



Implementing MPLS Layer 3 VPNs

A Multiprotocol Label Switching (MPLS) Layer 3 Virtual Private Network (VPN) consists of a set of sites that are interconnected by means of an MPLS provider core network. At each customer site, one or more customer edge (CE) routers attach to one or more provider edge (PE) routers.

This module provides the conceptual and configuration information for MPLS Layer 3 VPNs on Cisco IOS XR software.



Note

You must acquire an evaluation or permanent license in order to use MPLS Layer 3 VPN functionality. However, if you are upgrading from a previous version of the software, MPLS Layer 3 VPN functionality will continue to work using an implicit license for 90 days (during which time, you can purchase a permanent license). For more information about licenses, see the *Software Entitlement on Cisco IOS XR Software* module in the *Cisco IOS XR System Management Configuration Guide*.



Note

For a complete description of the commands listed in this module, refer to the *Cisco IOS XR MPLS Command Reference*. To locate documentation of other commands that appear in this chapter, use the command reference master index, or search online.

Feature History for Implementing MPLS Layer 3 VPNs on Cisco IOS XR software

Release	Modification
Release 3.3.0	This feature was introduced.
Release 3.4.0	Support was added for MPLS L3VPN Carrier Supporting Carrier (CSC) functionality, including conceptual information and configuration tasks.
Release 3.4.1	No modification.
Release 3.5.0	Support was added for 6VPE. MPLS L3VPN Carrier Supporting Carrier (CSC) information was upgraded.
Release 3.6.0	Support was added for Inter-AS and CSC over IP Tunnels.
Release 3.7.0	Support was added for: <ul style="list-style-type: none">IPv6 VPN Provider Edge (6VPE).Inter-AS support for 6VPE.

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Prerequisites for Implementing MPLS L3VPN

The following prerequisites are required to configure MPLS Layer 3 VPN:

- To perform these configuration tasks, your Cisco IOS XR software system administrator must assign you to a user group associated with a task group that includes the corresponding command task IDs. All command task IDs are listed in individual command references and in the *Cisco IOS XR Task ID Reference Guide*.

If you need assistance with your task group assignment, contact your system administrator.

- You must be in a user group associated with a task group that includes the proper task IDs for
 - BGP commands
 - MPLS commands (generally)
 - MPLS Layer 3 VPN commands

The following prerequisites are required for configuring MPLS VPN Inter-AS with autonomous system boundary routers (ASBRs) exchanging VPN-IPv4 addresses or IPv4 routes and MPLS labels:

- Before configuring external Border Gateway Protocol (eBGP) routing between autonomous systems or subautonomous systems in an MPLS VPN, ensure that all MPLS VPN routing instances and sessions are properly configured (see the [How to Implement MPLS Layer 3 VPNs, page VPC-285](#) for procedures).
- The following tasks must be performed:
 - Define VPN routing instances
 - Configure BGP routing sessions in the MPLS core
 - Configure PE-to-PE routing sessions in the MPLS core
 - Configure BGP PE-to-CE routing sessions
 - Configure a VPN-IPv4 eBGP session between directly connected ASBRs

To configure MPLS Layer 3 VPNs, routers must support MPLS forwarding and Forwarding Information Base (FIB).

MPLS L3VPN Restrictions

The following are restrictions for implementing MPLS Layer 3 VPNs:

- Multihop VPN-IPv4 eBGP is not supported for configuring eBGP routing between autonomous systems or subautonomous systems in an MPLS VPN.
- MPLS VPN supports only IPv4 address families.

The following restrictions apply when configuring MPLS VPN Inter-AS with ASBRs exchanging IPv4 routes and MPLS labels:

- For networks configured with eBGP multihop, a label switched path (LSP) must be configured between nonadjacent routers.
- Inter-AS supports IPv4 routes only. IPv6 is not supported.

**Note**

The physical interfaces that connect the BGP speakers must support FIB and MPLS.

The following restrictions apply to routing protocols OSPF and RIP:

- IPv6 is not supported on OSPF and RIP.

Information About MPLS Layer 3 VPNs

To implement MPLS Layer 3 VPNs, you need to understand the following concepts:

- [MPLS L3VPN Overview, page VPC-263](#)
- [MPLS L3VPN Benefits, page VPC-264](#)
- [How MPLS L3VPN Works, page VPC-265](#)
- [MPLS L3VPN Major Components, page VPC-267](#)

MPLS L3VPN Overview

Before defining an MPLS VPN, VPN in general must be defined. A VPN is:

- An IP-based network delivering private network services over a public infrastructure
- A set of sites that are allowed to communicate with each other privately over the Internet or other public or private networks

Conventional VPNs are created by configuring a full mesh of tunnels or permanent virtual circuits (PVCs) to all sites in a VPN. This type of VPN is not easy to maintain or expand, as adding a new site requires changing each edge device in the VPN.

MPLS-based VPNs are created in Layer 3 and are based on the peer model. The peer model enables the service provider and the customer to exchange Layer 3 routing information. The service provider relays the data between the customer sites without customer involvement.

MPLS VPNs are easier to manage and expand than conventional VPNs. When a new site is added to an MPLS VPN, only the edge router of the service provider that provides services to the customer site needs to be updated.

The components of the MPLS VPN are described as follows:

- Provider (P) router—Router in the core of the provider network. PE routers run MPLS switching and do not attach VPN labels to routed packets. VPN labels are used to direct data packets to the correct private network or customer edge router.
- PE router—Router that attaches the VPN label to incoming packets based on the interface or subinterface on which they are received, and also attaches the MPLS core labels. A PE router attaches directly to a CE router.
- Customer (C) router—Router in the Internet service provider (ISP) or enterprise network.
- Customer edge (CE) router—Edge router on the network of the ISP that connects to the PE router on the network. A CE router must interface with a PE router.

Figure 25 shows a basic MPLS VPN topology.

Figure 25 **Basic MPLS VPN Topology**

MPLS L3VPN Benefits

MPLS L3VPN provides the following benefits:

- Service providers can deploy scalable VPNs and deliver value-added services.
- Connectionless service guarantees that no prior action is necessary to establish communication between hosts.
- Centralized Service: Building VPNs in Layer 3 permits delivery of targeted services to a group of users represented by a VPN.
- Scalability: Create scalable VPNs using connection-oriented, point-to-point overlays, Frame Relay, or ATM virtual connections.
- Security: Security is provided at the edge of a provider network (ensuring that packets received from a customer are placed on the correct VPN) and in the backbone.
- Integrated Quality of Service (QoS) support: QoS provides the ability to address predictable performance and policy implementation and support for multiple levels of service in an MPLS VPN.
- Straightforward Migration: Service providers can deploy VPN services using a straightforward migration path.

- Migration for the end customer is simplified. There is no requirement to support MPLS on the CE router and no modifications are required for a customer intranet.

How MPLS L3VPN Works

MPLS VPN functionality is enabled at the edge of an MPLS network. The PE router performs the following tasks:

- Exchanges routing updates with the CE router
- Translates the CE routing information into VPN version 4 (VPNv4) and VPN version 6 (VPNv6) routes
- Exchanges VPNv4 and VPNv6 routes with other PE routers through the Multiprotocol Border Gateway Protocol (MP-BGP)

Virtual Routing and Forwarding Tables

Each VPN is associated with one or more VPN routing and forwarding (VRF) instances. A VRF defines the VPN membership of a customer site attached to a PE router. A VRF consists of the following components:

- An IP version 4 (IPv4) unicast routing table
- A derived FIB table
- A set of interfaces that use the forwarding table
- A set of rules and routing protocol parameters that control the information that is included in the routing table

These components are collectively called a VRF instance.

A one-to-one relationship does not necessarily exist between customer sites and VPNs. A site can be a member of multiple VPNs. However, a site can associate with only one VRF. A VRF contains all the routes available to the site from the VPNs of which it is a member.

Packet forwarding information is stored in the IP routing table and the FIB table for each VRF. A separate set of routing and FIB tables is maintained for each VRF. These tables prevent information from being forwarded outside a VPN and also prevent packets that are outside a VPN from being forwarded to a router within the VPN.

VPN Routing Information: Distribution

The distribution of VPN routing information is controlled through the use of VPN route target communities, implemented by BGP extended communities. VPN routing information is distributed as follows:

- When a VPN route that is learned from a CE router is injected into a BGP, a list of VPN route target extended community attributes is associated with it. Typically, the list of route target community extended values is set from an export list of route targets associated with the VRF from which the route was learned.
- An import list of route target extended communities is associated with each VRF. The import list defines route target extended community attributes that a route must have for the route to be imported into the VRF. For example, if the import list for a particular VRF includes route target extended communities A, B, and C, then any VPN route that carries any of those route target extended communities—A, B, or C—is imported into the VRF.

BGP Distribution of VPN Routing Information

A PE router can learn an IP prefix from the following sources:

- A CE router by static configuration
- An eBGP session with the CE router
- A Routing Information Protocol (RIP) exchange with the CE router
- Open Shortest Path First (OSPF), Enhanced Interior Gateway Routing Protocol (EIGRP), and RIP as Interior Gateway Protocols (IGPs)

The IP prefix is a member of the IPv4 address family. After the PE router learns the IP prefix, the PE converts it into the VPN-IPv4 prefix by combining it with a 64-bit route distinguisher. The generated prefix is a member of the VPN-IPv4 address family. It uniquely identifies the customer address, even if the customer site is using globally nonunique (unregistered private) IP addresses. The route distinguisher used to generate the VPN-IPv4 prefix is specified by the **rd** command associated with the VRF on the PE router.

BGP distributes reachability information for VPN-IPv4 prefixes for each VPN. BGP communication takes place at two levels:

- Within the IP domain, known as an autonomous system.
- Between autonomous systems.

PE to PE or PE to route reflector (RR) sessions are iBGP sessions, and PE to CE sessions are eBGP sessions. PE to CE eBGP sessions can be directly or indirectly connected (eBGP multihop).

BGP propagates reachability information for VPN-IPv4 prefixes among PE routers by the BGP protocol extensions (see RFC 2283, Multiprotocol Extensions for BGP-4), which define support for address families other than IPv4. Using the extensions ensures that the routes for a given VPN are learned only by other members of that VPN, enabling members of the VPN to communicate with each other.

MPLS Forwarding

Based on routing information stored in the VRF IP routing table and the VRF FIB table, packets are forwarded to their destination using MPLS.

A PE router binds a label to each customer prefix learned from a CE router and includes the label in the network reachability information for the prefix that it advertises to other PE routers. When a PE router forwards a packet received from a CE router across the provider network, it labels the packet with the label learned from the destination PE router. When the destination PE router receives the labeled packet, it pops the label and uses it to direct the packet to the correct CE router. Label forwarding across the provider backbone is based on either dynamic label switching or traffic engineered paths. A customer data packet carries two levels of labels when traversing the backbone:

- The top label directs the packet to the correct PE router.
- The second label indicates how that PE router should forward the packet to the CE router.

More labels can be stacked if other features are enabled. For example, if traffic engineering (TE) tunnels with fast reroute (FRR) are enabled, the total number of labels imposed in the PE is four (Layer 3 VPN, Label Distribution Protocol (LDP), TE, and FRR).

Automatic Route Distinguisher Assignment

To take advantage of iBGP load balancing, every network VRF must be assigned a unique route distinguisher. VRFs require a route distinguisher for BGP to distinguish between potentially identical prefixes received from different VPNs.

With thousands of routers in a network each supporting multiple VRFs, configuration and management of route distinguishers across the network can present a problem. Cisco IOS XR software simplifies this process by assigning unique route distinguisher to VRFs using the **rd auto** command.

To assign a unique route distinguisher for each router, you must ensure that each router has a unique BGP router-id. If so, the **rd auto** command assigns a Type 1 route distinguisher to the VRF using the following format: *ip-address:number*. The IP address is specified by the BGP router-id statement and the number (which is derived as an unused index in the 0 to 65535 range) is unique across the VRFs.

Finally, route distinguisher values are checkpointed so that route distinguisher assignment to VRF is persistent across failover or process restart. If an route distinguisher is explicitly configured for a VRF, this value is not overridden by the autoroute distinguisher.

MPLS L3VPN Major Components

An MPLS-based VPN network has three major components:

- VPN route target communities—A VPN route target community is a list of all members of a VPN community. VPN route targets need to be configured for each VPN community member.
- Multiprotocol BGP (MP-BGP) peering of the VPN community PE routers—MP-BGP propagates VRF reachability information to all members of a VPN community. MP-BGP peering needs to be configured in all PE routers within a VPN community.
- MPLS forwarding—MPLS transports all traffic between all VPN community members across a VPN service-provider network.

A one-to-one relationship does not necessarily exist between customer sites and VPNs. A given site can be a member of multiple VPNs. However, a site can associate with only one VRF. A customer-site VRF contains all the routes available to the site from the VPNs of which it is a member.

Inter-AS Support for L3VPN

This section contains the following topics:

- [Inter-AS Restrictions, page VPC-268](#)
- [Inter-AS Support: Overview, page VPC-268](#)
- [Inter-AS and ASBRs, page VPC-268](#)
- [Transmitting Information Between Autonomous Systems, page VPC-269](#)
- [Exchanging VPN Routing Information, page VPC-270](#)
- [Packet Forwarding, page VPC-272](#)
- [Confederations, page VPC-275](#)
- [MPLS VPN Inter-AS BGP Label Distribution, page VPC-277](#)
- [Exchanging IPv4 Routes with MPLS labels, page VPC-277](#)

Inter-AS Restrictions

Inter-AS functionality is available using VPNv4 only. VPNv6 is not currently supported.

Inter-AS Support: Overview

An autonomous system (AS) is a single network or group of networks that is controlled by a common system administration group and uses a single, clearly defined routing protocol.

As VPNs grow, their requirements expand. In some cases, VPNs need to reside on different autonomous systems in different geographic areas. In addition, some VPNs need to extend across multiple service providers (overlapping VPNs). Regardless of the complexity and location of the VPNs, the connection between autonomous systems must be seamless.

An MPLS VPN Inter-AS provides the following benefits:

- Allows a VPN to cross more than one service provider backbone.

Service providers, running separate autonomous systems, can jointly offer MPLS VPN services to the same end customer. A VPN can begin at one customer site and traverse different VPN service provider backbones before arriving at another site of the same customer. Previously, MPLS VPN could traverse only a single BGP autonomous system service provider backbone. This feature lets multiple autonomous systems form a continuous, seamless network between customer sites of a service provider.

- Allows a VPN to exist in different areas.

A service provider can create a VPN in different geographic areas. Having all VPN traffic flow through one point (between the areas) allows for better rate control of network traffic between the areas.

- Allows confederations to optimize iBGP meshing.

Internal Border Gateway Protocol (iBGP) meshing in an autonomous system is more organized and manageable. You can divide an autonomous system into multiple, separate subautonomous systems and then classify them into a single confederation. This capability lets a service provider offer MPLS VPNs across the confederation, as it supports the exchange of labeled VPN-IPv4 Network Layer Reachability Information (NLRI) between the subautonomous systems that form the confederation.

Inter-AS and ASBRs

Separate autonomous systems from different service providers can communicate by exchanging IPv4 NLRI in the form of VPN-IPv4 addresses. The ASBRs use eBGP to exchange that information. Then an Interior Gateway Protocol (IGP) distributes the network layer information for VPN-IPv4 prefixes throughout each VPN and each autonomous system. The following protocols are used for sharing routing information:

- Within an autonomous system, routing information is shared using an IGP.
- Between autonomous systems, routing information is shared using an eBGP. An eBGP lets service providers set up an interdomain routing system that guarantees the loop-free exchange of routing information between separate autonomous systems.

The primary function of an eBGP is to exchange network reachability information between autonomous systems, including information about the list of autonomous system routes. The autonomous systems use EBGP border edge routers to distribute the routes, which include label switching information. Each border edge router rewrites the next-hop and MPLS labels.

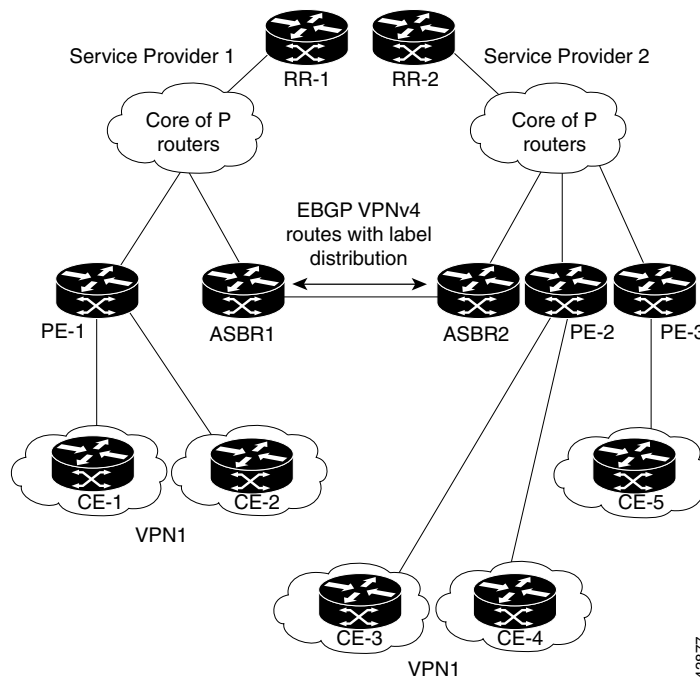
Inter-AS configurations supported in an MPLS VPN can include:

- Interprovider VPN—MPLS VPNs that include two or more autonomous systems, connected by separate border edge routers. The autonomous systems exchange routes using eBGP. No IGP or routing information is exchanged between the autonomous systems.
- BGP Confederations—MPLS VPNs that divide a single autonomous system into multiple subautonomous systems and classify them as a single, designated confederation. The network recognizes the confederation as a single autonomous system. The peers in the different autonomous systems communicate over eBGP sessions; however, they can exchange route information as if they were iBGP peers.

Transmitting Information Between Autonomous Systems

Figure 26 illustrates one MPLS VPN consisting of two separate autonomous systems. Each autonomous system operates under different administrative control and runs a different IGP. Service providers exchange routing information through eBGP border edge routers (ASBR1 and ASBR2).

Figure 26 eBGP Connection Between Two MPLS VPN Inter-AS Systems with ASBRs Exchanging VPN-IPv4 Addresses



This configuration uses the following process to transmit information:

-
- Step 1** The provider edge router (PE-1) assigns a label for a route before distributing that route. The PE router uses the multiprotocol extensions of BGP to transmit label mapping information. The PE router distributes the route as a VPN-IPv4 address. The address label and the VPN identifier are encoded as part of the NLRI.
- Step 2** The two route reflectors (RR-1 and RR-2) reflect VPN-IPv4 internal routes within the autonomous system. The border edge routers of the autonomous system (ASBR1 and ASBR2) advertise the VPN-IPv4 external routes.
- Step 3** The eBGP border edge router (ASBR1) redistributes the route to the next autonomous system (ASBR2). ASBR1 specifies its own address as the value of the eBGP next-hop attribute and assigns a new label. The address ensures:
- That the next-hop router is always reachable in the service provider (P) backbone network.
 - That the label assigned by the distributing router is properly interpreted. (The label associated with a route must be assigned by the corresponding next-hop router.)
- Step 4** The eBGP border edge router (ASBR2) redistributes the route in one of the following ways, depending on the configuration:
- If the iBGP neighbors are configured with the **next-hop-self** command, ASBR2 changes the next-hop address of updates received from the eBGP peer, then forwards it.
 - If the iBGP neighbors are not configured with the **next-hop-self** command, the next-hop address remains unchanged. ASBR2 must propagate a host route for the eBGP peer through the IGP. To propagate the eBGP VPN-IPv4 neighbor host route, use the **redistribute** command with the **static** keyword. An eBGP VPN-IPv4 neighbor host route must be manually configured to establish the label switched path (LSP) towards ASBR1. The static route needs to be redistributed to IGP, to let other PE routers use the /32 host prefix label to forward traffic for an Inter-AS VPN redistribute static option.



Note This option is not supported for Inter-AS over IP tunnels.

Exchanging VPN Routing Information

Autonomous systems exchange VPN routing information (routes and labels) to establish connections. To control connections between autonomous systems, the PE routers and eBGP border edge routers maintain a label forwarding information base (LFIB). The LFIB manages the labels and routes that the PE routers and eBGP border edge routers receive during the exchange of VPN information.

The autonomous systems use the following guidelines to exchange VPN routing information:

- Routing information includes:
 - The destination network (N)
 - The next-hop field associated with the distributing router
 - A local MPLS label (L)
- A route distinguisher (RD1). A route distinguisher is part of a destination network address. It makes the VPN-IPv4 route globally unique in the VPN service provider environment.

- The ASBRs are configured to change the next-hop when sending VPN-IPv4 NLRI to the iBGP neighbors. Therefore, the ASBRs must allocate a new label when they forward the NLRI to the iBGP neighbors.

Figure 27 *Exchanging Routes and Labels Between MPLS VPN Inter-AS Systems with ASBRs Exchanging VPN-IPv4 Address*

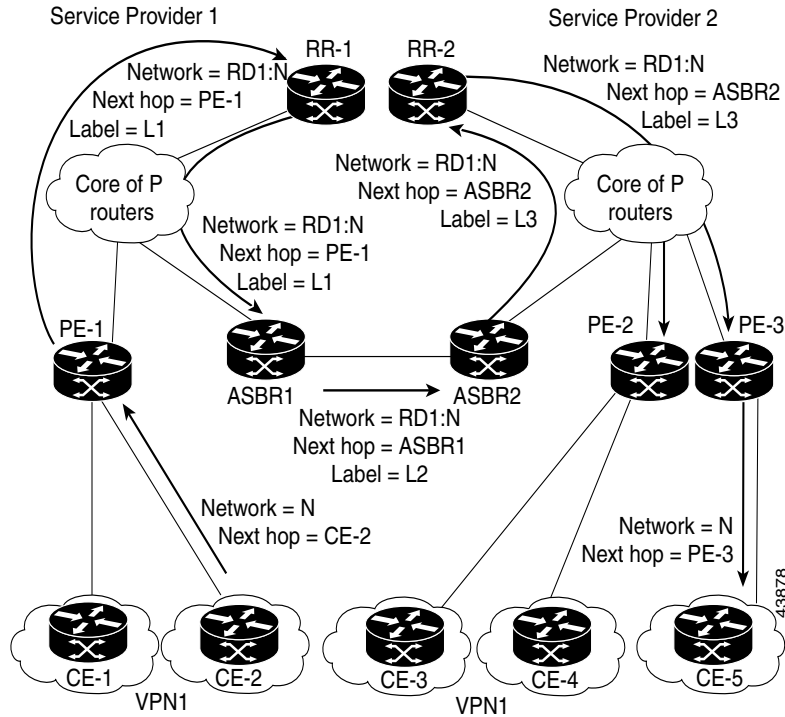
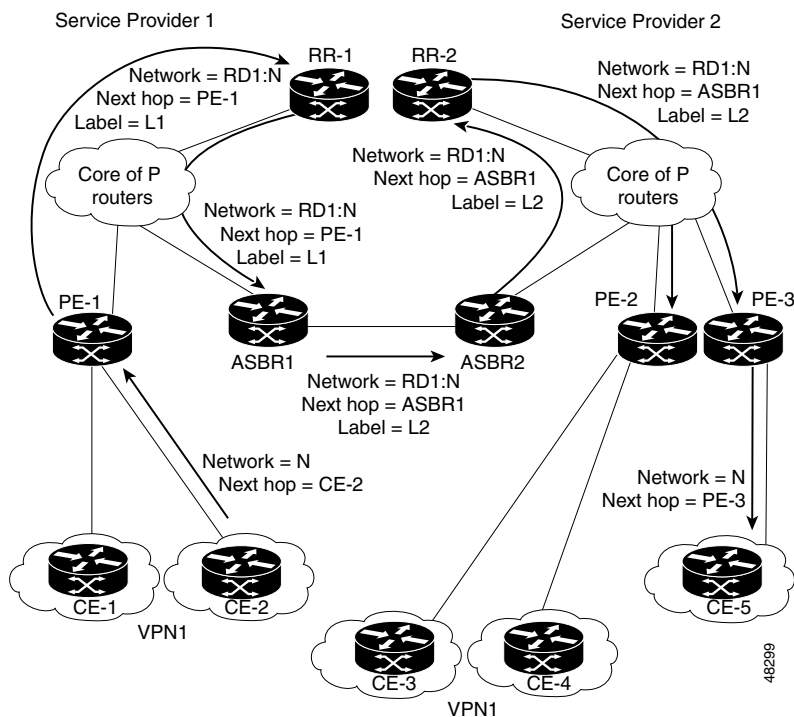


Figure 28 illustrates the exchange of VPN route and label information between autonomous systems. The only difference is that ASBR2 is configured with the **redistribute** command with the **connected** keyword, which propagates the host routes to all PEs. The command is necessary as ASBR2 is not configured to change the next-hop address.



Note Figure 28 is not applicable to Inter-AS over IP tunnels.

Figure 28 *Exchanging Routes and Labels with the redistributed Command in an MPLS VPN Inter-AS with ASBRs Exchanging VPN-IPv4 Addresses*



Packet Forwarding



Note

This section is not applicable to Inter-AS over IP tunnels.

Figure 29 illustrates how packets are forwarded between autonomous systems in an interprovider network using the following packet method.

Packets are forwarded to their destination by means of MPLS. Packets use the routing information stored in the LFIB of each PE router and eBGP border edge router.

The service provider VPN backbone uses dynamic label switching to forward labels.

Each autonomous system uses standard multilevel labeling to forward packets between the edges of the autonomous system routers (for example, from CE-5 to PE-3). Between autonomous systems, only a single level of labeling is used, corresponding to the advertised route.

A data packet carries two levels of labels when traversing the VPN backbone:

- The first label (IGP route label) directs the packet to the correct PE router on the eBGP border edge router. (For example, the IGP label of ASBR2 points to the ASBR2 border edge router.)
- The second label (VPN route label) directs the packet to the appropriate PE router or eBGP border edge router.

Figure 29 Forwarding Packets Between MPLS VPN Inter-AS Systems with ASBRs Exchanging VPN-IPv4 Addresses

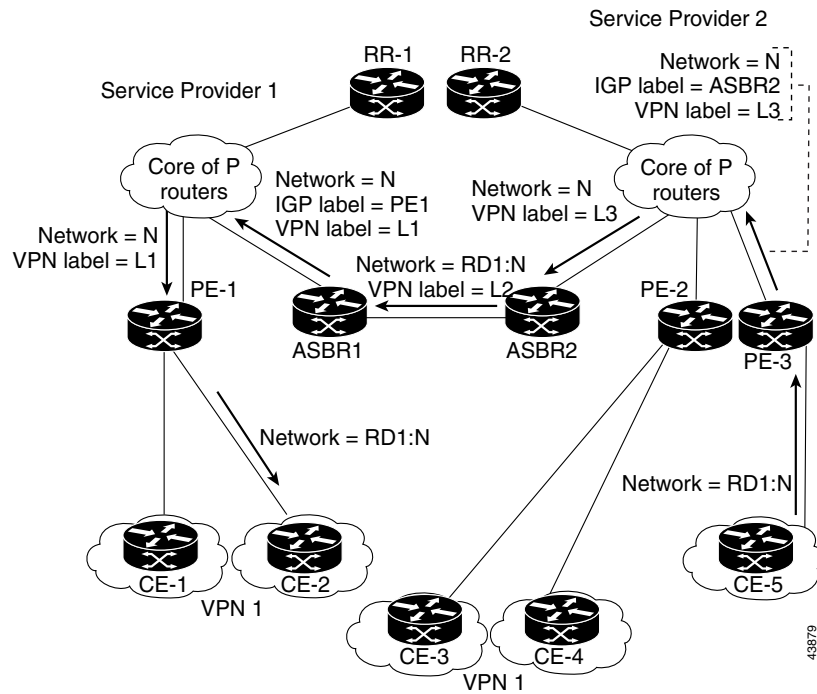
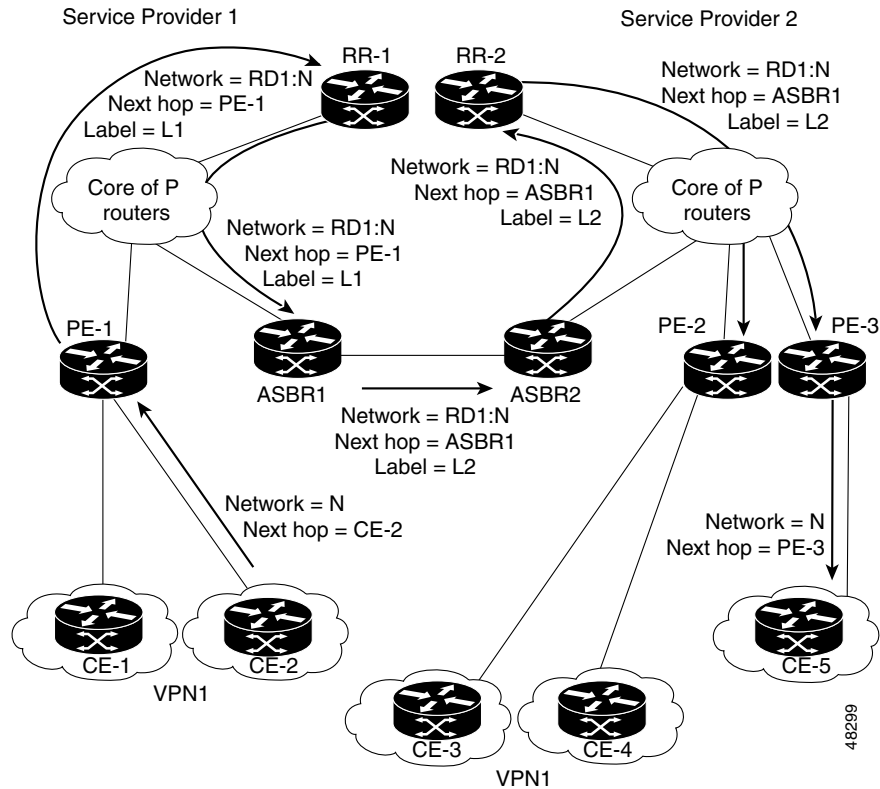


Figure 30 shows the same packet forwarding method, except the eBGP router (ASBR1) forwards the packet without reassigning a new label to it.

Figure 31 Exchanging Routes and Labels in an MPLS VPN Inter-AS with ASBRs



Confederations

A confederation is multiple subautonomous systems grouped together. A confederation reduces the total number of peer devices in an autonomous system. A confederation divides an autonomous system into subautonomous systems and assigns a confederation identifier to the autonomous systems. A VPN can span service providers running in separate autonomous systems or multiple subautonomous systems that form a confederation.

In a confederation, each subautonomous system is fully meshed with other subautonomous systems. The subautonomous systems communicate using an IGP, such as Open Shortest Path First (OSPF) or Intermediate System-to-Intermediate System (IS-IS). Each subautonomous system also has an eBGP connection to the other subautonomous systems. The confederation eBGP (CEBGP) border edge routers forward next-hop-self addresses between the specified subautonomous systems. The next-hop-self address forces the BGP to use a specified address as the next hop rather than letting the protocol choose the next hop.

You can configure a confederation with separate subautonomous systems two ways:

- Configure a router to forward next-hop-self addresses between only the CEBGP border edge routers (both directions). The subautonomous systems (iBGP peers) at the subautonomous system border do not forward the next-hop-self address. Each subautonomous system runs as a single IGP domain. However, the CEBGP border edge router addresses are known in the IGP domains.

- Configure a router to forward next-hop-self addresses between the CEBGP border edge routers (both directions) and within the iBGP peers at the subautonomous system border. Each subautonomous system runs as a single IGP domain but also forwards next-hop-self addresses between the PE routers in the domain. The CEBGP border edge router addresses are known in the IGP domains.

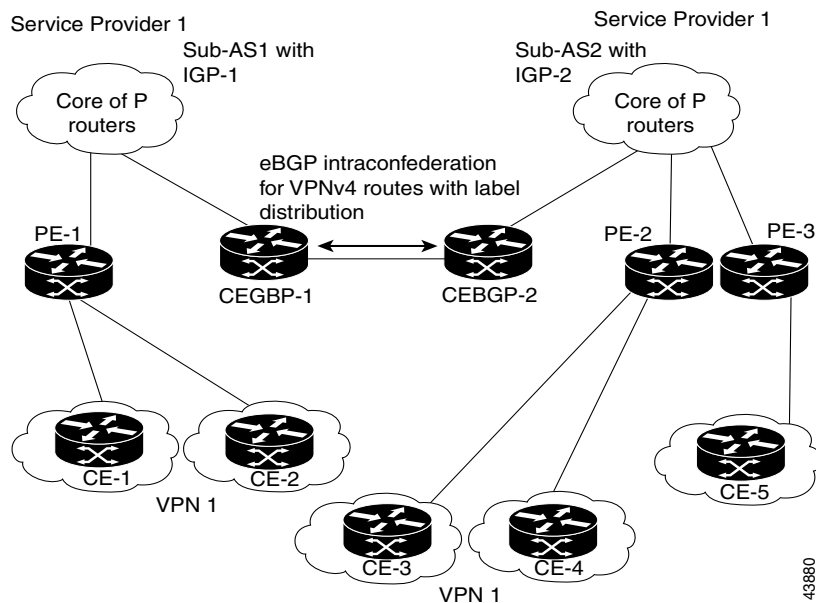
**Note**

Figure 26 illustrates how two autonomous systems exchange routes and forward packets. Subautonomous systems in a confederation use a similar method of exchanging routes and forwarding packets.

Figure 32 illustrates a typical MPLS VPN confederation configuration. In this configuration:

- The two CEBGP border edge routers exchange VPN-IPv4 addresses with labels between the two autonomous systems.
- The distributing router changes the next-hop addresses and labels and uses a next-hop-self address.
- IGP-1 and IGP-2 know the addresses of CEBGP-1 and CEBGP-2.

Figure 32 eBGP Connection Between Two Subautonomous Systems in a Confederation



In this confederation configuration:

- CEBGP border edge routers function as neighboring peers between the subautonomous systems. The subautonomous systems use eBGP to exchange route information.
- Each CEBGP border edge router (CEBGP-1 and CEBGP-2) assigns a label for the router before distributing the route to the next subautonomous system. The CEBGP border edge router distributes the route as a VPN-IPv4 address by using the multiprotocol extensions of BGP. The label and the VPN identifier are encoded as part of the NLRI.

- Each PE and CEBGP border edge router assigns its own label to each VPN-IPv4 address prefix before redistributing the routes. The CEBGP border edge routers exchange IPv-IPv4 addresses with the labels. The next-hop-self address is included in the label (as the value of the eBGP next-hop attribute). Within the subautonomous systems, the CEBGP border edge router address is distributed throughout the iBGP neighbors, and the two CEBGP border edge routers are known to both confederations.

For more information about how to configure confederations, see the [“Configuring MPLS Forwarding for ASBR Confederations”](#) section on page MPC-325.

MPLS VPN Inter-AS BGP Label Distribution



Note

This section is not applicable to Inter-AS over IP tunnels.

You can set up the MPLS VPN Inter-AS network so that the ASBRs exchange IPv4 routes with MPLS labels of the provider edge (PE) routers. Route reflectors (RRs) exchange VPN-IPv4 routes by using multihop, multiprotocol external Border Gateway Protocol (eBGP). This method of configuring the Inter-AS system is often called MPLS VPN Inter-AS BGP Label Distribution.

Configuring the Inter-AS system so that the ASBRs exchange the IPv4 routes and MPLS labels has the following benefits:

- Saves the ASBRs from having to store all the VPN-IPv4 routes. Using the route reflectors to store the VPN-IPv4 routes and forward them to the PE routers results in improved scalability compared with configurations in which the ASBR holds all the VPN-IPv4 routes and forwards the routes based on VPN-IPv4 labels.
- Having the route reflectors hold the VPN-IPv4 routes also simplifies the configuration at the border of the network.
- Enables a non-VPN core network to act as a transit network for VPN traffic. You can transport IPv4 routes with MPLS labels over a non-MPLS VPN service provider.
- Eliminates the need for any other label distribution protocol between adjacent label switch routers (LSRs). If two adjacent LSRs are also BGP peers, BGP can handle the distribution of the MPLS labels. No other label distribution protocol is needed between the two LSRs.

Exchanging IPv4 Routes with MPLS labels



Note

This section is not applicable to Inter-AS over IP tunnels.

You can set up a VPN service provider network to exchange IPv4 routes with MPLS labels. You can configure the VPN service provider network as follows:

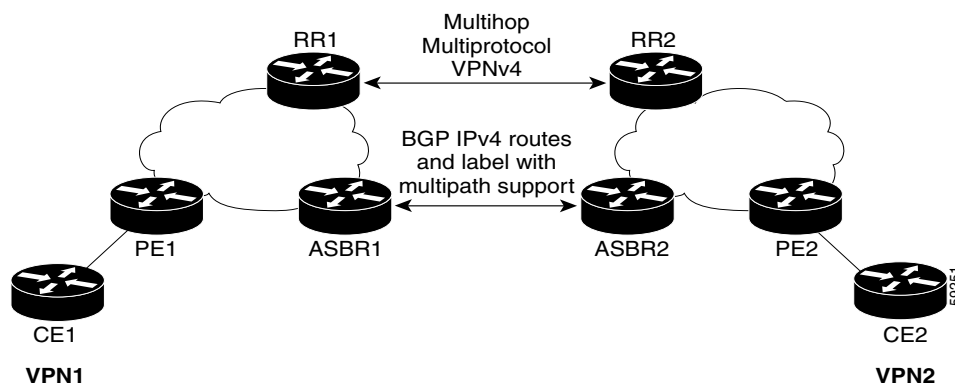
- Route reflectors exchange VPN-IPv4 routes by using multihop, multiprotocol eBGP. This configuration also preserves the next-hop information and the VPN labels across the autonomous systems.
- A local PE router (for example, PE1 in [Figure 33](#)) needs to know the routes and label information for the remote PE router (PE2).

This information can be exchanged between the PE routers and ASBRs in one of two ways:

- Internal Gateway Protocol (IGP) and Label Distribution Protocol (LDP): The ASBR can redistribute the IPv4 routes and MPLS labels it learned from eBGP into IGP and LDP and from IGP and LDP into eBGP.
- Internal Border Gateway Protocol (iBGP) IPv4 label distribution: The ASBR and PE router can use direct iBGP sessions to exchange VPN-IPv4 and IPv4 routes and MPLS labels.

Alternatively, the route reflector can reflect the IPv4 routes and MPLS labels learned from the ASBR to the PE routers in the VPN. This reflecting of learned IPv4 routes and MPLS labels is accomplished by enabling the ASBR to exchange IPv4 routes and MPLS labels with the route reflector. The route reflector also reflects the VPN-IPv4 routes to the PE routers in the VPN. For example, in VPN1, RR1 reflects to PE1 the VPN-IPv4 routes it learned and IPv4 routes and MPLS labels learned from ASBR1. Using the route reflectors to store the VPN-IPv4 routes and forward them through the PE routers and ASBRs allows for a scalable configuration.

Figure 33 VPNs Using eBGP and iBGP to Distribute Routes and MPLS Labels



BGP Routing Information

BGP routing information includes the following items:

- Network number (prefix), which is the IP address of the destination.
- Autonomous system (AS) path, which is a list of the other ASs through which a route passes on the way to the local router. The first AS in the list is closest to the local router; the last AS in the list is farthest from the local router and usually the AS where the route began.
- Path attributes, which provide other information about the AS path, for example, the next hop.

BGP Messages and MPLS Labels

MPLS labels are included in the update messages that a router sends. Routers exchange the following types of BGP messages:

- Open messages—After a router establishes a TCP connection with a neighboring router, the routers exchange open messages. This message contains the number of the autonomous system to which the router belongs and the IP address of the router that sent the message.
- Update messages—When a router has a new, changed, or broken route, it sends an update message to the neighboring router. This message contains the NLRI, which lists the IP addresses of the usable routes. The update message includes any routes that are no longer usable. The update message also includes path attributes and the lengths of both the usable and unusable paths. Labels for VPN-IPv4 routes are encoded in the update message, as specified in RFC 2858. The labels for the IPv4 routes are encoded in the update message, as specified in RFC 3107.
- Keepalive messages—Routers exchange keepalive messages to determine if a neighboring router is still available to exchange routing information. The router sends these messages at regular intervals. (Sixty seconds is the default for Cisco routers.) The keepalive message does not contain routing data; it contains only a message header.
- Notification messages—When a router detects an error, it sends a notification message.

Sending MPLS Labels with Routes

When BGP (eBGP and iBGP) distributes a route, it can also distribute an MPLS label that is mapped to that route. The MPLS label mapping information for the route is carried in the BGP update message that contains the information about the route. If the next hop is not changed, the label is preserved.

When you issue the **show bgp neighbors ip-address** command on both BGP routers, the routers advertise to each other that they can then send MPLS labels with the routes. If the routers successfully negotiate their ability to send MPLS labels, the routers add MPLS labels to all outgoing BGP updates.

Carrier Supporting Carrier Support for L3VPN

This section provides conceptual information about MPLS VPN Carrier Supporting Carrier (CSC) functionality and includes the following topics:

- [CSC Prerequisites, page VPC-280](#)
- [CSC Benefits, page VPC-280](#)
- [Configuration Options for the Backbone and Customer Carriers, page VPC-281](#)

Throughout this document, the following terminology is used in the context of CSC:

backbone carrier—Service provider that provides the segment of the backbone network to the other provider. A backbone carrier offers BGP and MPLS VPN services.

customer carrier—Service provider that uses the segment of the backbone network. The customer carrier may be an Internet service provider (ISP) or a BGP/MPLS VPN service provider.

CE router—A customer edge router is part of a customer network and interfaces to a provider edge (PE) router. In this document, the CE router sits on the edge of the customer carrier network.

PE router—A provider edge router is part of a service provider's network connected to a customer edge (CE) router. In this document, the PE router sits on the edge of the backbone carrier network.

ASBR—An autonomous system boundary router connects one autonomous system to another.

CSC Prerequisites

The following prerequisites are required to configure CSC:

- You must be able to configure MPLS VPNs with end-to-end (CE-to-CE router) pings working.
- You must be able to configure Interior Gateway Protocols (IGPs), MPLS Label Distribution Protocol (LDP), and Multiprotocol Border Gateway Protocol (MP-BGP).
- You must ensure that CSC-PE and CSC-CE routers support BGP label distribution.



Note

BGP is the only supported label distribution protocol on the link between CE and PE.

CSC Benefits

This section describes the benefits of CSC to the backbone carrier and customer carriers.

Benefits to the Backbone Carrier

- The backbone carrier can accommodate many customer carriers and give them access to its backbone.
- The MPLS VPN carrier supporting carrier feature is scalable.
- The MPLS VPN carrier supporting carrier feature is a flexible solution.

Benefits to the Customer Carriers

- The MPLS VPN carrier supporting carrier feature removes from the customer carrier the burden of configuring, operating, and maintaining its own backbone.

- Customer carriers who use the VPN services provided by the backbone carrier receive the same level of security that Frame Relay or ATM-based VPNs provide.
- Customer carriers can use any link layer technology to connect the CE routers to the PE routers and the PE routers to the P routers.
- The customer carrier can use any addressing scheme and still be supported by a backbone carrier.

Benefits of Implementing MPLS VPN CSC Using BGP

The benefits of using BGP to distribute IPv4 routes and MPLS label routes are:

- BGP takes the place of an IGP and LDP in a VPN forwarding and routing instance (VRF) table.
- BGP is the preferred routing protocol for connecting two ISPs,

Configuration Options for the Backbone and Customer Carriers

To enable CSC, the backbone and customer carriers must be configured accordingly:

- The backbone carrier must offer BGP and MPLS VPN services.
- The customer carrier can take several networking forms. The customer carrier can be:
 - An ISP with an IP core (see the “[Customer Carrier: ISP with IP Core](#)” section on page MPC-281).
 - An MPLS service provider with or without VPN services (see “[Customer Carrier: MPLS Service Provider](#)” section on page MPC-282).



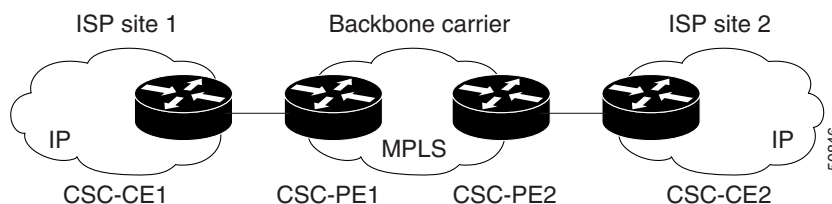
Note

An IGP in the customer carrier network is used to distribute next hops and loopbacks to the CSC-CE. IBGP with label sessions are used in the customer carrier network to distribute next hops and loopbacks to the CSC-CE.

Customer Carrier: ISP with IP Core

Figure 34 shows a network configuration where the customer carrier is an ISP. The customer carrier has two sites, each of which is a point of presence (POP). The customer carrier connects these sites using a VPN service provided by the backbone carrier. The backbone carrier uses MPLS or IP tunnels to provide VPN services. The ISP sites use IP.

Figure 34 Network: Customer Carrier Is an ISP

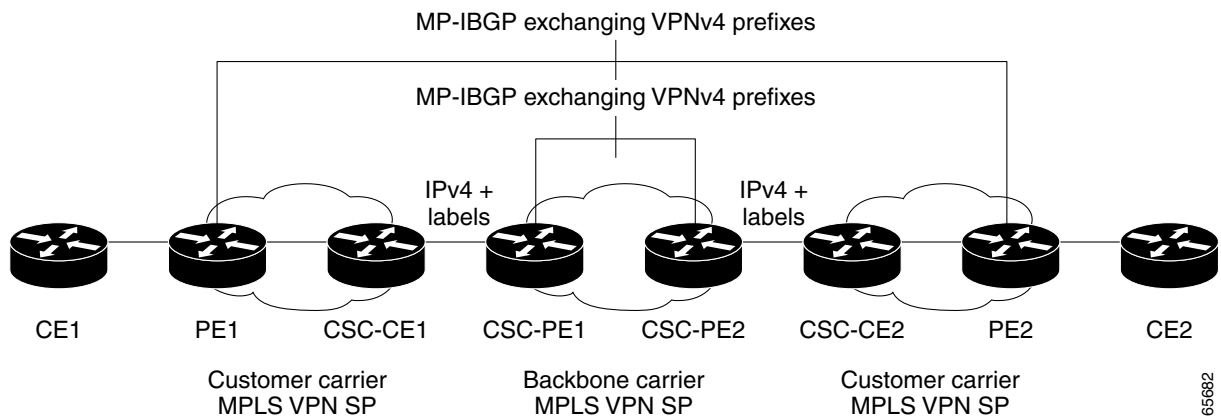


The links between the CE and PE routers use eBGP to distribute IPv4 routes and MPLS labels. Between the links, the PE routers use multiprotocol iBGP to distribute VPNv4 routes.

Customer Carrier: MPLS Service Provider

Figure 35 shows a network configuration where the backbone carrier and the customer carrier are BGP/MPLS VPN service providers. The customer carrier has two sites. The customer carrier uses MPLS in its network while the backbone carrier may use MPLS or IP tunnels in its network.

Figure 35 Network: Customer Carrier Is an MPLS VPN Service Provider



In this configuration (Figure 35), the customer carrier can configure its network in one of these ways:

- The customer carrier can run an IGP and LDP in its core network. In this case, the CSC-CE1 router in the customer carrier redistributes the eBGP routes it learns from the CSC-PE1 router of the backbone carrier to an IGP.
- The CSC-CE1 router of the customer carrier system can run an IPv4 and labels iBGP session with the PE1 router.

IPv6 VPN Provider Edge (6VPE) Support

6VPE uses the existing MPLS IPv4 core infrastructure for IPv6 transports to enable IPv6 sites to communicate over an MPLS IPv4 core network using MPLS label switch paths (LSPs). 6VPE relies on multiprotocol BGP extensions in the IPv4 network configuration on the provider edge (PE) router to exchange IPv6 reachability information. Edge routers are then configured to be dual stacks running both IPv4 and IPv6, and use the IPv4 mapped IPv6 address for IPv6 prefix reachability exchange (see “Dual Stack” section on page MPC-283).

This section includes the follow subsections:

- [6VPE Benefits, page VPC-283](#)
- [6VPE Network Architecture, page VPC-283](#)
- [Dual Stack, page VPC-283](#)
- [6VPE Operation, page VPC-284](#)

6VPE Benefits

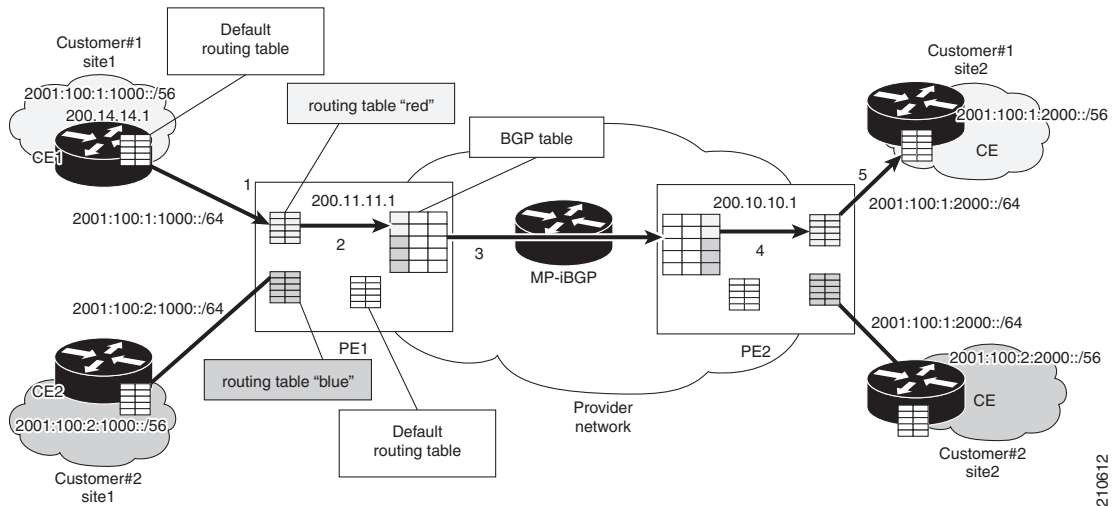
6VPE provides the following benefits to service providers:

- Support for IPv6 without changing the IPv4 MPLS backbone.
- No requirement for a separate signaling plane.
- Leverages operational IPv4 MPLS backbones.
- Cost savings from operating expenses.
- Addresses the security limitations of 6PE.
- Provides logically-separate routing table entries for VPN member devices.
- Provides support for Inter-AS and CSC scenarios. Inter-AS support for 6VPE requires support of Border Gateway Protocol (BGP) to enable the address families and to allocate and distribute the PE and ASBR labels.

6VPE Network Architecture

Figure 36 illustrates the 6VPE network architecture and control plane protocols when two IPv6 sites communicate through an MPLSv4 backbone.

Figure 36 6VPE Network Architecture



Dual Stack

Dual stack is a technique that lets IPv4 and IPv6 coexist on the same interfaces. Coexistence of IPv4 and IPv6 is a requirement for initial deployment. With regard to supporting IPv6 on a MPLS network, two important aspects of the network should be reviewed:

- *Core*: The 6VPE technique carries IPv6 in a VPN fashion over a non-IPv6-aware MPLS core, and enables IPv4 or IPv6 communities to communicate with each other over an IPv4 MPLS backbone without modifying the core infrastructure. By avoiding dual stacking on the core routers, the resources can be dedicated to their primary function to avoid any complexity on the operational side. The transition and integration with respect to the current state of networks is also transparent.
- *Access*: To support native IPv6, the access that connects to IPv4 and IPv6 domains must be IPv6-aware. Service provider edge elements can exchange routing information with end users; therefore, dual stacking is a mandatory requirement on the access layer.

6VPE Operation

When IPv6 is enabled on the subinterface that is participating in a VPN, it becomes an IPv6 VPN. The customer edge-provider edge link is running IPv6 or IPv4 natively. The addition of IPv6 on a provider edge router turns the provider edge into 6VPE, thereby enabling service providers to support IPv6 over the MPLS network.

Provider edge routers use VRF tables to maintain the segregated reachability and forwarding information of each IPv6 VPN. MPBGP with its IPv6 extensions distributes the routes from 6VPE to other 6VPEs through a direct IBGP session or through VPNv6 route reflectors. The next hop of the advertising provider edge router still remains the IPv4 address (normally it is a loopback interface), but with the addition of IPv6, a value of ::FFFF: is prepended to the IPv4 next hop.

The technique can be best described as automatic tunneling of the IPv6 packets through the IPv4 backbone. The MP-BGP relationships remain the same as they are for VPNv4 traffic, with an additional capability of VPNv6. Where both IPv4 and IPv6 are supported, the same set of MPBGP peering relationships is used.

To summarize, from the control plane perspective, the prefixes are signaled across the backbone in the same way as regular MPLS and VPN prefix advertisements. The top label represents the IGP information that remains the same as for IPv4 MPLS. The bottom label represents the VPN information that the packet belongs to. As described earlier, additionally the MPBGP next hop is updated to make it IPv6-compliant. The forwarding or data plane function remains the same as it is deployed for the IPv4 MPLS VPN. The packet forwarding of IPv4 on the current MPLS VPN remains intact.

For detailed information on commands used to configure 6VPE over MPLS, see *Cisco IOS XR MPLS Configuration Guide*.

How to Implement MPLS Layer 3 VPNs

This section contains instructions for the following tasks:

- [Configuring the Core Network, page VPC-285](#)
- [Connecting MPLS VPN Customers, page VPC-288](#)
- [Providing VPN Connectivity Across Multiple Autonomous Systems with MPLS VPN Inter-AS with ASBRs Exchanging IPv4 Routes and MPLS Labels, page VPC-309 \(optional\)](#)
- [Providing VPN Connectivity Across Multiple Autonomous Systems with MPLS VPN Inter-AS with ASBRs Exchanging VPN-IPv4 Addresses, page VPC-318 \(optional\)](#)
- [Configuring Carrier Supporting Carrier, page VPC-329 \(optional\)](#)
- [Verifying the MPLS Layer 3 VPN Configuration, page VPC-337](#)

Configuring the Core Network

Configuring the core network includes the following tasks:

- [Assessing the Needs of MPLS VPN Customers, page VPC-285](#)
- [Configuring Routing Protocols in the Core, page VPC-286](#)
- [Configuring MPLS in the Core, page VPC-286](#)
- [Determining if FIB Is Enabled in the Core, page VPC-286](#)
- [Configuring Multiprotocol BGP on the PE Routers and Route Reflectors, page VPC-287](#)

Assessing the Needs of MPLS VPN Customers

Before configuring an MPLS VPN, the core network topology must be identified so that it can best serve MPLS VPN customers. Perform this task to identify the core network topology.

SUMMARY STEPS

1. Identify the size of the network.
2. Identify the routing protocols in the core.
3. Determine if MPLS High Availability support is required.
4. Determine if BGP load sharing and redundant paths are required.

DETAILED STEPS

	Command or Action	Purpose
Step 1	Identify the size of the network.	Identify the following to determine the number of routers and ports required: <ul style="list-style-type: none"> • How many customers will be supported? • How many VPNs are required for each customer? • How many virtual routing and forwarding (VRF) instances are there for each VPN?
Step 2	Identify the routing protocols in the core.	Determine which routing protocols are required in the core network.
Step 3	Determine if MPLS High Availability support is required.	MPLS VPN nonstop forwarding and graceful restart are supported on select routers and Cisco IOS XR software releases.
Step 4	Determine if BGP load sharing and redundant paths are required.	Determine if BGP load sharing and redundant paths in the MPLS VPN core are required.

Configuring Routing Protocols in the Core

To configure a routing protocol, see the *Cisco IOS XR Routing Configuration Guide*.

Configuring MPLS in the Core

To enable MPLS on all routers in the core, you must configure a Label Distribution Protocol (LDP). You can use either of the following as an LDP:

- MPLS LDP—See the *Implementing MPLS Label Distribution Protocol on Cisco IOS XR Software* for configuration information.
- MPLS Traffic Engineering Resource Reservation Protocol (RSVP)—See *Implementing RSVP for MPLS-TE and MPLS O-UNI on Cisco IOS XR Software* for configuration information.

Determining if FIB Is Enabled in the Core

Forwarding Information Base (FIB) must be enabled on all routers in the core, including the provider edge (PE) routers. For information on how to determine if FIB is enabled, see the *Implementing Cisco Express Forwarding on Cisco IOS XR Software* module in the *Cisco IOS XR IP Addresses and Services Configuration Guide*.

Configuring Multiprotocol BGP on the PE Routers and Route Reflectors

Perform this task to configure multiprotocol BGP (MP-BGP) connectivity on the PE routers and route reflectors.

SUMMARY STEPS

1. **configure**
2. **router bgp** *autonomous-system-number*
3. **address-family vpnv4 unicast**
or
address-family vpnv6 unicast
4. **neighbor** *ip-address* **remote-as** *autonomous-system-number*
5. **address-family vpnv4 unicast**
or
address-family vpnv6 unicast
6. **end**
or
commit

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/0/CPU0:router# configure	Enters global configuration mode.
Step 2	router bgp <i>autonomous-system-number</i> Example: RP/0/0/CPU0:router(config)# router bgp 120	Enters BGP configuration mode allowing you to configure the BGP routing process.
Step 3	address-family vpnv4 unicast or address-family vpnv6 unicast Example: RP/0/0/CPU0:router(config-bgp)# address-family vpnv4 unicast	Enters VPNv4 or VPNv6 address family configuration mode for the VPNv4 or VPNv6 address family.
Step 4	neighbor <i>ip-address</i> remote-as <i>autonomous-system-number</i> Example: RP/0/0/CPU0:router(config-bgp)# neighbor 172.168.40.24 remote-as 2002	Creates a neighbor and assigns it a remote autonomous system number.

	Command or Action	Purpose
Step 5	<pre>address-family vpnv4 unicast or address-family vpnv6 unicast</pre> <p>Example: RP/0/0/CPU0:router(config-bgp-nbr)# address-family vpnv4 unicast </p>	Enters VPNv4 or VPNv6 address family configuration mode for the VPNv4 or VPNv6 address family.
Step 6	<pre>end or commit</pre> <p>Example: RP/0/0/CPU0:router(config-bgp-nbr-af)# end or RP/0/0/CPU0:router(config-bgp-nbr-af)# commit </p>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> When you issue the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting (yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.

Connecting MPLS VPN Customers

To connect MPLS VPN customers to the VPN, perform the following tasks:

- [Defining VRFs on the PE Routers to Enable Customer Connectivity, page VPC-289](#)
- [Configuring VRF Interfaces on PE Routers for Each VPN Customer, page VPC-291](#)
- [Configuring BGP as the Routing Protocol Between the PE and CE Routers, page VPC-293 \(optional\)](#)
- [Configuring RIPv2 as the Routing Protocol Between the PE and CE Routers, page VPC-297 \(optional\)](#)
- [Configuring Static Routes Between the PE and CE Routers, page VPC-300 \(optional\)](#)
- [Configuring OSPF as the Routing Protocol Between the PE and CE Routers, page VPC-301 \(optional\)](#)
- [Configuring EIGRP as the Routing Protocol Between the PE and CE Routers, page VPC-304 \(optional\)](#)
- [Configuring EIGRP Redistribution in the MPLS VPN, page VPC-307 \(optional\)](#)

Defining VRFs on the PE Routers to Enable Customer Connectivity

Perform this task to define VPN routing and forwarding (VRF) instances.

SUMMARY STEPS

1. **configure**
2. **vrf** *vrf-name*
3. **address-family ipv4 unicast**
4. **import route-policy** *policy-name*
5. **import route-target** [*as-number:nn* | *ip-address:nn*]
6. **export route-policy** *policy-name*
7. **export route-target** [*as-number:nn* | *ip-address:nn*]
8. **exit**
9. **exit**
10. **router bgp** *autonomous-system-number*
11. **vrf** *vrf-name*
12. **rd** {*as-number* | *ip-address* | **auto**}
13. **end**
or
commit

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/0/CPU0:router# configure	Enters global configuration mode.
Step 2	vrf <i>vrf-name</i> Example: RP/0/0/CPU0:router(config)# vrf vrf_1	Configures a VRF instance and enters VRF configuration mode.
Step 3	address-family ipv4 unicast Example: RP/0/0/CPU0:router(config-vrf)# address-family ipv4 unicast	Enters VRF address family configuration mode for the IPv4 address family.
Step 4	import route-policy <i>policy-name</i> Example: RP/0/0/CPU0:router(config-vrf-af)# import route-policy policy_A	Specifies a route policy that can be imported into the local VPN.

	Command or Action	Purpose
Step 5	import route-target [<i>as-number:nn</i> <i>ip-address:nn</i>] Example: RP/0/0/CPU0:router(config-vrf-af)# import route-target 120:1	Allows exported VPN routes to be imported into the VPN if one of the route targets of the exported route matches one of the local VPN import route targets.
Step 6	export route-policy <i>policy-name</i> Example: RP/0/0/CPU0:router(config-vrf-af)# export route-policy policy_B	Specifies a route policy that can be exported from the local VPN.
Step 7	export route-target [<i>as-number:nn</i> <i>ip-address:nn</i>] Example: RP/0/0/CPU0:router(config-vrf-af)# export route-target 120:2	Associates the local VPN with a route target. When the route is advertised to other provider edge (PE) routers, the export route target is sent along with the route as an extended community.
Step 8	exit Example: RP/0/0/CPU0:router(config-vrf-af)# exit	Exits VRF address family configuration mode and returns the router to VRF configuration mode.
Step 9	exit Example: RP/0/0/CPU0:router(config-vrf)# exit	Exits VRF configuration mode and returns the router to global configuration mode.
Step 10	router bgp <i>autonomous-system-number</i> Example: RP/0/0/CPU0:router(config)# router bgp 120	Enters BGP configuration mode allowing you to configure the BGP routing process.
Step 11	vrf <i>vrf-name</i> Example: RP/0/0/CPU0:router(config-bgp)# vrf vrf_1	Configures a VRF instance and enters VRF configuration mode for BGP routing.

Command or Action	Purpose
Step 12 <code>rd {as-number ip-address auto}</code> Example: RP/0/0/CPU0:router(config-bgp-vrf)# rd auto	Automatically assigns a unique route distinguisher (RD) to vrf_1.
Step 13 <code>end</code> OR <code>commit</code> Example: RP/0/0/CPU0:router(config-bgp-vrf)# end OR RP/0/0/CPU0:router(config-bgp-vrf)# commit	Saves configuration changes. <ul style="list-style-type: none"> • When you issue the end command, the system prompts you to commit changes: Uncommitted changes found, commit them before exiting (yes/no/cancel)? [cancel]: <ul style="list-style-type: none"> – Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. – Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. – Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. • Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring VRF Interfaces on PE Routers for Each VPN Customer

Perform this task to associate a VPN routing and forwarding (VRF) instance with an interface or a subinterface on the PE routers.



Note

You must remove IPv4/IPv6 addresses from an interface prior to assigning, removing, or changing an interface's VRF. If this is not done in advance, any attempt to change the VRF on an IP interface is rejected.

SUMMARY STEPS

1. **configure**
2. **interface** *type interface-path-id*
3. **vrf** *vrf-name*
4. **ipv4 address** *ipv4-address mask*
5. **end**
or
commit

DETAILED STEPS

	Command or Action	Purpose
Step 1	<p>configure</p> <p>Example: RP/0/0/CPU0:router# configure</p>	Enters global configuration mode.
Step 2	<p>interface <i>type interface-path-id</i></p> <p>Example: RP/0/0/CPU0:router(config)# interface GigabitEthernet 0/3/0/0</p>	Enters interface configuration mode.
Step 3	<p>vrf <i>vrf-name</i></p> <p>Example: RP/0/0/CPU0:router(config-if)# vrf vrf_A</p>	Configures a VRF instance and enters VRF configuration mode.
Step 4	<p>ipv4 address <i>ipv4-address mask</i></p> <p>Example: RP/0/0/CPU0:router(config-if)# ipv4 address 192.168.1.27 255.255.255.0</p>	Configures a primary IPv4 address for the specified interface.
Step 5	<p>end OR commit</p> <p>Example: RP/0/0/CPU0:router(config-if)# end OR RP/0/0/CPU0:router(config-if)# commit</p>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> When you issue the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring BGP as the Routing Protocol Between the PE and CE Routers

Perform this task to configure PE-to-CE routing sessions using BGP.

SUMMARY STEPS

1. **configure**
2. **router bgp** *autonomous-system-number*
3. **bgp router-id** {*ip-address*}
4. **vrf** *vrf-name*
5. **label-allocation-mode** *per-ce*
6. **address-family ipv4 unicast**
7. **redistribute connected** [**metric** *metric-value*] [**route-policy** *route-policy-name*]
or
redistribute isis *process-id* [**level** {**1** | **1-inter-area** | **2**}] [**metric** *metric-value*] [**route-policy** *route-policy-name*]
or
redistribute ospf *process-id* [**match** {**external** [**1** | **2**] | **internal** | **nssa-external** [**1** | **2**]}] [**metric** *metric-value*] [**route-policy** *route-policy-name*]
or
redistribute ospfv3 *process-id* [**match** {**external** [**1** | **2**] | **internal** | **nssa-external** [**1** | **2**]}] [**metric** *metric-value*] [**route-policy** *route-policy-name*]
or
redistribute static [**metric** *metric-value*] [**route-policy** *route-policy-name*]
8. **aggregate-address** *address/mask-length* [**as-set**] [**as-confed-set**] [**summary-only**] [**route-policy** *route-policy-name*]
9. **network** {*ip-address/prefix-length* | *ip-address mask*} [**route-policy** *route-policy-name*]
10. **exit**
11. **neighbor** *ip-address*
12. **remote-as** *autonomous-system-number*
13. **password** {**clear** | **encrypted**} *password*
14. **ebgp-multihop** [*tth-value*]
15. **address-family ipv4 unicast**
16. **allowas-in** [*as-occurrence-number*]
17. **route-policy** *route-policy-name* **in**
18. **route-policy** *route-policy-name* **out**
19. **end**
or
commit

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/0/CPU0:router# configure	Enters global configuration mode.
Step 2	router bgp <i>autonomous-system-number</i> Example: RP/0/0/CPU0:router(config)# router bgp 120	Enters Border Gateway Protocol (BGP) configuration mode allowing you to configure the BGP routing process.
Step 3	bgp router-id { <i>ip-address</i> } Example: RP/0/0/CPU0:router(config-bgp)# bgp router-id 192.168.70.24	Configures the local router with a router ID of 192.168.70.24.
Step 4	vrf <i>vrf-name</i> Example: RP/0/0/CPU0:router(config-bgp)# vrf vrf_1	Configures a VPN routing and forwarding (VRF) instance and enters VRF configuration mode for BGP routing.
Step 5	label-allocation-mode per-ce Example: RP/0/0/CPU0:router(config-bgp-vrf)# label-allocation-mode per-ce	Sets the MPLS VPN label allocation mode for each customer edge (CE) label mode allowing the provider edge (PE) router to allocate one label for every immediate next-hop.
Step 6	address-family ipv4 unicast Example: RP/0/0/CPU0:router(config-bgp-vrf)# address-family ipv4 unicast	Enters VRF address family configuration mode for the IPv4 address family.

	Command or Action	Purpose
Step 7	<pre> redistribute connected [metric <i>metric-value</i>] [route-policy <i>route-policy-name</i>] or redistribute isis <i>process-id</i> [level {1 1-inter-area 2}] [metric <i>metric-value</i>] [route-policy <i>route-policy-name</i>] or redistribute ospf <i>process-id</i> [match {external [1 2] internal nssa-external [1 2]}] [metric <i>metric-value</i>] [route-policy <i>route-policy-name</i>] or redistribute ospfv3 <i>process-id</i> [match {external [1 2] internal nssa-external [1 2]}] [metric <i>metric-value</i>] [route-policy <i>route-policy-name</i>] or redistribute static [metric <i>metric-value</i>] [route-policy <i>route-policy-name</i>] Example: RP/0/0/CPU0:router(config-bgp-vrf-af)# redistribute connected </pre>	<p>Causes routes to be redistributed into BGP. The routes that can be redistributed into BGP are:</p> <ul style="list-style-type: none"> • Connected • Intermediate System-to-Intermediate System (IS-IS) • Open Shortest Path First (OSPF) • Static
Step 8	<pre> aggregate-address <i>address/mask-length</i> [as-set] [as-confed-set] [summary-only] [route-policy <i>route-policy-name</i>] Example: RP/0/0/CPU0:router(config-bgp-vrf-af)# aggregate-address 10.0.0.0/8 as-set </pre>	<p>Creates an aggregate address. The path advertised for this route is an autonomous system set consisting of all elements contained in all paths that are being summarized.</p> <ul style="list-style-type: none"> • The as-set keyword generates autonomous system set path information and community information from contributing paths. • The as-confed-set keyword generates autonomous system confederation set path information from contributing paths. • The summary-only keyword filters all more specific routes from updates. • The route-policy <i>route-policy-name</i> keyword and argument specify the route policy used to set the attributes of the aggregate route.
Step 9	<pre> network {<i>ip-address/prefix-length</i> <i>ip-address</i> <i>mask</i>} [route-policy <i>route-policy-name</i>] Example: RP/0/0/CPU0:router(config-bgp-vrf-af)# network 172.20.0.0/16 </pre>	<p>Configures the local router to originate and advertise the specified network.</p>
Step 10	<pre> exit Example: RP/0/0/CPU0:router(config-bgp-vrf-af)# exit </pre>	<p>Exits VRF address family configuration mode and returns the router to VRF configuration mode for BGP routing.</p>

	Command or Action	Purpose
Step 11	neighbor <i>ip-address</i> Example: RP/0/0/CPU0:router(config-bgp-vrf)# neighbor 172.168.40.24	Places the router in VRF neighbor configuration mode for BGP routing and configures the neighbor IP address 172.168.40.24 as a BGP peer.
Step 12	remote-as <i>autonomous-system-number</i> Example: RP/0/0/CPU0:router(config-bgp-vrf-nbr)# remote-as 2002	Creates a neighbor and assigns it a remote autonomous system number.
Step 13	password { clear encrypted } <i>password</i> Example: RP/0/0/CPU0:router(config-bgp-vrf-nbr)# password clear pswd123	Configures neighbor 172.168.40.24 to use MD5 authentication with the password pswd123.
Step 14	ebgp-multihop [<i>ttl-value</i>] Example: RP/0/0/CPU0:router(config-bgp-vrf-nbr)# ebgp-multihop	Allows a BGP connection to neighbor 172.168.40.24.
Step 15	address-family ipv4 unicast Example: RP/0/0/CPU0:router(config-bgp-vrf-nbr)# address-family ipv4 unicast	Enters VRF neighbor address family configuration mode for BGP routing.
Step 16	allowas-in [<i>as-occurrence-number</i>] Example: RP/0/0/CPU0:router(config-bgp-vrf-nbr-af)# allowas-in 3	Replaces the neighbor autonomous system number (ASN) with the PE ASN in the AS path three times.
Step 17	route-policy <i>route-policy-name</i> in Example: RP/0/0/CPU0:router(config-bgp-vrf-nbr-af)# route-policy In-Ipv4 in	Applies the In-Ipv4 policy to inbound IPv4 unicast routes.

	Command or Action	Purpose
Step 18	<pre>route-policy route-policy-name out</pre> <p>Example: RP/0/0/CPU0:router(config-bgp-vrf-nbr-af)# route-policy In-Ipv4 in </p>	Applies the In-Ipv4 policy to outbound IPv4 unicast routes.
Step 19	<pre>end</pre> <p>or</p> <pre>commit</pre> <p>Example: RP/0/0/CPU0:router(config-bgp-vrf-nbr-af)# end or RP/0/0/CPU0:router(config-bgp-vrf-nbr-af)# commit </p>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> When you issue the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting (yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring RIPv2 as the Routing Protocol Between the PE and CE Routers

Perform this task to configure provider edge (PE)-to-customer edge (CE) routing sessions using Routing Information Protocol version 2 (RIPv2).

SUMMARY STEPS

- configure**
- router rip**
- vrf vrf-name**
- interface type instance**
- site-of-origin {as-number:number | ip-address:number}**
- exit**
- redistribute bgp as-number [[external | internal | local] [route-policy name]**
or
redistribute connected [route-policy name]
or
redistribute isis process-id [level-1 | level-1-2 | level-2] [route-policy name]
or
redistribute eigrp as-number [route-policy name]
or

```

redistribute ospf process-id [match { external [1 | 2] | internal | nssa-external [1 | 2]}]
[route-policy name]
or
redistribute static [route-policy name]

```

8. **end**
- or
- commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/0/CPU0:router# configure	Enters global configuration mode.
Step 2	router rip Example: RP/0/0/CPU0:router(config)# router rip	Enters the Routing Information Protocol (RIP) configuration mode allowing you to configure the RIP routing process.
Step 3	vrf vrf-name Example: RP/0/0/CPU0:router(config-rip)# vrf vrf_1	Configures a VPN routing and forwarding (VRF) instance and enters VRF configuration mode for RIP routing.
Step 4	interface type instance Example: RP/0/0/CPU0:router(config-rip-vrf)# interface GigabitEthernet 0/3/0/0	Enters VRF interface configuration mode.
Step 5	site-of-origin {as-number:number ip-address:number} Example: RP/0/0/CPU0:router(config-rip-vrf-if)# site-of-origin 200:1	Identifies routes that have originated from a site so that the re-advertisement of that prefix back to the source site can be prevented. Uniquely identifies the site from which a PE router has learned a route.
Step 6	exit Example: RP/0/0/CPU0:router(config-rip-vrf-if)# exit	Exits VRF interface configuration mode, and returns the router to VRF configuration mode for RIP routing.

	Command or Action	Purpose
<p>Step 7</p> <pre> redistribute bgp as-number [[external internal local] [route-policy name] or redistribute connected [route-policy name] or redistribute eigrp as-number [route-policy name] or redistribute isis process-id [level-1 level-1-2 level-2] [route-policy name] or redistribute ospf process-id [match {external [1 2] internal nssa-external [1 2]}} [route-policy name] or redistribute static [route-policy name] Example: RP/0/0/CPU0:router(config-rip-vrf)# redistribute connected </pre>	<p>Causes routes to be redistributed into RIP. The routes that can be redistributed into RIP are:</p> <ul style="list-style-type: none"> • Border Gateway Protocol (BGP) • Connected • Enhanced Interior Gateway Routing Protocol (EIGRP) • Intermediate System-to-Intermediate System (IS-IS) • Open Shortest Path First (OSPF) • Static 	
<p>Step 8</p> <pre> end or commit Example: RP/0/0/CPU0:router(config-rip-vrf)# end or RP/0/0/CPU0:router(config-rip-vrf)# commit </pre>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> • When you issue the end command, the system prompts you to commit changes: <pre> Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]: </pre> <ul style="list-style-type: none"> – Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. – Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. – Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. • Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session. 	

Configuring Static Routes Between the PE and CE Routers

Perform this task to configure provider edge (PE)-to-customer edge (CE) routing sessions that use static routes.



Note

You must remove IPv4/IPv6 addresses from an interface prior to assigning, removing, or changing an interface's VRF. If this is not done in advance, any attempt to change the VRF on an IP interface is rejected.

SUMMARY STEPS

1. **configure**
2. **router static**
3. **vrf vrf-name**
4. **address-family ipv4 unicast**
5. *prefix/mask [vrf vrf-name] {ip-address | type interface-path-id}*
6. *prefix/mask [vrf vrf-name] bfd fast-detect*
7. **end**
or
commit

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/0/CPU0:router# configure	Enters global configuration mode.
Step 2	router static Example: RP/0/0/CPU0:router(config)# router static	Enters static routing configuration mode allowing you to configure the static routing process.
Step 3	vrf vrf-name Example: RP/0/0/CPU0:router(config-static)# vrf vrf_1	Configures a VPN routing and forwarding (VRF) instance and enters VRF configuration mode for static routing.
Step 4	address-family ipv4 unicast Example: RP/0/0/CPU0:router(config-static-vrf)# address-family ipv4 unicast	Enters VRF address family configuration mode for the IPv4 address family.

	Command or Action	Purpose
Step 5	<pre>prefix/mask [vrf vrf-name] {ip-address type interface-path-id}</pre> <p>Example: RP/0/0/CPU0:router(config-static-vrf-afi)# 172.168.40.24/24 vrf vrf_1 10.1.1.1 </p>	Assigns the static route to vrf_1.
Step 6	<pre>prefix/mask [vrf vrf-name] bfd fast-detect</pre> <p>Example: RP/0/0/CPU0:router(config-static-vrf-afi)# 172.168.40.24/24 vrf vrf_1 bfd fast-detect </p>	<p>Enables bidirectional forwarding detection (BFD) to detect failures in the path between adjacent forwarding engines.</p> <p>This option is available is when the forwarding router address is specified in Step 5.</p>
Step 7	<pre>end or commit</pre> <p>Example: RP/0/0/CPU0:router(config-static-vrf-afi)# end or RP/0/0/CPU0:router(config-static-vrf-afi)# commit </p>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> When you issue the end command, the system prompts you to commit changes: Uncommitted changes found, commit them before exiting (yes/no/cancel)? [cancel]: <ul style="list-style-type: none"> Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring OSPF as the Routing Protocol Between the PE and CE Routers

Perform this task to configure provider edge (PE)-to-customer edge (CE) routing sessions that use Open Shortest Path First (OSPF).

SUMMARY STEPS

- configure**
- router ospf** *process-name*
- vrf** *vrf-name*
- router-id** {*router-id* | *type interface-path-id*}
- redistribute bgp** *process-id* [**metric** *metric-value*] [**metric-type** {**1** | **2**}] [**route-policy** *policy-name*] [**tag** *tag-value*]
or
redistribute connected [**metric** *metric-value*] [**metric-type** {**1** | **2**}] [**route-policy** *policy-name*] [**tag** *tag-value*]

```

or
redistribute ospf process-id [match { external [1 | 2] | internal | nssa-external [1 | 2]}] [metric
metric-value] [metric-type {1 | 2}] [route-policy policy-name] [tag tag-value]
or
redistribute static [metric metric-value] [metric-type {1 | 2}] [route-policy policy-name] [tag
tag-value]
or
redistribute eigrp process-id [match { external [1 | 2] | internal | nssa-external [1 | 2]}] [metric
metric-value] [metric-type {1 | 2}] [route-policy policy-name] [tag tag-value]
or
redistribute rip [metric metric-value] [metric-type {1 | 2}] [route-policy policy-name] [tag
tag-value]
6. area area-id
7. interface type interface-path-id
8. end
or
commit

```

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/0/CPU0:router# configure	Enters global configuration mode.
Step 2	router ospf <i>process-name</i> Example: RP/0/0/CPU0:router(config)# router ospf 109	Enters OSPF configuration mode allowing you to configure the OSPF routing process.
Step 3	vrf <i>vrf-name</i> Example: RP/0/0/CPU0:router(config-ospf)# vrf vrf_1	Configures a VPN routing and forwarding (VRF) instance and enters VRF configuration mode for OSPF routing.
Step 4	router-id { <i>router-id</i> <i>type interface-path-id</i> } Example: RP/0/0/CPU0:router(config-ospf-vrf)# router-id 172.20.10.10	Configures the router ID for the OSPF routing process.

	Command or Action	Purpose
<p>Step 5</p>	<pre> redistribute bgp <i>process-id</i> [metric <i>metric-value</i>] [metric-type {1 2}] [route-policy <i>policy-name</i>] [tag <i>tag-value</i>] or redistribute connected [metric <i>metric-value</i>] [metric-type {1 2}] [route-policy <i>policy-name</i>] [tag <i>tag-value</i>] or redistribute ospf <i>process-id</i> [match {external [1 2] internal nssa-external [1 2]}] [metric <i>metric-value</i>] [metric-type {1 2}] [route-policy <i>policy-name</i>] [tag <i>tag-value</i>] or redistribute static [metric <i>metric-value</i>] [metric-type {1 2}] [route-policy <i>policy-name</i>] [tag <i>tag-value</i>] or redistribute eigrp <i>process-id</i> [match {external [1 2] internal nssa-external [1 2]}] [metric <i>metric-value</i>] [metric-type {1 2}] [route-policy <i>policy-name</i>] [tag <i>tag-value</i>] or redistribute rip [metric <i>metric-value</i>] [metric-type {1 2}] [route-policy <i>policy-name</i>] [tag <i>tag-value</i>] Example: RP/0/0/CPU0:router(config-ospf-vrf)# redistribute connected </pre>	<p>Causes routes to be redistributed into OSPF. The routes that can be redistributed into OSPF are:</p> <ul style="list-style-type: none"> • Border Gateway Protocol (BGP) • Connected • Enhanced Interior Gateway Routing Protocol (EIGRP) • OSPF • Static • Routing Information Protocol (RIP)
<p>Step 6</p>	<pre> area <i>area-id</i> Example: RP/0/0/CPU0:router(config-ospf-vrf)# area 0 </pre>	<p>Configures the OSPF area as area 0.</p>

	Command or Action	Purpose
Step 7	<pre>interface type interface-path-id</pre> <p>Example: RP/0/0/CPU0:router(config-ospf-vrf-ar)# interface GigabitEthernet 0/3/0/0 </p>	Associates interface GigabitEthernet 0/3/0/0 with area 0.
Step 8	<pre>end</pre> <p>or</p> <pre>commit</pre> <p>Example: RP/0/0/CPU0:router(config-ospf-vrf-ar-if)# end</p> <p>or</p> <pre>RP/0/0/CPU0:router(config-ospf-vrf-ar-if)# commit</pre>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> When you issue the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring EIGRP as the Routing Protocol Between the PE and CE Routers

Perform this task to configure provider edge (PE)-to-customer edge (CE) routing sessions that use Enhanced Interior Gateway Routing Protocol (EIGRP).

Using EIGRP between the PE and CE routers allows you to transparently connect EIGRP customer networks through an MPLS-enabled Border Gateway Protocol (BGP) core network so that EIGRP routes are redistributed through the VPN across the BGP network as internal BGP (iBGP) routes.

Prerequisites

BGP must be configured in the network. See the *Implementing BGP on Cisco IOS XR Software* module in *Cisco IOS XR Routing Configuration Guide*.



Note

You must remove IPv4/IPv6 addresses from an interface prior to assigning, removing, or changing an interface's VRF. If this is not done in advance, any attempt to change the VRF on an IP interface is rejected.

SUMMARY STEPS

1. **configure**
2. **router eigrp** *as-number*
3. **vrf** *vrf-name*
4. **address-family ipv4**
5. **router-id** *router-id*
6. **autonomous-system** *as-number*
7. **default-metric** *bandwidth delay reliability loading mtu*
8. **redistribute** {{ **bgp** | **connected** | **isis** | **ospfl** | **rip** | **static** } [*as-number* | *instance-name*]} [*route-policy name*]
9. **interface** *type interface-path-id*
10. **site-of-origin** {*as-number:number* | *ip-address:number*}
11. **end**
or
commit

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/0/CPU0:router# configure	Enters global configuration mode.
Step 2	router eigrp <i>as-number</i> Example: RP/0/0/CPU0:router(config)# router eigrp 24	Enters EIGRP configuration mode allowing you to configure the EIGRP routing process.
Step 3	vrf <i>vrf-name</i> Example: RP/0/0/CPU0:router(config-eigrp)# vrf vrf_1	Configures a VPN routing and forwarding (VRF) instance and enters VRF configuration mode for EIGRP routing.
Step 4	address-family ipv4 Example: RP/0/0/CPU0:router(config-eigrp-vrf)# address family ipv4	Enters VRF address family configuration mode for the IPv4 address family.
Step 5	router-id <i>router-id</i> Example: RP/0/0/CPU0:router(config-eigrp-vrf-af)# router-id 172.20.0.0	Configures the router ID for the Enhanced Interior Gateway Routing Protocol (EIGRP) routing process.

	Command or Action	Purpose
Step 6	<p>autonomous-system <i>as-number</i></p> <p>Example: RP/0/0/CPU0:router(config-eigrp-vrf-af)# autonomous-system 6</p>	Configures the EIGRP routing process to run within a VRF.
Step 7	<p>default-metric <i>bandwidth delay reliability loading mtu</i></p> <p>Example: RP/0/0/CPU0:router(config-eigrp-vrf-af)# default-metric 100000 4000 200 45 4470</p>	Sets the metrics for an EIGRP.
Step 8	<p>redistribute {{bgp connected isis ospf rip static} [<i>as-number</i> <i>instance-name</i>]} [route-policy <i>name</i>]</p> <p>Example: RP/0/0/CPU0:router(config-eigrp-vrf-af)# redistribute connected</p>	Causes connected routes to be redistributed into EIGRP.
Step 9	<p>interface <i>type interface-path-id</i></p> <p>Example: RP/0/0/CPU0:router(config-eigrp-vrf-af)# interface GigabitEthernet 0/3/0/0</p>	Associates interface GigabitEthernet 0/3/0/0 with the EIGRP routing process.
Step 10	<p>site-of-origin {<i>as-number:number</i> <i>ip-address:number</i>}</p> <p>Example: RP/0/0/CPU0:router(config-eigrp-vrf-af-if)# site-of-origin 201:1</p>	Configures site of origin (SoO) on interface GigabitEthernet 0/3/0/0.
Step 11	<p>end OR commit</p> <p>Example: RP/0/0/CPU0:router(config-eigrp-vrf-af-if)# end OR RP/0/0/CPU0:router(config-eigrp-vrf-af-if)# commit</p>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> When you issue the end command, the system prompts you to commit changes: Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]: <ul style="list-style-type: none"> Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring EIGRP Redistribution in the MPLS VPN

Perform this task for every provider edge (PE) router that provides VPN services to enable Enhanced Interior Gateway Routing Protocol (EIGRP) redistribution in the MPLS VPN.

Prerequisites

The metric can be configured in the route-policy configuring using the **redistribute** command (or configured with the **default-metric** command). If an external route is received from another EIGRP autonomous system or a non-EIGRP network without a configured metric, the route is not installed in the EIGRP database. If an external route is received from another EIGRP autonomous system or a non-EIGRP network without a configured metric, the route is not advertised to the CE router. See the *Implementing EIGRP on Cisco IOS XR Software* module in the *Cisco IOS XR Routing Configuration Guide*.

Restrictions

Redistribution between native EIGRP VPN routing and forwarding (VRF) instances is not supported. This behavior is designed.

SUMMARY STEPS

1. **configure**
2. **router eigrp** *as-number*
3. **vrf** *vrf-name*
4. **address-family ipv4**
5. **redistribute bgp** [*as-number*] [**route-policy** *policy-name*]
6. **end**
or
commit

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/0/CPU0:router# configure	Enters global configuration mode.
Step 2	router eigrp <i>as-number</i> Example: RP/0/0/CPU0:router(config)# router eigrp 24	Enters EIGRP configuration mode allowing you to configure the EIGRP routing process.
Step 3	vrf <i>vrf-name</i> Example: RP/0/0/CPU0:router(config-eigrp)# vrf vrf_1	Configures a VRF instance and enters VRF configuration mode for EIGRP routing.

	Command or Action	Purpose
Step 4	<p>address-family ipv4</p> <p>Example: RP/0/0/CPU0:router(config-eigrp-vrf)# address family ipv4</p>	Enters VRF address family configuration mode for the IPv4 address family.
Step 5	<p>redistribute bgp [<i>as-number</i>] [route-policy <i>policy-name</i>]</p> <p>Example: RP/0/0/CPU0:router(config-eigrp-vrf-af)# redistribute bgp 24 route-policy policy_A</p>	Causes Border Gateway Protocol (BGP) routes to be redistributed into EIGRP.
Step 6	<p>end or commit</p> <p>Example: RP/0/0/CPU0:router(config-eigrp-vrf-af-if)# end or RP/0/0/CPU0:router(config-eigrp-vrf-af-if)# commit</p>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> When you issue the end command, the system prompts you to commit changes: Uncommitted changes found, commit them before exiting (yes/no/cancel)? [cancel]: <ul style="list-style-type: none"> Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.

Providing VPN Connectivity Across Multiple Autonomous Systems with MPLS VPN Inter-AS with ASBRs Exchanging IPv4 Routes and MPLS Labels

**Note**

This section is not applicable to Inter-AS over IP tunnels.

This section contains instructions for the following tasks:

- [Configuring ASBRs to Exchange IPv4 Routes and MPLS Labels](#), page VPC-310
- [Configuring the Route Reflectors to Exchange VPN-IPv4 Routes](#), page VPC-312
- [Configuring the Route Reflector to Reflect Remote Routes in its AS](#), page VPC-315

Configuring ASBRs to Exchange IPv4 Routes and MPLS Labels

Perform this task to configure the autonomous system boundary routers (ASBRs) to exchange IPv4 routes and MPLS labels.

SUMMARY STEPS

1. **configure**
2. **router bgp** *autonomous-system-number*
3. **address-family ipv4 unicast**
4. **allocate-label all**
5. **neighbor** *ip-address*
6. **remote-as** *autonomous-system-number*
7. **address-family ipv4 labeled-unicast**
8. **route-policy** *route-policy-name* **in**
9. **route-policy** *route-policy-name* **out**
10. **end**
or
commit

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/0/CPU0:router# configure	Enters global configuration mode.
Step 2	router bgp <i>autonomous-system-number</i> Example: RP/0/0/CPU0:router(config)# router bgp 120 RP/0/0/CPU0:router(config-bgp)#	Enters Border Gateway Protocol (BGP) configuration mode allowing you to configure the BGP routing process.
Step 3	address-family ipv4 unicast Example: RP/0/0/CPU0:router(config-bgp)# address-family ipv4 unicast RP/0/0/CPU0:router(config-bgp-af)#	Enters global address family configuration mode for the IPv4 unicast address family.
Step 4	allocate-label all Example: RP/0/0/CPU0:router(config-bgp-af)# allocate-label all	Allocates the MPLS labels for a specific IPv4 unicast or VPN routing and forwarding (VRF) IPv4 unicast routes so that the BGP router can send labels with BGP routes to a neighboring router that is configured for a labeled-unicast session.

	Command or Action	Purpose
Step 5	<p>neighbor <i>ip-address</i></p> <p>Example: RP/0/0/CPU0:router(config-bgp-af)# neighbor 172.168.40.24 RP/0/0/CPU0:router(config-bgp-nbr)#</p>	Places the router in neighbor configuration mode for BGP routing and configures the neighbor IP address 172.168.40.24 as a BGP peer.
Step 6	<p>remote-as <i>autonomous-system-number</i></p> <p>Example: RP/0/0/CPU0:router(config-bgp-nbr)# remote-as 2002</p>	Creates a neighbor and assigns it a remote autonomous system number.
Step 7	<p>address-family ipv4 labeled-unicast</p> <p>Example: RP/0/0/CPU0:router(config-bgp-nbr)# address-family ipv4 labeled-unicast RP/0/0/CPU0:router(config-bgp-nbr-af)</p>	Enters neighbor address family configuration mode for the IPv4 labeled-unicast address family.
Step 8	<p>route-policy <i>route-policy-name</i> in</p> <p>Example: RP/0/0/CPU0:router(config-bgp-nbr-af)# route-policy pass-all in</p>	<p>Applies a routing policy to updates that are received from a BGP neighbor.</p> <ul style="list-style-type: none"> Use the <i>route-policy-name</i> argument to define the name of the of route policy. The example shows that the route policy name is defined as pass-all. Use the in keyword to define the policy for inbound routes.

	Command or Action	Purpose
Step 9	<pre>route-policy route-policy-name out</pre> <p>Example: RP/0/0/CPU0:router(config-bgp-nbr-af)# route-policy pass-all out </p>	<p>Applies a routing policy to updates that are sent to a BGP neighbor.</p> <ul style="list-style-type: none"> Use the <i>route-policy-name</i> argument to define the name of the of route policy. The example shows that the route policy name is defined as pass-all. Use the out keyword to define the policy for outbound routes.
Step 10	<pre>end OR commit</pre> <p>Example: RP/0/0/CPU0:router(config-bgp-nbr-af)# end OR RP/0/0/CPU0:router(config-bgp-nbr-af)# commit </p>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> When you issue the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring the Route Reflectors to Exchange VPN-IPv4 Routes

Perform this task to enable the route reflectors to exchange VPN-IPv4 routes by using multihop. This task specifies that the next-hop information and the VPN label are to be preserved across the autonomous system.

SUMMARY STEPS

1. **configure**
2. **router bgp** *autonomous-system-number*
3. **neighbor** *ip-address*
4. **remote-as** *autonomous-system-number*
5. **ebgp-multihop** [*tth-value*]
6. **update-source** *type interface-path-id*
7. **address-family vpnv4 unicast**
8. **route-policy** *route-policy-name in*
9. **route-policy** *route-policy-name out*

- ```

10. next-hop-unchanged
11. end
 or
 commit

```

## DETAILED STEPS

|        | Command or Action                                                                                                                                                           | Purpose                                                                                                                              |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| Step 1 | <b>configure</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router# configure                                                                                                    | Enters global configuration mode.                                                                                                    |
| Step 2 | <b>router bgp</b> <i>autonomous-system-number</i><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config)# router bgp 120<br>RP/0/0/CPU0:router(config-bgp)#                   | Enters Border Gateway Protocol (BGP) configuration mode allowing you to configure the BGP routing process.                           |
| Step 3 | <b>neighbor</b> <i>ip-address</i><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp)# neighbor<br>172.168.40.24<br>RP/0/0/CPU0:router(config-bgp-nbr)#                | Places the router in neighbor configuration mode for BGP routing and configures the neighbor IP address 172.168.40.24 as a BGP peer. |
| Step 4 | <b>remote-as</b> <i>autonomous-system-number</i><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-nbr)# remote-as<br>2002                                            | Creates a neighbor and assigns it a remote autonomous system number.                                                                 |
| Step 5 | <b>ebgp-multihop</b> [ <i>ttl-value</i> ]<br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-nbr)#<br>ebgp-multihop                                                    | Enables multihop peerings with external BGP neighbors.                                                                               |
| Step 6 | <b>update-source</b> <i>type interface-path-id</i><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-nbr)#<br>update-source loopback0                                 | Allows BGP sessions to use the primary IP address from a particular interface as the local address.                                  |
| Step 7 | <b>address-family vpnv4 unicast</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-nbr)#<br>address-family vpnv4 unicast<br>RP/0/0/CPU0:router(config-bgp-nbr-af)# | Configures VPNv4 address family.                                                                                                     |

|         | Command or Action                                                                                                                                                              | Purpose                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Step 8  | <p><b>route-policy</b> <i>route-policy-name</i> <b>in</b></p> <p><b>Example:</b><br/> RP/0/0/CPU0:router(config-bgp-nbr-af)#<br/> route-policy pass-all in</p>                 | <p>Applies a routing policy to updates that are received from a BGP neighbor.</p> <ul style="list-style-type: none"> <li>Use the <i>route-policy-name</i> argument to define the name of the of route policy. The example shows that the route policy name is defined as pass-all.</li> <li>Use the <b>in</b> keyword to define the policy for inbound routes.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Step 9  | <p><b>route-policy</b> <i>route-policy-name</i> <b>out</b></p> <p><b>Example:</b><br/> RP/0/0/CPU0:router(config-bgp-nbr-af)#<br/> route-policy pass-all out</p>               | <p>Applies a routing policy to updates that are sent to a BGP neighbor.</p> <ul style="list-style-type: none"> <li>Use the <i>route-policy-name</i> argument to define the name of the of route policy. The example shows that the route policy name is defined as pass-all.</li> <li>Use the <b>out</b> keyword to define the policy for outbound routes.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Step 10 | <p><b>next-hop-unchanged</b></p> <p><b>Example:</b><br/> RP/0/0/CPU0:router(config-bgp-nbr-af)#<br/> next-hop-unchanged</p>                                                    | <p>Disables overwriting of the next hop before advertising to external Border Gateway Protocol (eBGP) peers.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Step 11 | <p><b>end</b><br/> OR<br/> <b>commit</b></p> <p><b>Example:</b><br/> RP/0/0/CPU0:router(config-bgp-nbr-af)# end<br/> OR<br/> RP/0/0/CPU0:router(config-bgp-nbr-af)# commit</p> | <p>Saves configuration changes.</p> <ul style="list-style-type: none"> <li>When you issue the <b>end</b> command, the system prompts you to commit changes:<br/> <pre>Uncommitted changes found, commit them before exiting (yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> <li>Entering <b>yes</b> saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.</li> <li>Entering <b>no</b> exits the configuration session and returns the router to EXEC mode without committing the configuration changes.</li> <li>Entering <b>cancel</b> leaves the router in the current configuration session without exiting or committing the configuration changes.</li> </ul> </li> <li>Use the <b>commit</b> command to save the configuration changes to the running configuration file and remain within the configuration session.</li> </ul> |

## Configuring the Route Reflector to Reflect Remote Routes in its AS

Perform this task to enable the route reflector (RR) to reflect the IPv4 routes and labels learned by the autonomous system boundary router (ASBR) to the provider edge (PE) routers in the autonomous system. This task is accomplished by making the ASBR and PE route reflector clients of the RR.

### SUMMARY STEPS

1. **configure**
2. **router bgp** *autonomous-system-number*
3. **address-family ipv4 unicast**
4. **allocate-label all**
5. **neighbor** *ip-address*
6. **remote-as** *autonomous-system-number*
7. **update-source** *type interface-path-id*
8. **address-family ipv4 labeled-unicast**
9. **route-reflector-client**
10. **neighbor** *ip-address*
11. **remote-as** *autonomous-system-number*
12. **update-source** *type interface-path-id*
13. **address-family ipv4 labeled-unicast**
14. **route-reflector-client**
15. **end**  
or  
**commit**

### DETAILED STEPS

|        | Command or Action                                                                                                                                                 | Purpose                                                                                                    |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| Step 1 | <b>configure</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router# configure                                                                                          | Enters global configuration mode.                                                                          |
| Step 2 | <b>router bgp</b> <i>autonomous-system-number</i><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config)# router bgp 120                                            | Enters Border Gateway Protocol (BGP) configuration mode allowing you to configure the BGP routing process. |
| Step 3 | <b>address-family ipv4 unicast</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp)# address-family<br>ipv4 unicast<br>RP/0/0/CPU0:router(config-bgp-af)# | Enters global address family configuration mode for the IPv4 unicast address family.                       |

|         | Command or Action                                                                                                                                                                         | Purpose                                                                                                                                                                                                                                        |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Step 4  | <b>allocate-label all</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-af)#<br>allocate-label all                                                                              | Allocates the MPLS labels for a specific IPv4 unicast or VPN routing and forwarding (VRF) IPv4 unicast routes so that the BGP router can send labels with BGP routes to a neighboring router that is configured for a labeled-unicast session. |
| Step 5  | <b>neighbor ip-address</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-af)# neighbor<br>172.168.40.24<br>RP/0/0/CPU0:router(config-bgp-nbr)#                                  | Places the router in neighbor configuration mode for BGP routing and configures the neighbor IP address 172.168.40.24 as an ASBR eBGP peer.                                                                                                    |
| Step 6  | <b>remote-as autonomous-system-number</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-nbr)# remote-as<br>2002                                                                 | Creates a neighbor and assigns it a remote autonomous system number.                                                                                                                                                                           |
| Step 7  | <b>update-source type interface-path-id</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-nbr)#<br>update-source loopback0                                                      | Allows BGP sessions to use the primary IP address from a particular interface as the local address.                                                                                                                                            |
| Step 8  | <b>address-family ipv4 labeled-unicast</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-nbr)#<br>address-family ipv4 labeled-unicast<br>RP/0/0/CPU0:router(config-bgp-nbr-af)# | Enters neighbor address family configuration mode for the IPv4 labeled-unicast address family.                                                                                                                                                 |
| Step 9  | <b>route-reflector-client</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-nbr-af)#<br>route-reflector-client                                                                  | Configures the router as a BGP route reflector and neighbor 172.168.40.24 as its client.                                                                                                                                                       |
| Step 10 | <b>neighbor ip-address</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-nbr-af)# neighbor<br>10.40.25.2<br>RP/0/0/CPU0:router(config-bgp-nbr)#                                 | Places the router in neighbor configuration mode for BGP routing and configures the neighbor IP address .40.25.2 as an VPNv4 iBGP peer.                                                                                                        |
| Step 11 | <b>remote-as autonomous-system-number</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-nbr)# remote-as<br>2002                                                                 | Creates a neighbor and assigns it a remote autonomous system number.                                                                                                                                                                           |



|         | Command or Action                                                                                                                                                                                      | Purpose                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Step 12 | <p><b>update-source</b> <i>type interface-path-id</i></p> <p><b>Example:</b><br/> RP/0/0/CPU0:router(config-bgp-nbr)#<br/> update-source loopback0</p>                                                 | Allows BGP sessions to use the primary IP address from a particular interface as the local address.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Step 13 | <p><b>address-family ipv4 labeled-unicast</b></p> <p><b>Example:</b><br/> RP/0/0/CPU0:router(config-bgp-nbr)#<br/> address-family ipv4 labeled-unicast<br/> RP/0/0/CPU0:router(config-bgp-nbr-af)#</p> | Enters neighbor address family configuration mode for the IPv4 labeled-unicast address family.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Step 14 | <p><b>route-reflector-client</b></p> <p><b>Example:</b><br/> RP/0/0/CPU0:router(config-bgp-nbr-af)#<br/> route-reflector-client</p>                                                                    | Configures the neighbor as a route reflector client.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Step 15 | <p><b>end</b><br/> or<br/> <b>commit</b></p> <p><b>Example:</b><br/> RP/0/0/CPU0:router(config-bgp-nbr-af)# end<br/> or<br/> RP/0/0/CPU0:router(config-bgp-nbr-af)# commit</p>                         | <p>Saves configuration changes.</p> <ul style="list-style-type: none"> <li>When you issue the <b>end</b> command, the system prompts you to commit changes:<br/> <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> <li>Entering <b>yes</b> saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.</li> <li>Entering <b>no</b> exits the configuration session and returns the router to EXEC mode without committing the configuration changes.</li> <li>Entering <b>cancel</b> leaves the router in the current configuration session without exiting or committing the configuration changes.</li> </ul> </li> <li>Use the <b>commit</b> command to save the configuration changes to the running configuration file and remain within the configuration session.</li> </ul> |

# Providing VPN Connectivity Across Multiple Autonomous Systems with MPLS VPN Inter-AS with ASBRs Exchanging VPN-IPv4 Addresses

This section contains instructions for the following tasks:

- [Configuring the ASBRs to Exchange VPN-IPv4 Addresses, page VPC-318](#)
- [Configuring a Static Route to an ASBR Peer, page VPC-321](#)
- [Configuring EBGP Routing to Exchange VPN Routes Between Subautonomous Systems in a Confederation, page VPC-323](#)
- [Configuring MPLS Forwarding for ASBR Confederations, page VPC-325](#)
- [Configuring a Static Route to an ASBR Confederation Peer, page VPC-327](#)

## Configuring the ASBRs to Exchange VPN-IPv4 Addresses

Perform this task to configure an external Border Gateway Protocol (eBGP) autonomous system boundary router (ASBR) to exchange VPN-IPv4 routes with another autonomous system.

### SUMMARY STEPS

1. **configure**
2. **router bgp** *autonomous-system-number*
3. **address-family vpnv4 unicast**
4. **neighbor** *ip-address*
5. **remote-as** *autonomous-system-number*
6. **address-family vpnv4 unicast**
7. **route-policy** *route-policy-name* **in**
8. **route-policy** *route-policy-name* **out**
9. **neighbor** *ip-address*
10. **remote-as** *autonomous-system-number*
11. **update-source** *type interface-path-id*
12. **address-family vpnv4 unicast**
13. **end**  
or  
**commit**

## DETAILED STEPS

|        | Command or Action                                                                                                                                                        | Purpose                                                                                                                                                                                                                                                                                                                                                         |
|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Step 1 | <b>configure</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router# configure                                                                                                 | Enters global configuration mode.                                                                                                                                                                                                                                                                                                                               |
| Step 2 | <b>router bgp</b> <i>autonomous-system-number</i><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config)# router bgp 120<br>RP/0/0/CPU0:router(config-bgp)#                | Enters Border Gateway Protocol (BGP) configuration mode allowing you to configure the BGP routing process.                                                                                                                                                                                                                                                      |
| Step 3 | <b>address-family vpnv4 unicast</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp)# address-family vpnv4 unicast<br>RP/0/0/CPU0:router(config-bgp-af)#         | Configures VPNv4 address family.                                                                                                                                                                                                                                                                                                                                |
| Step 4 | <b>neighbor</b> <i>ip-address</i><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-af)# neighbor 172.168.40.24<br>RP/0/0/CPU0:router(config-bgp-nbr)#             | Places the router in neighbor configuration mode for BGP routing and configures the neighbor IP address 172.168.40.24 as an ASBR eBGP peer.                                                                                                                                                                                                                     |
| Step 5 | <b>remote-as</b> <i>autonomous-system-number</i><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-nbr)# remote-as 2002                                            | Creates a neighbor and assigns it a remote autonomous system number.                                                                                                                                                                                                                                                                                            |
| Step 6 | <b>address-family vpnv4 unicast</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-nbr)# address-family vpnv4 unicast<br>RP/0/0/CPU0:router(config-bgp-nbr-af)# | Configures VPNv4 address family.                                                                                                                                                                                                                                                                                                                                |
| Step 7 | <b>route-policy</b> <i>route-policy-name in</i><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-nbr-af)# route-policy pass-all in                                | Applies a routing policy to updates that are received from a BGP neighbor. <ul style="list-style-type: none"> <li>Use the <i>route-policy-name</i> argument to define the name of the route policy. The example shows that the route policy name is defined as pass-all.</li> <li>Use the <b>in</b> keyword to define the policy for inbound routes.</li> </ul> |

|         | Command or Action                                                                                                                                                             | Purpose                                                                                                                                                                                                                                                                                                                                                                 |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Step 8  | <p><b>route-policy</b> <i>route-policy-name</i> <b>out</b></p> <p><b>Example:</b><br/> RP/0/0/CPU0:router(config-bgp-nbr-af)#<br/> route-policy pass-all out</p>              | <p>Applies a routing policy to updates that are sent from a BGP neighbor.</p> <ul style="list-style-type: none"> <li>Use the <i>route-policy-name</i> argument to define the name of the of route policy. The example shows that the route policy name is defined as pass-all.</li> <li>Use the <b>out</b> keyword to define the policy for outbound routes.</li> </ul> |
| Step 9  | <p><b>neighbor</b> <i>ip-address</i></p> <p><b>Example:</b><br/> RP/0/0/CPU0:router(config-bgp-nbr-af)# neighbor<br/> 10.40.25.2<br/> RP/0/0/CPU0:router(config-bgp-nbr)#</p> | <p>Places the router in neighbor configuration mode for BGP routing and configures the neighbor IP address 10.40.25.2 as an VPNv4 iBGP peer.</p>                                                                                                                                                                                                                        |
| Step 10 | <p><b>remote-as</b> <i>autonomous-system-number</i></p> <p><b>Example:</b><br/> RP/0/0/CPU0:router(config-bgp-nbr)# remote-as<br/> 2002</p>                                   | <p>Creates a neighbor and assigns it a remote autonomous system number.</p>                                                                                                                                                                                                                                                                                             |
| Step 11 | <p><b>update-source</b> <i>type interface-path-id</i></p> <p><b>Example:</b><br/> RP/0/0/CPU0:router(config-bgp-nbr)#<br/> update-source loopback0</p>                        | <p>Allows BGP sessions to use the primary IP address from a particular interface as the local address.</p>                                                                                                                                                                                                                                                              |

|         | Command or Action                                                                                                                                                                      | Purpose                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Step 12 | <pre>address-family vpnv4 unicast</pre> <p><b>Example:</b><br/> RP/0/0/CPU0:router(config-bgp-nbr)#<br/> address-family vpnv4 unicast<br/> RP/0/0/CPU0:router(config-bgp-nbr-af)# </p> | Configures VPNv4 address family.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Step 13 | <pre>end</pre> <p>or</p> <pre>commit</pre> <p><b>Example:</b><br/> RP/0/0/CPU0:router(config-bgp-nbr-af)# end<br/> or<br/> RP/0/0/CPU0:router(config-bgp-nbr-af)# commit </p>          | <p>Saves configuration changes.</p> <ul style="list-style-type: none"> <li>When you issue the <b>end</b> command, the system prompts you to commit changes:<br/> <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> <li>Entering <b>yes</b> saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.</li> <li>Entering <b>no</b> exits the configuration session and returns the router to EXEC mode without committing the configuration changes.</li> <li>Entering <b>cancel</b> leaves the router in the current configuration session without exiting or committing the configuration changes.</li> </ul> </li> <li>Use the <b>commit</b> command to save the configuration changes to the running configuration file and remain within the configuration session.</li> </ul> |

## Configuring a Static Route to an ASBR Peer

Perform this task to configure a static route to an ASBR peer.

### SUMMARY STEPS

1. **configure**
2. **router static**
3. **address-family ipv4 unicast**
4. **A.B.C.D/length next-hop**
5. **end**  
or  
**commit**

## DETAILED STEPS

|        | Command or Action                                                                                                                                                                  | Purpose                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Step 1 | <p><b>configure</b></p> <p><b>Example:</b><br/>RP/0/0/CPU0:router# configure</p>                                                                                                   | Enters global configuration mode.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Step 2 | <p><b>router static</b></p> <p><b>Example:</b><br/>RP/0/0/CPU0:router(config)# router static<br/>RP/0/0/CPU0:router(config-static)#</p>                                            | Enters router static configuration mode.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Step 3 | <p><b>address-family ipv4 unicast</b></p> <p><b>Example:</b><br/>RP/0/0/CPU0:router(config-static)#<br/>address-family ipv4 unicast<br/>RP/0/0/CPU0:router(config-static-afi)#</p> | Enables an IPv4 address family.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Step 4 | <p><b>A.B.C.D/length next-hop</b></p> <p><b>Example:</b><br/>RP/0/0/CPU0:router(config-static-afi)#<br/>10.10.10.10/32 10.9.9.9</p>                                                | Enters the address of the destination router (including IPv4 subnet mask).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Step 5 | <p><b>end</b><br/>OR<br/><b>commit</b></p> <p><b>Example:</b><br/>RP/0/0/CPU0:router(config-static-afi)# end<br/>OR<br/>RP/0/0/CPU0:router(config-static-afi)# commit</p>          | <p>Saves configuration changes.</p> <ul style="list-style-type: none"> <li>When you issue the <b>end</b> command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> <li>Entering <b>yes</b> saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.</li> <li>Entering <b>no</b> exits the configuration session and returns the router to EXEC mode without committing the configuration changes.</li> <li>Entering <b>cancel</b> leaves the router in the current configuration session without exiting or committing the configuration changes.</li> </ul> </li> <li>Use the <b>commit</b> command to save the configuration changes to the running configuration file and remain within the configuration session.</li> </ul> |

## Configuring EBGW Routing to Exchange VPN Routes Between Subautonomous Systems in a Confederation

Perform this task to configure external Border Gateway Protocol (eBGP) routing to exchange VPN routes between subautonomous systems in a confederation.



### Note

To ensure that host routes for VPN-IPv4 eBGP neighbors are propagated (by means of the Interior Gateway Protocol [IGP]) to other routers and PE routers, specify the **redistribute connected** command in the IGP configuration portion of the confederation eBGP (CEBGP) router. If you are using Open Shortest Path First (OSPF), make sure that the OSPF process is not enabled on the CEBGP interface in which the “redistribute connected” subnet exists.

### SUMMARY STEPS

1. **configure**
2. **router bgp** *autonomous-system-number*
3. **bgp confederation peers** *peer autonomous-system-number*
4. **bgp confederation identifier** *autonomous-system-number*
5. **address-family vpnv4 unicast**
6. **neighbor** *ip-address*
7. **remote-as** *autonomous-system-number*
8. **address-family vpnv4 unicast**
9. **route-policy** *route-policy-name* **in**
10. **route-policy** *route-policy-name* **out**
11. **next-hop-self**
12. **end**  
or  
**commit**

### DETAILED STEPS

|        | Command or Action                                                                                                                                         | Purpose                                                                          |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| Step 1 | <b>configure</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router# configure                                                                                  | Enters global configuration mode.                                                |
| Step 2 | <b>router bgp</b> <i>autonomous-system-number</i><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config)# router bgp 120<br>RP/0/0/CPU0:router(config-bgp)# | Enters BGP configuration mode allowing you to configure the BGP routing process. |

|         | Command or Action                                                                                                                                                           | Purpose                                                                                                                             |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| Step 3  | <b>bgp confederation peers</b> <i>peer</i><br><i>autonomous-system-number</i><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp)# bgp<br>confederation peers 8        | Configures the peer autonomous system number that belongs to the confederation.                                                     |
| Step 4  | <b>bgp confederation identifier</b><br><i>autonomous-system-number</i><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp)# bgp<br>confederation identifier 5          | Specifies the autonomous system number for the confederation ID.                                                                    |
| Step 5  | <b>address-family vpnv4 unicast</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp)# address-family<br>vpnv4 unicast<br>RP/0/0/CPU0:router(config-bgp-af)#         | Configures VPNv4 address family.                                                                                                    |
| Step 6  | <b>neighbor</b> <i>ip-address</i><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-af)# neighbor<br>10.168.40.24<br>RP/0/0/CPU0:router(config-bgp-nbr)#              | Places the router in neighbor configuration mode for BGP routing and configures the neighbor IP address 10.168.40.24 as a BGP peer. |
| Step 7  | <b>remote-as</b> <i>autonomous-system-number</i><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-nbr)# remote-as<br>2002                                            | Creates a neighbor and assigns it a remote autonomous system number.                                                                |
| Step 8  | <b>address-family vpnv4 unicast</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-nbr)#<br>address-family vpnv4 unicast<br>RP/0/0/CPU0:router(config-bgp-nbr-af)# | Configures VPNv4 address family.                                                                                                    |
| Step 9  | <b>route-policy</b> <i>route-policy-name</i> <b>in</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-nbr-af)#<br>route-policy In-Ipv4 in                          | Applies a routing policy to updates received from a BGP neighbor.                                                                   |
| Step 10 | <b>route-policy</b> <i>route-policy-name</i> <b>out</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-nbr-af)#<br>route-policy Out-Ipv4 out                       | Applies a routing policy to updates advertised to a BGP neighbor.                                                                   |



|         | Command or Action                                                                                                                                                                | Purpose                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Step 11 | <p><b>next-hop-self</b></p> <p><b>Example:</b><br/> RP/0/0/CPU0:router(config-bgp-nbr-af) #<br/> next-hop-self</p>                                                               | Disables next-hop calculation and let you insert your own address in the next-hop field of BGP updates.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Step 12 | <p><b>end</b><br/> or<br/> <b>commit</b></p> <p><b>Example:</b><br/> RP/0/0/CPU0:router(config-bgp-nbr-af) # end<br/> or<br/> RP/0/0/CPU0:router(config-bgp-nbr-af) # commit</p> | <p>Saves configuration changes.</p> <ul style="list-style-type: none"> <li>When you issue the <b>end</b> command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting (yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> <li>Entering <b>yes</b> saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.</li> <li>Entering <b>no</b> exits the configuration session and returns the router to EXEC mode without committing the configuration changes.</li> <li>Entering <b>cancel</b> leaves the router in the current configuration session without exiting or committing the configuration changes.</li> </ul> </li> <li>Use the <b>commit</b> command to save the configuration changes to the running configuration file and remain within the configuration session.</li> </ul> |

## Configuring MPLS Forwarding for ASBR Confederations

Perform this task to configure MPLS forwarding for autonomous system boundary router (ASBR) confederations (in BGP) on a specified interface.



### Note

This configuration adds the implicit NULL rewrite corresponding to the peer associated with the interface, which is required to prevent BGP from automatically installing rewrites by LDP (in multihop instances).

## SUMMARY STEPS

- configure**
- router bgp** *as-number*
- mpls activate**
- interface** *type interface-path-id*
- end**  
or  
**commit**

## DETAILED STEPS

| Command or Action                                                                                                                                                                                       | Purpose                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Step 1</b> <code>configure</code><br><br><b>Example:</b><br>RP/0/0/CPU0:router# <code>configure</code>                                                                                               | Enters global configuration mode.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Step 2</b> <code>router bgp as-number</code><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config)# <code>router bgp 120</code><br>RP/0/0/CPU0:router(config-bgp)                                     | Enters BGP configuration mode allowing you to configure the BGP routing process.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Step 3</b> <code>mpls activate</code><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp)# <code>mpls activate</code><br>RP/0/0/CPU0:router(config-bgp-mpls)#                                   | Enters BGP MPLS activate configuration mode.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Step 4</b> <code>interface type interface-path-id</code><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-mpls)# <code>interface GigabitEthernet 0/3/0/0</code>                               | Enables MPLS on the interface.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Step 5</b> <code>end</code><br>OR<br><b>commit</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-mpls)# <code>end</code><br>OR<br>RP/0/0/CPU0:router(config-bgp-mpls)# <code>commit</code> | Saves configuration changes. <ul style="list-style-type: none"> <li>• When you issue the <b>end</b> command, the system prompts you to commit changes:<br/> <pre>Uncommitted changes found, commit them before exiting (yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> <li>– Entering <b>yes</b> saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.</li> <li>– Entering <b>no</b> exits the configuration session and returns the router to EXEC mode without committing the configuration changes.</li> <li>– Entering <b>cancel</b> leaves the router in the current configuration session without exiting or committing the configuration changes.</li> </ul> </li> <li>• Use the <b>commit</b> command to save the configuration changes to the running configuration file and remain within the configuration session.</li> </ul> |

## Configuring a Static Route to an ASBR Confederation Peer

Perform this task to configure a static route to an Inter-AS confederation peer. For more detailed information, see [“Configuring a Static Route to a Peer”](#) section on page MPC-335.

### SUMMARY STEPS

1. **configure**
2. **router static**
3. **address-family ipv4 unicast**
4. **A.B.C.D/length next-hop**
5. **end**  
or  
**commit**

### DETAILED STEPS

|        | Command or Action                                                                                                                                                        | Purpose                                  |
|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|
| Step 1 | <b>configure</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router# configure                                                                                                 | Enters global configuration mode.        |
| Step 2 | <b>router static</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config)# router static<br>RP/0/0/CPU0:router(config-static)#                                           | Enters router static configuration mode. |
| Step 3 | <b>address-family ipv4 unicast</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-static)#<br>address-family ipv4 unicast<br>RP/0/0/CPU0:router(config-static-afi)# | Enables an IPv4 address family.          |

| Command or Action                                                                                                                                                                                   | Purpose                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Step 4</b></p> <p><b>A.B.C.D/length</b> <i>next-hop</i></p> <p><b>Example:</b><br/> RP/0/0/CPU0:router(config-static-afi)#<br/> 10.10.10.10/32 10.9.9.9</p>                                   | <p>Enters the address of the destination router (including IPv4 subnet mask).</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <p><b>Step 5</b></p> <p><b>end</b><br/> OR<br/> <b>commit</b></p> <p><b>Example:</b><br/> RP/0/0/CPU0:router(config-static-afi)# end<br/> OR<br/> RP/0/0/CPU0:router(config-static-afi)# commit</p> | <p>Saves configuration changes.</p> <ul style="list-style-type: none"> <li>• When you issue the <b>end</b> command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> <li>– Entering <b>yes</b> saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.</li> <li>– Entering <b>no</b> exits the configuration session and returns the router to EXEC mode without committing the configuration changes.</li> <li>– Entering <b>cancel</b> leaves the router in the current configuration session without exiting or committing the configuration changes.</li> </ul> </li> <li>• Use the <b>commit</b> command to save the configuration changes to the running configuration file and remain within the configuration session.</li> </ul> |

## Configuring Carrier Supporting Carrier

Perform the tasks in this section to configure Carrier Supporting Carrier (CSC):

- [Identifying the Carrier Supporting Carrier Topology, page VPC-329](#)
- [Configuring the Backbone Carrier Core, page VPC-330](#)
- [Configuring the CSC-PE and CSC-CE Routers, page VPC-330](#)
- [Configuring a Static Route to a Peer, page VPC-335](#)

### Identifying the Carrier Supporting Carrier Topology

Before you configure the MPLS VPN CSC with BGP, you must identify both the backbone and customer carrier topology.



#### Note

You can connect multiple CSC-CE routers to the same PE, or you can connect a single CSC-CE router to multiple CSC-PEs using more than one CSC-CE interface to provide redundancy and multiple path support in a CSC topology.

Perform this task to identify the carrier supporting carrier topology.

#### SUMMARY STEPS

1. Identify the type of customer carrier, ISP, or MPLS VPN service provider.
2. Identify the CE routers.
3. Identify the customer carrier core router configuration.
4. Identify the customer carrier edge (CSC-CE) routers.
5. Identify the backbone carrier router configuration.

#### DETAILED STEPS

|        | Command or Action                                                         | Purpose                                                                                                                                    |
|--------|---------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| Step 1 | Identify the type of customer carrier, ISP, or MPLS VPN service provider. | Sets up requirements for configuration of carrier supporting carrier network.                                                              |
| Step 2 | Identify the CE routers.                                                  | Sets up requirements for configuration of CE to PE connections.                                                                            |
| Step 3 | Identify the customer carrier core router configuration.                  | Sets up requirements for configuration between core (P) routers and between P routers and edge routers (PE and CSC-CE routers).            |
| Step 4 | Identify the customer carrier edge (CSC-CE) routers.                      | Sets up requirements for configuration of CSC-CE to CSC-PE connections.                                                                    |
| Step 5 | Identify the backbone carrier router configuration.                       | Sets up requirements for configuration between CSC core routers and between CSC core routers and edge routers (CSC-CE and CSC-PE routers). |

## Configuring the Backbone Carrier Core

Configuring the backbone carrier core requires setting up connectivity and routing functions for the CSC core and the CSC-PE routers. To do so, you must complete the following high-level tasks:

- Verify IP connectivity in the CSC core.
- Verify LDP configuration in the CSC core.



**Note** This task is not applicable to CSC over IP tunnels.

- Configure VRFs for CSC-PE routers.
- Configure multiprotocol BGP for VPN connectivity in the backbone carrier.

## Configuring the CSC-PE and CSC-CE Routers

Perform the following tasks to configure links between a CSC-PE router and the carrier CSC-CE router for an MPLS VPN CSC network that uses BGP to distribute routes and MPLS labels:

- [Configuring a CSC-PE](#)
- [Configuring a CSC-CE](#)

Figure 37 shows the configuration for the peering with directly connected interfaces between CSC-PE and CSC-CE routers. This configuration is used as the example in the tasks that follow.

**Figure 37** Configuration for Peering with Directly Connected Interfaces Between CSC-PE and CSC-CE Routers



### Configuring a CSC-PE

Perform this task to configure a CSC-PE.

#### SUMMARY STEPS

1. **configure**
2. **router bgp** *as-number*
3. **address-family vpnv4 unicast**
4. **neighbor** *A.B.C.D*
5. **remote-as** *as-number*
6. **update-source** *type interface-path-id*
7. **address-family vpnv4 unicast**
8. **vrf** *vrf-name*
9. **rd** {*as-number:nn* | *ip-address:nn* | **auto**}

10. **address-family ipv4 unicast**
11. **allocate-label all**
12. **neighbor A.B.C.D**
13. **remote-as as-number**
14. **address-family ipv4 labeled-unicast**
15. **route-policy route-policy-name in**
16. **route-policy route-policy-name out**
17. **end**  
or  
**commit**

## DETAILED STEPS

|        | Command or Action                                                                                                                                                | Purpose                                                                                                                                                                                                          |
|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Step 1 | <b>configure</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router# configure                                                                                         | Enters global configuration mode.                                                                                                                                                                                |
| Step 2 | <b>router bgp as-number</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config)# router bgp 2<br>RP/0/0/CPU0:router(config-bgp)#                                | Configures a BGP routing process and enters router configuration mode. <ul style="list-style-type: none"> <li>Range for 2-byte numbers is 1 to 65535. Range for 4-byte numbers is 1.0 to 65535.65535.</li> </ul> |
| Step 3 | <b>address-family vpnv4 unicast</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp)# address-family vpnv4 unicast<br>RP/0/0/CPU0:router(config-bgp-af)# | Configures VPNv4 address family.                                                                                                                                                                                 |
| Step 4 | <b>neighbor A.B.C.D</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-af)# neighbor 10.10.10.0<br>RP/0/0/CPU0:router(config-bgp-nbr)#                  | Configures the IP address for the BGP neighbor.                                                                                                                                                                  |
| Step 5 | <b>remote-as as-number</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-nbr)# remote-as 888                                                           | Configures the AS number for the BGP neighbor.                                                                                                                                                                   |
| Step 6 | <b>update-source type interface-path-id</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-nbr)# update-source loopback0                                | Allows BGP sessions to use the primary IP address from a particular interface as the local address.                                                                                                              |

|         | Command or Action                                                                                                                                                                                 | Purpose                                                                                                                                |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| Step 7  | <b>address-family vpnv4 unicast</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-nbr)#<br>address-family vpnv4 unicast<br>RP/0/0/CPU0:router(config-bgp-nbr-af)#                       | Configures VPNv4 unicast address family.                                                                                               |
| Step 8  | <b>vrf vrf-name</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-nbr-af)# vrf 9999<br>RP/0/0/CPU0:router(config-bgp-vrf)#                                                              | Configures a VRF instance.                                                                                                             |
| Step 9  | <b>rd {as-number:nn   ip-address:nn   auto}</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(onfig-bgp-vrf)# rd auto                                                                              | Configures a route distinguisher.<br><br><b>Note</b> Use the <b>auto</b> keyword to automatically assign a unique route distinguisher. |
| Step 10 | <b>address-family ipv4 unicast</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-vrf)#<br>address-family ipv4 unicast<br>RP/0/0/CPU0:router(config-bgp-vrf-af)#                         | Configures IPv4 unicast address family.                                                                                                |
| Step 11 | <b>allocate-label all</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-vrf-af)#<br>allocate-label all                                                                                  | Allocate labels for all local prefixes and prefixes received with labels.                                                              |
| Step 12 | <b>neighbor A.B.C.D</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-vrf-af)# neighbor<br>10.10.10.0<br>RP/0/0/CPU0:router(config-bgp-vrf-nbr)#                                        | Configures the IP address for the BGP neighbor.                                                                                        |
| Step 13 | <b>remote-as as-number</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-vrf-nbr)#<br>remote-as 888                                                                                     | Enables the exchange of information with a neighboring BGP router.                                                                     |
| Step 14 | <b>address-family ipv4 labeled-unicast</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-vrf-nbr)#<br>address-family ipv4 labeled-unicast<br>RP/0/0/CPU0:router(config-bgp-vrf-nbr-af)# | Configures IPv4 labeled-unicast address family.                                                                                        |



|         | Command or Action                                                                                                                                                                                  | Purpose                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Step 15 | <pre>route-policy route-policy-name in</pre> <p><b>Example:</b><br/> RP/0/0/CPU0:router(config-bgp-vrf-nbr-af)#<br/> route-policy pass-all in </p>                                                 | Applies the pass-all policy to all inbound routes.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Step 16 | <pre>route-policy route-policy-name out</pre> <p><b>Example:</b><br/> RP/0/0/CPU0:router(config-bgp-vrf-nbr-af)#<br/> route-policy pass-all out </p>                                               | Applies the pass-all policy to all outbound routes.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Step 17 | <pre>end</pre> <p>or</p> <pre>commit</pre> <p><b>Example:</b><br/> RP/0/0/CPU0:router(cconfig-bgp-vrf-nbr-af)# end</p> <p>or</p> <pre>RP/0/0/CPU0:router(config-bgp-vrf-nbr-af)#<br/> commit</pre> | <p>Saves configuration changes.</p> <ul style="list-style-type: none"> <li>When you issue the <b>end</b> command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before<br/> exiting (yes/no/cancel)?<br/> [cancel]:</pre> <ul style="list-style-type: none"> <li>Entering <b>yes</b> saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.</li> <li>Entering <b>no</b> exits the configuration session and returns the router to EXEC mode without committing the configuration changes.</li> <li>Entering <b>cancel</b> leaves the router in the current configuration session without exiting or committing the configuration changes.</li> </ul> </li> <li>Use the <b>commit</b> command to save the configuration changes to the running configuration file and remain within the configuration session.</li> </ul> |

## Configuring a CSC-CE

Perform this task to configure a CSC-CE.

### SUMMARY STEPS

1. **configure**
2. **router bgp** *as-number*
3. **address-family ipv4 unicast**
4. **redistribute ospf** *instance-number*
5. **allocate-label route-policy** *route-policy-name*
6. **exit**
7. **neighbor** *A.B.C.D*
8. **remote-as** *as-number*
9. **address-family ipv4 labeled-unicast**

10. **route-policy** *route-policy-name* **in**
11. **route-policy** *route-policy-name* **out**
12. **end**  
or  
**commit**

## DETAILED STEPS

|        | Command or Action                                                                                                                                                       | Purpose                                                                                                                                                                                                          |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Step 1 | <b>configure</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router# configure                                                                                                | Enters global configuration mode.                                                                                                                                                                                |
| Step 2 | <b>router bgp</b> <i>as-number</i><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config)# router bgp 1                                                                   | Configures a BGP routing process and enters router configuration mode. <ul style="list-style-type: none"> <li>Range for 2-byte numbers is 1 to 65535. Range for 4-byte numbers is 1.0 to 65535.65535.</li> </ul> |
| Step 3 | <b>address-family ipv4 unicast</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp)# address-family ipv4 unicast                                                | Configures IPv4 unicast address-family.                                                                                                                                                                          |
| Step 4 | <b>redistribute ospf</b> <i>instance-number</i><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-router-af)# redistribute ospf 1                                     | Redistributes OSPF routes into BGP.                                                                                                                                                                              |
| Step 5 | <b>allocate-label route-policy</b> <i>route-policy-name</i><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-router-af)# allocate-label route-policy internal-routes | Allocates labels for those routes that match the route policy. These labeled routes are advertised to neighbors configured with address-family ipv4 labeled-unicast.                                             |
| Step 6 | <b>exit</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-af)# exit                                                                                           | Exits the current configuration mode.                                                                                                                                                                            |
| Step 7 | <b>neighbor</b> <i>A.B.C.D</i><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp)# neighbor 10.0.0.1                                                              | Configures the IP address for the BGP neighbor.                                                                                                                                                                  |
| Step 8 | <b>remote-as</b> <i>as-number</i><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-nbr)# remote-as 1                                                             | Enables the exchange of information with a neighboring BGP router.                                                                                                                                               |

|         | Command or Action                                                                                                                                                                         | Purpose                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Step 9  | <b>address-family ipv4 labeled-unicast</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-nbr)#<br>address-family ipv4 labeled-unicast<br>RP/0/0/CPU0:router(config-bgp-nbr-af)# | Configures IPv4 labeled-unicast address family.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Step 10 | <b>route-policy route-policy-name in</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-nbr-af)#<br>route-policy pass-all in                                                     | Applies the route-policy to all inbound routes.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Step 11 | <b>route-policy route-policy-name out</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp-nbr-af)#<br>route-policy pass-all out                                                   | Applies the route-policy to all outbound routes.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Step 12 | <b>end</b><br>OR<br><b>commit</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-bgp)# <b>end</b><br>OR<br>RP/0/0/CPU0:router(config-bgp)# <b>commit</b>                             | Saves configuration changes. <ul style="list-style-type: none"> <li>When you issue the <b>end</b> command, the system prompts you to commit changes:<br/> Uncommitted changes found, commit them before exiting(yes/no/cancel)?<br/> [cancel]: <ul style="list-style-type: none"> <li>Entering <b>yes</b> saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.</li> <li>Entering <b>no</b> exits the configuration session and returns the router to EXEC mode without committing the configuration changes.</li> <li>Entering <b>cancel</b> leaves the router in the current configuration session without exiting or committing the configuration changes.</li> </ul> </li> <li>Use the <b>commit</b> command to save the configuration changes to the running configuration file and remain within the configuration session.</li> </ul> |

## Configuring a Static Route to a Peer

Perform this task to configure a static route to an Inter-AS or CSC-CE peer.

When you configure an Inter-AS or CSC peer, BGP allocates a label for a /32 route to that peer and performs a NULL label rewrite. When forwarding a labeled packet to the peer, the router removes the top label from the label stack; however, in such an instance, BGP expects a /32 route to the peer. This task ensures that there is, in fact, a /32 route to the peer.

Please be aware of the following facts before performing this task:

- A /32 route is not required to establish BGP peering. A route using a shorter prefix length will also work.
- A shorter prefix length route is not associated with the allocated label; even though the BGP session comes up between the peers, without the static route, forwarding will not work.


**Note**

To configure a static route on a CSC-PE, you must configure the router under the VRF (as noted in the detailed steps).

## SUMMARY STEPS

1. **configure**
2. **router static**
3. **address-family ipv4 unicast**
4. **A.B.C.D/length next-hop**
5. **end**  
or  
**commit**

## DETAILED STEPS

|        | Command or Action                                                                                                              | Purpose                                                                                                                                                                                  |
|--------|--------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Step 1 | <b>configure</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config)# configure                                               | Enters global configuration mode.                                                                                                                                                        |
| Step 2 | <b>router static</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config)# router static                                       | Enters router static configuration mode.                                                                                                                                                 |
| Step 3 | <b>address-family ipv4 unicast</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-static)#<br>address-family ipv4 unicast | Enables an IPv4 address family.<br><br><b>Note</b> To configure a static route on a CSC-PE, you must first configure the VRF using the <b>vrf</b> command before <b>address-family</b> . |

|        | Command or Action                                                                                                                                                                     | Purpose                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Step 4 | <p><b>A.B.C.D/length next-hop</b></p> <p><b>Example:</b><br/>RP/0/0/CPU0:router(config-static-afi)#<br/>10.10.10.10/32 10.9.9.9</p>                                                   | Enters the address of the destination router (including IPv4 subnet mask).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Step 5 | <p><b>end</b><br/>or<br/><b>commit</b></p> <p><b>Example:</b><br/>RP/0/0/CPU0:router(config-static-af)# <b>end</b><br/>or<br/>RP/0/0/CPU0:router(config-static-af)# <b>commit</b></p> | <p>Saves configuration changes.</p> <ul style="list-style-type: none"> <li>When you issue the <b>end</b> command, the system prompts you to commit changes:           <pre>Uncommitted changes found, commit them before exiting (yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> <li>Entering <b>yes</b> saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.</li> <li>Entering <b>no</b> exits the configuration session and returns the router to EXEC mode without committing the configuration changes.</li> <li>Entering <b>cancel</b> leaves the router in the current configuration session without exiting or committing the configuration changes.</li> </ul> </li> <li>Use the <b>commit</b> command to save the configuration changes to the running configuration file and remain within the configuration session.</li> </ul> |

## Verifying the MPLS Layer 3 VPN Configuration

Perform this task to verify the MPLS Layer 3 VPN configuration.

### SUMMARY STEPS

1. **show running-config router bgp** *as-number vrf vrf-name*
2. **show running-config routes**
3. **show ospf vrf** *vrf-name database*
4. **show running-config router bgp** *as-number vrf vrf-name neighbor ip-address*
5. **show bgp vrf** *vrf-name summary*
6. **show bgp vrf** *vrf-name neighbors ip-address*
7. **show bgp vrf** *vrf-name*
8. **show route vrf** *vrf-name ip-address*
9. **show bgp vpn unicast summary**
10. **show running-config router isis**
11. **show running-config mpls**
12. **show isis adjacency**

13. **show mpls ldp forwarding**
14. **show bgp vpnv4 unicast**  
or  
**show bgp vpnv6 unicast**
15. **show bgp vrf vrf-name**
16. **show bgp vrf vrf-name imported-routes**
17. **show route vrf vrf-name ip-address**
18. **show cef vrf vrf-name ip-address**
19. **show cef vrf vrf-name ip-address location node-id**
20. **show bgp vrf vrf-name ip-address**
21. **show ospf vrf vrf-name database**

## DETAILED STEPS

|        | Command or Action                                                                                                                                                                                                     | Purpose                                                                                                 |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| Step 1 | <b>show running-config router bgp <i>as-number</i> vrf <i>vrf-name</i></b><br><br><b>Example:</b><br>RP/0/0/CPU0:router# show running-config router bgp 3 vrf vrf_A                                                   | Displays the specified VPN routing and forwarding (VRF) content of the currently running configuration. |
| Step 2 | <b>show running-config routes</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router# show running-config routes                                                                                                            | Displays the Open Shortest Path First (OSPF) routes table in the currently running configuration.       |
| Step 3 | <b>show ospf vrf <i>vrf-name</i> database</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router# show ospf vrf vrf_A database                                                                                              | Displays lists of information related to the OSPF database for a specified VRF.                         |
| Step 4 | <b>show running-config router bgp <i>as-number</i> vrf <i>vrf-name</i> neighbor <i>ip-address</i></b><br><br><b>Example:</b><br>RP/0/0/CPU0:router# show running-config router bgp 3 vrf vrf_A neighbor 172.168.40.24 | Displays the Border Gateway Protocol (BGP) VRF neighbor content of the currently running configuration. |
| Step 5 | <b>show bgp vrf <i>vrf-name</i> summary</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router# show bgp vrf vrf_A summary                                                                                                  | Displays the status of the specified BGP VRF connections.                                               |
| Step 6 | <b>show bgp vrf <i>vrf-name</i> neighbors <i>ip-address</i></b><br><br><b>Example:</b><br>RP/0/0/CPU0:router# show bgp vrf vrf_A neighbors 172.168.40.24                                                              | Displays information about BGP VRF connections to the specified neighbors.                              |

|         | Command or Action                                                                                                                      | Purpose                                                                                                         |
|---------|----------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| Step 7  | <pre>show bgp vrf vrf-name</pre> <p><b>Example:</b><br/>RP/0/0/CPU0:router# show bgp vrf vrf_A</p>                                     | Displays information about a specified BGP VRF.                                                                 |
| Step 8  | <pre>show route vrf vrf-name ip-address</pre> <p><b>Example:</b><br/>RP/0/0/CPU0:router# show route vrf vrf_A<br/>10.0.0.0</p>         | Displays the current routes in the Routing Information Base (RIB) for a specified VRF.                          |
| Step 9  | <pre>show bgp vpn unicast summary</pre> <p><b>Example:</b><br/>RP/0/0/CPU0:router# show bgp vpn unicast<br/>summary</p>                | Displays the status of all BGP VPN unicast connections.                                                         |
| Step 10 | <pre>show running-config router isis</pre> <p><b>Example:</b><br/>RP/0/0/CPU0:router# show running-config router<br/>isis</p>          | Displays the Intermediate System-to-Intermediate System (IS-IS) content of the currently running configuration. |
| Step 11 | <pre>show running-config mpls</pre> <p><b>Example:</b><br/>RP/0/0/CPU0:router# show running-config mpls</p>                            | Displays the MPLS content of the currently running-configuration.                                               |
| Step 12 | <pre>show isis adjacency</pre> <p><b>Example:</b><br/>RP/0/0/CPU0:router# show isis adjacency</p>                                      | Displays IS-IS adjacency information.                                                                           |
| Step 13 | <pre>show mpls ldp forwarding</pre> <p><b>Example:</b><br/>RP/0/0/CPU0:router# show mpls ldp forwarding</p>                            | Displays the Label Distribution Protocol (LDP) forwarding state installed in MPLS forwarding.                   |
| Step 14 | <pre>show bgp vpnv4 unicast or show bgp vpnv6 unicast</pre> <p><b>Example:</b><br/>RP/0/0/CPU0:router# show bgp vpnv4 unicast</p>      | Displays entries in the BGP routing table for VPNv4 or VPNv6 unicast addresses.                                 |
| Step 15 | <pre>show bgp vrf vrf-name</pre> <p><b>Example:</b><br/>RP/0/0/CPU0:router# show bgp vrf vrf_A</p>                                     | Displays entries in the BGP routing table for VRF vrf_A.                                                        |
| Step 16 | <pre>show bgp vrf vrf-name imported-routes</pre> <p><b>Example:</b><br/>RP/0/0/CPU0:router# show bgp vrf vrf_A<br/>imported-routes</p> | Displays BGP information for routes imported into specified VRF instances.                                      |

|         | Command or Action                                                                                                                                              | Purpose                                                                         |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|
| Step 17 | <b>show route vrf</b> <i>vrf-name ip-address</i><br><br><b>Example:</b><br>RP/0/0/CPU0:router# show route vrf vrf_A<br>10.0.0.0                                | Displays the current specified VRF routes in the RIB.                           |
| Step 18 | <b>show cef vrf</b> <i>vrf-name ip-address</i><br><br><b>Example:</b><br>RP/0/0/CPU0:router# show cef vrf vrf_A 10.0.0.1                                       | Displays the IPv4 Cisco Express Forwarding (CEF) table for a specified VRF.     |
| Step 19 | <b>show cef vrf</b> <i>vrf-name ip-address location node-id</i><br><br><b>Example:</b><br>RP/0/0/CPU0:router# show cef vrf vrf_A 10.0.0.1<br>location 0/1/cpu0 | Displays the IPv4 CEF table for a specified VRF and location.                   |
| Step 20 | <b>show bgp vrf</b> <i>vrf-name ip-address</i><br><br><b>Example:</b><br>RP/0/0/CPU0:router# show bgp vrf vrf_A 10.0.0.0                                       | Displays entries in the BGP routing table for VRF vrf_A.                        |
| Step 21 | <b>show ospf vrf</b> <i>vrf-name database</i><br><br><b>Example:</b><br>RP/0/0/CPU0:router# show ospf vrf vrf_A<br>database                                    | Displays lists of information related to the OSPF database for a specified VRF. |

## Configuring 6VPE Support

The following tasks are required to configure 6VPE support:

- [Configuring an IPv6 Address Family Under VRF, page VPC-341](#)
- [Configuring BGP Route Distinguisher and Core-facing Sessions, page VPC-342](#)
- [Configuring a PE-CE Protocol, page VPC-344](#)



## Configuring an IPv6 Address Family Under VRF

Perform this task to configure an IPv6 address-family under the VRF for 6VPE support.



### Note

You can also configure a maximum-routes limit for the VRF, export, and import policies.

### SUMMARY STEPS

1. **configure**
2. **vrf** *vrf\_name*
3. **address-family ipv6 unicast**
4. **import route-target** [*as-number:nn* | *ip-address:nn*]
5. **export route-target** [*as-number:nn* | *ip-address:nn*]
6. **end**  
or  
**commit**

### DETAILED STEPS

|        | Command or Action                                                                                                                                                      | Purpose                                                                               |
|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Step 1 | <b>configure</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router# <b>configure</b>                                                                                        | Enters global configuration mode.                                                     |
| Step 2 | <b>vrf</b> <i>vrf-name</i><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config)# vrf <i>vrf_1</i>                                                                      | Configures a VRF instance and enters VRF configuration mode.                          |
| Step 3 | <b>address-family ipv6 unicast</b><br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-vrf)# address-family<br>ipv4 unicast                                            | Enters VRF address family configuration mode for the IPv6 address family.             |
| Step 4 | <b>import route-target</b> [ <i>as-number:nn</i>  <br><i>ip-address:nn</i> ]<br><br><b>Example:</b><br>RP/0/0/CPU0:router(config-vrf-af)# import<br>route-target 120:1 | Configures a VPN routing and forwarding (VRF) import route-target extended community. |

|        | Command or Action                                                                                                                                                 | Purpose                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Step 5 | <pre>export route-target [as-number:nn   ip-address:nn]</pre> <p><b>Example:</b><br/>RP/0/0/CPU0:router(config-vrf-af)# export route-target 120:2</p>             | Associates the local VPN with a route target. When the route is advertised to other provider edge (PE) routers, the export route target is sent along with the route as an extended community.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Step 6 | <pre>end</pre> <p>OR</p> <pre>commit</pre> <p><b>Example:</b><br/>RP/0/0/CPU0:router(config-vrf-af)# end<br/>OR<br/>RP/0/0/CPU0:router(config-vrf-af)# commit</p> | <p>Saves configuration changes.</p> <ul style="list-style-type: none"> <li>When you issue the <b>end</b> command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> <li>Entering <b>yes</b> saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.</li> <li>Entering <b>no</b> exits the configuration session and returns the router to EXEC mode without committing the configuration changes.</li> <li>Entering <b>cancel</b> leaves the router in the current configuration session without exiting or committing the configuration changes.</li> </ul> </li> <li>Use the <b>commit</b> command to save the configuration changes to the running configuration file and remain within the configuration session.</li> </ul> |

## Configuring BGP Route Distinguisher and Core-facing Sessions

Perform this task to configure VRF route distinguisher values and core-facing neighbors under BGP.



### Note

Before you perform this task, you must first configure a VRF and map the VRF to an interface. For more information, see *Implementing MPLS VPNs over IP Tunnels on Cisco IOS XR Software*.

### SUMMARY STEPS

- configure**
- router bgp** *as-number*
- address-family vpnv6 unicast**
- vrf** *vrf-name*
- rd** {*as-number:nn* | *ip-address:nn* | **auto**}
- address-family ipv6 unicast**
- exit**
- neighbor** *ip-address* **remote-as** *as-number*

- ```

9. address-family ipv6 unicast
10. end
    or
    commit

```

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/0/CPU0:router# configure	Enters global configuration mode.
Step 2	router bgp <i>as-number</i> Example: RP/0/0/CPU0:router(config)# router bgp 100 RP/0/0/CPU0:router(config-bgp)#	Enters router BGP configuration mode.
Step 3	address-family vpnv6 unicast Example: RP/0/0/CPU0:router(config-bgp)# address-family vpnv6 unicast RP/0/0/CPU0:router(config-bgp-af)	Enters address family configuration mode for the VPNv6 address family.
Step 4	vrf <i>vrf-name</i> Example: RP/0/0/CPU0:router(config-bgp)# vrf red	Configures a VPN VRF instance and enters VRF configuration mode.
Step 5	rd { <i>as-number:nn</i> <i>ip-address:nn</i> auto }	Configures a route distinguisher.
	Example: RP/0/0/CPU0:router(config-bgp-vrf)# router bgp 100	
Step 6	address-family ipv6 unicast Example: RP/0/0/CPU0:router(config-bgp-vrf)# address-family ipv6 unicast	Enters IPv6 address family configuration mode.
Step 7	exit Example: RP/0/0/CPU0:router(config-bgp-vrf-af)# exit	Exits the current configuration mode.
Step 8	neighbor <i>ip-address</i> remote-as <i>as-number</i> Example: RP/0/0/CPU0:router(config-bgp-vrf)# neighbor 172.168.40.24 remote-as 2002f	Creates a neighbor and assigns it a remote autonomous system number.

Command or Action	Purpose
Step 9 <code>address-family ipv6 unicast</code> Example: RP/0/0/CPU0:router(config-bgp-vrf)# address-family ipv6 unicast	Enters IPv6 address family configuration mode.
Step 10 <code>end</code> or <code>commit</code> Example: RP/0/0/CPU0:router(config-vrf-af)# end or RP/0/0/CPU0:router(config-vrf-af)# commit	Saves configuration changes. <ul style="list-style-type: none"> When you issue the end command, the system prompts you to commit changes: Uncommitted changes found, commit them before exiting (yes/no/cancel)? [cancel]: <ul style="list-style-type: none"> Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring a PE-CE Protocol

Perform this task to configure a PE-CE protocol for 6VPE.



Note

eBGP, iBGP and eiBGP load-balancing configuration options are also supported for 6VPE.

SUMMARY STEPS

- configure**
- router bgp** *as-number*
- vrf** *vrf-name*
- address-family ipv6 unicast**
- exit**
- exit**
- neighbor** *ip-address*
- remote-as** *as-number*
- address-family vpnv6 unicast**

10. **route-policy** *route-policy-name* **in**
11. **end**
or
commit

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/0/CPU0:router# configure	Enters global configuration mode.
Step 2	router bgp <i>as-number</i> Example: RP/0/0/CPU0:router(config)# router bgp 120 RP/0/0/CPU0:router(config-bgp)	Enters router BGP configuration mode.
Step 3	vrf <i>vrf-name</i> Example: RP/0/0/CPU0:router(config-bgp)# vrf red RP/0/0/CPU0:router(config-bgp-vrf)	Configures a VPN VRF instance and enters VRF configuration mode.
Step 4	address-family ipv6 unicast Example: RP/0/0/CPU0:router(config-bgp-vrf) address-family ipv6 unicast RP/0/0/CPU0:router(config-bgp-vrf-af)	Enters IPv6 address family configuration mode.
Step 5	exit Example: RP/0/0/CPU0:router(config-bgp-vrf-af)# exit	Exits the current configuration mode.
Step 6	exit Example: RP/0/0/CPU0:router(config-bgp-vrf)# exit	Exits the current configuration mode.
Step 7	neighbor <i>ip-address</i> Example: RP/0/0/CPU0:router(config-bgp)# neighbor 10,10.10,10	Creates a neighbor and assigns it a remote autonomous system number of 2002.
Step 8	remote-as <i>as-number</i> Example: RP/0/0/CPU0:router(config-bgp-nbr)# remote-as 1000	Creates a BGP neighbor and begin the exchange of routing information.

	Command or Action	Purpose
Step 9	<p>address-family <i>vpn6</i> unicast</p> <p>Example: RP/0/0/CPU0:router(config-bgp-nbr)# address-family vpn6 unicast RP/0/0/CPU0:router(config-bgp-nbr-af)</p>	Enters address family configuration mode for the VPNv6 address family.
Step 10	<p>route-policy <i>route-policy-name</i> in</p> <p>Example: RP/0/0/CPU0:router(config-bgp-nbr-af)# route-policy In-Ipv4 in</p>	Applies a routing policy to updates advertised to or received from a BGP neighbor.
Step 11	<p>end OR commit</p> <p>Example: RP/0/0/CPU0:router(config-bgp-nbr-af)# end OR RP/0/0/CPU0:router(config-bgp-nbr-af)# commit</p>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> When you issue the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting (yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuration Examples for Implementing MPLS Layer 3 VPNs

The following section provides sample configurations for MPLS L3VPN features, including:

- [Configuring an MPLS VPN Using BGP: Example, page VPC-347](#)
- [Configuring the Routing Information Protocol on the PE Router: Example, page VPC-348](#)
- [Configuring the PE Router Using EIGRP: Example, page VPC-348](#)
- [Configuration Examples for MPLS VPN CSC, page VPC-348](#)
- [Configuration Examples for 6VPE, page VPC-350](#)

Configuring an MPLS VPN Using BGP: Example

The following example shows the configuration for an MPLS VPN using BGP on “vrf vpn1”:

```

address-family ipv4 unicast
  import route-target
    100:1
  !
  export route-target
    100:1
  !
!
!
route-policy pass-all
  pass
end-policy
!
interface Loopback0
  ipv4 address 10.0.0.1 255.255.255.255
!
interface gigabitEthernet 0/1/0/0
  vrf vpn1
  ipv4 address 10.0.0.2 255.0.0.0
!
interface gigabitEthernet 0/1/0/1
  ipv4 address 10.0.0.1 255.0.0.0
!
router ospf 100
  area 100
    interface loopback0
    interface gigabitEthernet 0/1/0/1
!
!
router bgp 100
  address-family vpnv4 unicast
  neighbor 10.0.0.3
    remote-as 100
    update-source Loopback0
  address-family vpnv4 unicast
!
vrf vpn1
  rd 100:1
  address-family ipv4 unicast
    redistribute connected
  !
  neighbor 10.0.0.1
    remote-as 200
    address-family ipv4 unicast
      as-override
      route-policy pass-all in
      route-policy pass-all out
  !
  advertisement-interval 5
!
!
!
mpls ldp
  route-id loopback0
  interface gigabitEthernet 0/1/0/1
!

```

Configuring the Routing Information Protocol on the PE Router: Example

The following example shows the configuration for the RIP on the PE router:

```
vrf vpn1
  address-family ipv4 unicast
    import route-target
      100:1
    !
    export route-target
      100:1
    !
  !
!
route-policy pass-all
  pass
end-policy
!

interface gigabitEthernet 0/1/0/0
  vrf vpn1
  ipv4 address 10.0.0.2 255.0.0.0
!

router rip
  vrf vpn1
  interface GigabitEthernet0/1/0/0
  !
  timers basic 30 90 90 120
  redistribute bgp 100
  default-metric 3
  route-policy pass-all in
!
```

Configuring the PE Router Using EIGRP: Example

The following example shows the configuration for the Enhanced Interior Gateway Routing Protocol (EIGRP) on the PE router:

```
Router eigrp 10
  vrf VRF1
  address-family ipv4
    router-id 10.1.1.2
    default-metric 100000 2000 255 1 1500
    as 62
    redistribute bgp 2000
  interface Loopback0
  !
  interface GigabitEthernet0/6/0/0
```

Configuration Examples for MPLS VPN CSC

Configuration examples for the MPLS VPN CSC include:

- [Configuring the Backbone Carrier Core: Examples, page VPC-349](#)
- [Configuring the Links Between CSC-PE and CSC-CE Routers: Examples, page VPC-349](#)
- [Configuring a Static Route to a Peer: Example, page VPC-350](#)

Configuring the Backbone Carrier Core: Examples

Configuration examples for the backbone carrier core included in this section are as follows:

- [Configuring VRFs for CSC-PE Routers: Example, page VPC-349](#)
- [Configuring the Links Between CSC-PE and CSC-CE Routers: Examples, page VPC-349](#)

Configuring VRFs for CSC-PE Routers: Example

The following example shows how to configure a VPN routing and forwarding instance (VRF) for a CSC-PE router:

```
config
vrf vpn1
  address-family ipv4 unicast
  import route-target 100:1
  export route-target 100:1
end
```

Configuring the Links Between CSC-PE and CSC-CE Routers: Examples

This section contains the following examples:

- [Configuring a CSC-PE: Example, page VPC-349](#)
- [Configuring a CSC-CE: Example, page VPC-349](#)

Configuring a CSC-PE: Example

In this example, a CSC-PE router peers with a PE router, 10.1.0.2, in its own AS. It also has a labeled unicast peering with a CSC-CE router, 10.0.0.1.

```
config
router bgp 2
  address-family vpnv4 unicast
  neighbor 10.1.0.2
  remote-as 2
  update-source loopback0
  address-family vpnv4 unicast
vrf customer-carrier
  rd 1:100
  address-family ipv4 unicast
  allocate-label all
  redistribute static
neighbor 10.0.0.1
  remote-as 1
  address-family ipv4 labeled-unicast
  route-policy pass-all in
  route-policy pass-all out
  as-override
end
```

Configuring a CSC-CE: Example

The following example shows how to configure a CSC-CE router. In this example, the CSC-CE router peers CSC-PE router 10.0.0.2 in AS 2.

```
config
router bgp 1
  address-family ipv4 unicast
```

```

        redistribute ospf 200
        allocate-label all
neighbor 10.0.0.2
    remote-as 2
    address-family ipv4 labeled-unicast
    route-policy pass-all in
    route-policy pass-all out
end

```

Configuring a Static Route to a Peer: Example

The following example shows how to configure a static route to an Inter-AS or CSC-CE peer:

```

config
router static
    address-family ipv4 unicast
    10.0.0.2/32 40.1.1.1
end

```

Configuration Examples for 6VPE

Configuration examples for the MPLS VPN CSC include:

- [Configuring an IPv6 Address Family Under VRF: Example, page VPC-350](#)
- [Configuring BGP for the Address Family VPNv6: Example, page VPC-350](#)
- [Configuring a PE-CE Protocol: Example, page VPC-351](#)
- [Configuring an Entire 6VPE Configuration: Example, page VPC-351](#)

Configuring an IPv6 Address Family Under VRF: Example

The following example shows a standard configuration of an IPv6 address family under VRF:

```

configure
vrf red
    address-family ipv6 unicast
    import route-target
    500:1
    !
    export route-target
    500:1
    !
    !

```

Configuring BGP for the Address Family VPNv6: Example

The following example shows the configuration for the address family VPNv6 under the PE peer:

```

configure
router bgp 3
    address-family vpnv6 unicast
    !
    neighbor 192.168.254.3
    remote-as 3
    update-source Loopback0
    address-family ipv4 unicast
    !
    address-family vpnv44 unicast

```

```

!
address-family ipv6 labeled-unicast
!
address-family vpnv6 unicast
!
!

```

Configuring the Address Family IPv6 for the VRF Configuration Under BGP: Example

The following example shows the configuration for the address family IPv6 for the VRF configuration under BGP:

```

!
vrf red
address-family ipv6 unicast
redistribute connected
!

```

Configuring a PE-CE Protocol: Example

The following example shows the eBGP configuration of a PE-CE protocol:

```

!
neighbor 2001:db80:cafe:1::2
remote-as 100
address-family ipv6 unicast
route-policy pass in
route-policy pass out

```

Configuring an Entire 6VPE Configuration: Example

Two VPNs, which are named red and blue, are created across router2 and router4. The VRF red is for the user running IPv6 addressing in the network. The VRF blue is for the user running IPv4 addressing. 6VPE is implemented to carry the VPNv6 prefixes across to the other PE.

The following example shows the entire 6VPE configuration that includes the interface and VRF configurations of both PE routers across the route reflectors:

```

router2 (PE router)
interface GigabitEthernet0/0/1/3.1
vrf red
ipv4 address 192.3.1.1 255.255.255.0
ipv6 address 2001:db80:cafe:1::1/64
dot1q vlan 2
!

show run interface gigabitEthernet 0/0/1/3.2
interface GigabitEthernet0/0/1/3.2
vrf blue
ipv4 address 192.3.2.1 255.255.255.0
dot1q vlan 3
!

vrf red
address-family ipv4 unicast
import route-target
500:1

```

```

!
export route-target
  500:1
!
!
address-family ipv6 unicast
import route-target
  500:1
!
export route-target
  500:1
!
!
!
vrf blue
address-family ipv4 unicast
import route-target
  600:1
!
export route-target
  600:1
!
!

router bgp 3
address-family ipv4 unicast
network 3.3.3.3/32
!
address-family vpnv4 unicast
!
address-family ipv6 unicast
network 2001:db82:cafe:1::/64
allocate-label all
!
address-family vpnv6 unicast
!
neighbor 192.168.253.4
remote-as 3
update-source Loopback0
address-family ipv4 unicast
!
address-family vpnv4 unicast
!
address-family ipv6 labeled-unicast
!
address-family vpnv6 unicast
!
!
neighbor 192.168.254.3
remote-as 3
update-source Loopback0
address-family ipv4 unicast
!
address-family vpnv4 unicast
!
address-family ipv6 labeled-unicast
!
address-family vpnv6 unicast
!
!
vrf red
rd 500:1
address-family ipv4 unicast

```

```

    redistribute connected
    !
    address-family ipv6 unicast
    redistribute connected
    !
    neighbor 2001:db80:cafe:1::2
    remote-as 100
    address-family ipv6 unicast
    route-policy pass in
    route-policy pass out
    !
    !
    !
    vrf blue
    rd 600:1
    address-family ipv4 unicast
    redistribute connected
    !
    !
    !

router3 (RR)

router bgp 3
  bgp router-id 192.168.253.4
  address-family ipv4 unicast
  !
  address-family vpv4 unicast
  !
  address-family ipv6 unicast
  !
  address-family vpv6 unicast
  !
  neighbor-group all
  remote-as 3
  update-source Loopback0
  address-family ipv4 unicast
  route-reflector-client
  !
  address-family vpv4 unicast
  route-reflector-client
  !
  address-family ipv6 labeled-unicast
  route-reflector-client
  !
  address-family vpv6 unicast
  route-reflector-client
  !
  !
  neighbor 192.168.253.1
  use neighbor-group all
  !
  neighbor 192.168.253.2
  use neighbor-group all
  !
  neighbor 192.168.253.3
  use neighbor-group all
  !
  neighbor 192.168.253.5
  use neighbor-group all
  !
  neighbor 192.168.253.6
  use neighbor-group all
```

```

!
neighbor 192.168.254.3
  remote-as 3
  update-source Loopback0
  address-family ipv4 unicast
!
!
!

router4(PE router)

vrf red
  address-family ipv4 unicast
  import route-target
    500:1
  !
  export route-target
    500:1
  !
  !
  address-family ipv6 unicast
  import route-target
    500:1
  !
  export route-target
    500:1
  !
  !
!
!
vrf blue
  address-family ipv4 unicast
  import route-target
    600:1
  !
  export route-target
    600:1
  !
  !
!
!

router bgp 3
  address-family ipv4 unicast
  !
  address-family vpnv4 unicast
  !
  address-family ipv6 unicast
  network 2001:db84:beef:1::/64
  allocate-label all
  !
  address-family vpnv6 unicast
  !
  neighbor 192.168.253.4
  remote-as 3
  update-source Loopback0
  address-family ipv4 unicast
  !
  address-family vpnv4 unicast
  !
  address-family ipv6 labeled-unicast
  !
  address-family vpnv6 unicast
  !
  !
!
!

```

```

neighbor 192.168.254.3
  remote-as 3
  update-source Loopback0
  address-family ipv4 unicast
  !
  address-family vpv4 unicast
  !
  address-family ipv6 labeled-unicast
  !
  !
vrf red
  rd 500:1
  address-family ipv4 unicast
    redistribute connected
  !
  address-family ipv6 unicast
    redistribute connected
  !
  !
vrf blue
  rd 600:1
  address-family ipv4 unicast
    redistribute connected
  !
  !
!
```

The following example displays the sample output for the entire 6VPE configuration:

```
show route vrf red ipv6
```

```

Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - ISIS, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, su - IS-IS summary null, * - candidate default
       U - per-user static route, o - ODR, L - local
```

Gateway of last resort is not set

```

C    2001:db80:beef:1::/64 is directly connected,
     19:09:50, GigabitEthernet0/0/1/3.1
L    2001:db80:beef:1::1/128 is directly connected,
     19:09:50, GigabitEthernet0/0/1/3.1
B    2001:db80:cafe:1::/64
     [200/0] via ::ffff:192.168.253.3 (nexthop in vrf default), 07:03:40
```

```
show route vrf red ipv6
```

```

Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - ISIS, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, su - IS-IS summary null, * - candidate default
       U - per-user static route, o - ODR, L - local
```

Gateway of last resort is not set

```

B    2001:db80:beef:1::/64
     [200/0] via ::ffff:192.168.253.6 (nexthop in vrf default), 07:04:14
C    2001:db80:cafe:1::/64 is directly connected,
```

```

08:28:12, GigabitEthernet0/0/1/3.1
L 2001:db80:cafe:1::1/128 is directly connected,
08:28:12, GigabitEthernet0/0/1/3.1

```

Additional References

For additional information, refer to the following documents:

Related Documents

Related Topic	Document Title
Cisco IOS XR L2VPN command reference document	<i>MPLS Virtual Private Network Commands on Cisco IOS XR Software module in Cisco IOS XR MPLS Configuration Guide</i>
Routing (BGP, EIGRP, OSPF, and RIP) commands: complete command syntax, command modes, command history, defaults, usage guidelines, and examples	<i>Cisco IOS XR Routing Command Reference</i>
Routing (BGP, EIGRP, OSPF, and RIP) configuration	<i>Cisco IOS XR Routing Configuration Guide</i>
MPLS LDP configuration: configuration concepts, task, and examples	<i>Implementing MPLS Label Distribution Protocol on Cisco IOS XR Software</i>
MPLS Traffic Engineering Resource Reservation Protocol configuration: configuration concepts, task, and examples	<i>Implementing RSVP for MPLS-TE and MPLS O-UNI on Cisco IOS XR Software module in Cisco IOS XR MPLS Command Reference</i>
Cisco CRS router getting started material	<i>Cisco IOS XR Getting Started Guide</i>
Information about user groups and task IDs	<i>Configuring AAA Services on Cisco IOS XR Software module in Cisco IOS XR System Security Configuration Guide</i>

Standards

Standards	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	—

MIBs

MIBs	MIBs Link
—	To locate and download MIBs using Cisco IOS XR software, use the Cisco MIB Locator found at the following URL and choose a platform under the Cisco Access Products menu: http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml

RFCs

RFCs	Title
RFC 1700	<i>Assigned Numbers</i>
RFC 1918	<i>Address Allocation for Private Internets</i>
RFC 1966	<i>BGP Route Reflectors: An Alternative to Full Mesh iBGP</i>
RFC 2283	<i>Multiprotocol Extensions for BGP-4</i>
RFC 2547	<i>BGP/MPLS VPNs</i>
RFC 2842	<i>Capabilities Advertisement with BGP-4</i>
RFC 2858	<i>Multiprotocol Extensions for BGP-4</i>
RFC 3107	<i>Carrying Label Information in BGP-4</i>

Technical Assistance

Description	Link
The Cisco Technical Support website contains thousands of pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/techsupport

