For NX-OS software releases

	Command or Action	Purpose
		10.2(2) and later, BGP sessions dynamically advertise Graceful Restart capabilities without needing to restart the BGP sessions when this command is enabled.
Step 6	**graceful-restart-helper** **Example:** `switch(config-router)# graceful-restart restart-time 300`	With BGP GR disabled, the N9K itself will not necessarily preserve its own forwarding state during certain GR-capable events like SSO, BGP process restart, etc. occurring locally on the N9K. However, as a GR helper, it will support a peer that has advertised its GR capability and is restarting. This means, when the N9K detects the peering has gone down (other than a holdtimer expiration or receipt of a Notification message), the N9K will stale the routes pointing to the peer and will wait for the peer's EOR (or stalepath timeout). When the peer restarts and re-establishes its peering with the N9K, it will re-advertise all its own routes and the N9K will refresh them in its BGP and routing tables. On receipt of the EOR from the peer or the stalepath timeout (whichever occurs first), the N9K will flush any remaining stale routes from that peer. In the absence of helper mode, the N9K would instantly clear out the routes learnt from the remote peer that was restarting which could lead to traffic loss.
Step 7	(Optional) **show running-config bgp** **Example:** `switch(config-router)# show running-config bgp`	Displays the BGP configuration.
Step 8	(Optional) **copy running-config startup-config** **Example:** `switch(config-router)# copy running-config startup-config`	Saves this configuration change.

Example

This example shows how to enable a graceful restart:

```
switch# configure terminal
switch(config)# router bgp 65536
switch(config-router)# graceful-restart
switch(config-router)# graceful-restart restart-time 300
switch(config-router)# copy running-config startup-config
```

Configuring Virtualization

You can create multiple VRFs within each VDC and use the same BGP process in each VRF.

You can configure one BGP process in each VDC. You can create multiple VRFs within each VDC and use the same BGP process in each VRF.

You can configure one BGP process, create multiple VRFs, and use the same BGP process in each VRF.

Before you begin

Ensure that you have enabled the BGP feature

- You must enable BGP (see the Enabling BGP section).
- Ensure that you are in the correct VDC (or use the **switchto vdc** command).

You must enable BGP.

SUMMARY STEPS

1. **configure terminal**
2. **vrf context** *vrf-name*
3. **exit**
4. **router bgp** *as-number*
5. **vrf** *vrf-name*
6. **neighbor** *ip-address* **remote-as** *as-number*
7. (Optional) **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**vrf context** *vrf-name*
	Example:
	`switch(config)# vrf context`
	`RemoteOfficeVRF`
	`switch(config-vrf)#`
		Creates a new VRF and enters VRF configuration mode.

Step 3	**exit**
	Example:
	`switch(config-vrf)# exit`
	`switch(config)#`
		Exits VRF configuration mode.

Step 4	**router bgp** *as-number*
	Example:
	`switch(config)# router bgp 65535`
	`switch(config-router)#`
		Creates a new BGP process with the configured autonomous system number.

	Command or Action	Purpose

Step 5	**vrf** *vrf-name*
	Example:
	`switch(config-router)# vrf RemoteOfficeVRF`
	`switch(config-router-vrf)#`
		Enters the router VRF configuration mode and associates this BGP instance with a VRF.

Step 6	**neighbor** *ip-address* **remote-as** *as-number*
	Example:
	`switch(config-router-vrf)# neighbor 209.165.201.1 remote-as 65535`
	`switch(config-router--vrf-neighbor)#`
		Configures the IP address and AS number for a remote BGP peer.

Step 7	(Optional) **copy running-config startup-config** **Example:** `switch(config-router-vrf-neighbor)# copy running-config startup-config`	Saves this configuration change.

Example

This example shows how to create a VRF and configure the router ID in the VRF:

```
switch# configure terminal
switch(config)# vrf context NewVRF
switch(config-vrf)# exit
switch(config)# router bgp 65536
switch(config-router)# vrf NewVRF
switch(config-router-vrf)# neighbor 209.165.201.1 remote-as 65536
switch(config-router-vrf-neighbor)# copy running-config startup-config
```

Verifying the Advanced BGP Configuration

To display the BGP configuration, perform one of the following tasks:

Command	Purpose
show bgp all [**summary**] [**vrf** *vrf-name*]	Displays the BGP information for all address families.
show bgp convergence [vrf *vrf-name]*	Displays the BGP information for all address families.
show bgp {**ipv4** | **ipv6**} {**unicast** | **multicast**} [*ip-address* | *ipv6-prefix*] **community** {**regexp** *expression* | [**community**] [**no-advertise**] [**no-export**] [**no-export-subconfed**]} [**vrf** *vrf-name*]	Displays the BGP routes that match a BGP community.
show bgp [**vrf** *vrf-name*] {**ipv4** | **ipv6**} {**unicast** | **multicast**} [*ip-address* | *ipv6-prefix*] **community-list** *list-name* [**vrf** *vrf-name*]	Displays the BGP routes that match a BGP community list.

Command	Purpose
show bgp {**ipv4** | **ipv6**} {**unicast** | **multicast**} [*ip-address* | *ipv6-prefix*] **extcommunity** {**regexp** *expression* | **generic** [**non-transitive** | **transitive**] *aa4:nn* [**exact-match**]} [**vrf** *vrf-name*]	Displays the BGP routes that match a BGP extended community.
show bgp {**ipv4** | **ipv6**} {**unicast** | **multicast**} [*ip-address* | *ipv6-prefix*] **extcommunity-list** *list-name* [**exact-match**]} [**vrf** vrf-name]	Displays the BGP routes that match a BGP extended community list.
show bgp {**ipv4** | **ipv6**} {**unicast** | **multicast**} [*ip-address* | *ipv6-prefix*] **extcommunity-list** *list-name* [**exact-match**]} [**vrf** vrf-name]	Displays the information for BGP route dampening. Use the **clear bgp dampening** command to clear the route flap dampening information.
show bgp {**ipv4** | **ipv6**} {**unicast** | **multicast**} [*ip-address* | *ipv6-prefix*] {**dampening dampened-paths** [**regexp** *expression*]} [**vrf** vrf-name]	Displays the BGP route history paths.
show bgp {**ipv4** | **ipv6** | **vpnv4** | **vpnv6**} {**unicast** | **multicast**} [*ip-address* | *ipv6-prefix*] **filter-list** *list-name* [**vrf** *vrf-name*]	Displays the information for the BGP filter list.
show bgp {**ipv4** | **ipv6** | **vpnv4** | **vpnv6**} {**unicast** | **multicast**} [*ip-address* | *ipv6-prefix*] **neighbors** [*ip-address* | *ipv6-prefix*] [**vrf** *vrf-name*]	Displays the information for BGP peers. Use the **clear bgp neighbors** command to clear these neighbors.
show bgp {**ipv4** | **ipv6**} {**unicast** | **multicast**} [*ip-address* | *ipv6-prefix*] {**nexthop** | **nexthop-database**} [**vrf** *vrf-name*]	Displays the information for the BGP route next hop.
show bgp paths	Displays the BGP path information.
show bgp {**ipv4** | **ipv6**} {**unicast** | **multicast**} [*ip-address* | *ipv6-prefix*] **policy** *name* [**vrf** *vrf-name*]	Displays the BGP policy information. Use the **clear bgp policy** command to clear the policy information.
show bgp {**ipv4** | **ipv6**} {**unicast** | **multicast**} [*ip-address* | *ipv6-prefix*] **prefix-list** *list-name* [**vrf** *vrf-name*]	Displays the BGP routes that match the prefix list.
show bgp {**ipv4** | **ipv6**} {**unicast** | **multicast**} [*ip-address* | *ipv6-prefix*] **received-paths** [**vrf** *vrf-name*]	Displays the BGP paths stored for soft reconfiguration.
show bgp {**ipv4** | **ipv6**} {**unicast** | **multicast**} [*ip-address* | *ipv6-prefix*] **regexp** *expression* [**vrf** *vrf-name*]	Displays the BGP routes that match the AS_path regular expression.
show bgp {**ipv4** | **ipv6**} {**unicast** | **multicast**} [*ip-address* | *ipv6-prefix*] **route-map** *map-name* [**vrf** *vrf-name*]	Displays the BGP routes that match the route map.
show bgp peer-policy *name* [**vrf** *vrf-name*]	Displays the information about BGP peer policies.
show bgp peer-session *name* [**vrf** *vrf-name*]	Displays the information about BGP peer sessions.

Command	Purpose
show bgp peer-template *name* [**vrf** *vrf-name*]	Displays the information about BGP peer templates. Use the **clear bgp peer-template** command to clear all neighbors in a peer template.
show bgp process	Displays the BGP process information.
show bgp {**ipv4** | **ipv6**} **unicast neighbors** *interface*	Displays information about BGP peers for the specified interface.
show ip bgp neighbors *interface-name*	Displays the interface used as a BGP peer.
show ip route *ip-address* **detail vrf all | i bw**	Displays the link bandwidth EXTCOMM fields. bw:xx (such as bw:40) in the output indicates that BGP peers are sending BGP extended attributes with the bandwidth (for weighted ECMP).
show {**ipv4** | **ipv6**} **bgp** *options*	Displays the BGP status and configuration information.
show {**ipv4** | **ipv6**} **mbgp** *options*	Displays the BGP status and configuration information.
show ipv6 routers interface *interface*	Displays the link-local address of remote IPv6 routers, which is learned through IPv6 ICMP router advertisement.
show running-configuration bgp	Displays the current running BGP configuration.

Monitoring BGP Statistics

To display BGP statistics, use the following commands:

Command	Purpose
show bgp {**ipv4** | **vpnv4** | **vpnv6** | **ipv6**} {**unicast** | **multicast**} [*ip-address* | *ipv6-prefix*] **flap-statistics** [**vrf** *vrf-name*] **show bgp** {**ipv4** | **ipv6**} {**unicast** | **multicast**} [*ip-address* | *ipv6-prefix*] **flap-statistics** [**vrf** *vrf-name*]	Displays the BGP route flap statistics. Use the **clear bgp flap-statistics** command to clear these statistics.

show bgp {**ipv4** | **ipv6** | **vpnv4** | **vpnv6**} **unicast injected-routes** **show bgp** {**ipv4** | **ipv6**} **unicast injected-routes**	Displays injected routes in the routing table.
show bgp sessions [**vrf** *vrf-name*]	Displays the BGP sessions for all peers. Use the **clear bgp sessions** command to clear these statistics.
show bgp statistics	Displays the BGP statistics.

Configuration Examples

This example shows how to enable BFD for individual BGP neighbors:

```
router bgp 400
  router-id 2.2.2.2
  neighbor 172.16.2.3
    bfd
    remote-as 400
    update-source Vlan1002
    address-family ipv4 unicast
```

This example shows how to enable BFD for BGP prefix peers:

```
router bgp 400
  router-id 1.1.1.1
  neighbor 172.16.2.0/24
    bfd
    remote-as 400
    update-source Vlan1002
    address-family ipv4 unicast
```

This example shows how to configure MD5 authentication for prefix-based neighbors:

```
template peer BasePeer-V6
    description BasePeer-V6
    password 3 f4200cfc725bbd28
    transport connection-mode passive
    address-family ipv6 unicast
template peer BasePeer-V4
    bfd
    description BasePeer-V4
    password 3 f4200cfc725bbd28
    address-family ipv4 unicast
--
    neighbor fc00::10:3:11:0/127 remote-as 65006
      inherit peer BasePeer-V6
    neighbor 10.3.11.0/31 remote-as 65006
      inherit peer BasePeer-V4
```

This example shows how to enable neighbor status change messages globally and suppress them for a specific neighbor:

```
router bgp 65100
   log-neighbor-changes
     neighbor 209.165.201.1 remote-as 65535
       description test
       address-family ipv4 unicast
         soft-reconfiguration inbound
          disable log-neighbor-changes
```

Related Topics

The following topics can give more information on BGP:

- *Configuring Basic BGP*
- *Configuring Route Policy Manager*

Additional References

For additional information related to implementing BGP, see the following sections:

MIBs

MIBs	MIBs Link
MIBs related to BGP	To locate and download supported MIBs, go to the following URL: ftp://ftp.cisco.com/pub/mibs/supportlists/nexus9000/Nexus9000MIBSupportList.html