



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.

Feature History for Implementing MPLS Layer 3 VPNs

Release	Modification
Release 5.2.1	This feature was introduced.

- [Prerequisites for Implementing MPLS L3VPN, on page 1](#)
- [MPLS L3VPN Restrictions, on page 2](#)
- [Information About MPLS Layer 3 VPNs, on page 2](#)
- [How to Implement MPLS Layer 3 VPNs, on page 6](#)
- [Configuration Examples for Implementing MPLS Layer 3 VPNs, on page 30](#)

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 suspect user group assignment is preventing you from using a command, contact your AAA administrator for assistance.
- 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

- 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 non adjacent 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

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.

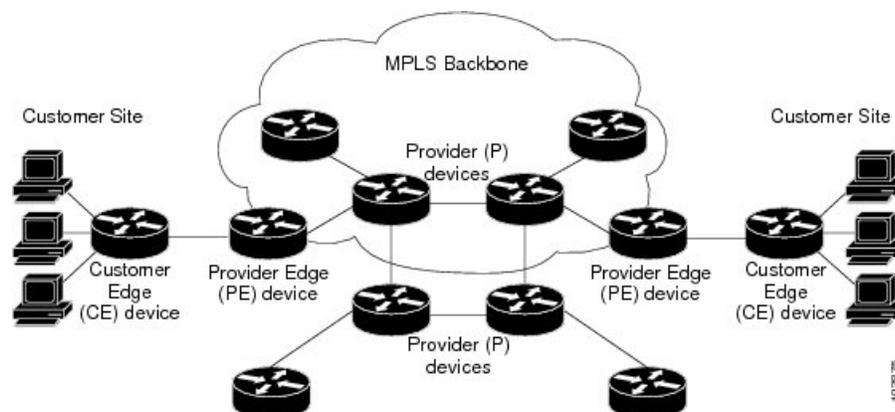
MPLS VPNs are easier to manage and expand than conventional VPNs. When a new site is added to an MPLS VPN, only the edge router of the service provider that provides services to the customer site needs to be updated.

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.

The following figure shows a basic MPLS VPN topology.

Figure 1: 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) 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. VRF is 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

How to Implement MPLS Layer 3 VPNs

This section contains instructions for the following tasks:

Configuring the Core Network

Configuring the core network includes the following tasks:

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

-
- Step 1** Identify the size of the network.
- Identify the following to determine the number of routers and ports required:
- 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 .

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* chapter in the *MPLS Configuration Guide for Cisco NCS 6000 Series Routers* for configuration information.
- MPLS Traffic Engineering Resource Reservation Protocol (RSVP)—See module in the *MPLS Configuration Guide for Cisco NCS 6000 Series Routers* 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* module in the *IP Addresses and Services Configuration Guide for Cisco NCS 6000 Series Routers*.

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. Use the **commit** or **end** command.

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
Enters the XR Config mode.
```

Step 2 **router bgp** *autonomous-system-number*

Example:

```
RP/0/RP0/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/RP0/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 ip-address remote-as** *autonomous-system-number*

Example:

```
RP/0/RP0/CPU0:router(config-bgp)# neighbor 172.168.40.24 remote-as 2002
```

Creates a neighbor and assigns it a remote autonomous system number.

Step 5 `address-family vpnv4 unicast` or `address-family vpnv6 unicast`

Example:

```
RP/0/RP0/CPU0:router(config-bgp-nbr)# address-family vpnv4 unicast
```

Enters VPNv4 or VPNv6 address family configuration mode for the VPNv4 or VPNv6 address family.

Step 6 Use the `commit` or `end` command.

commit - Saves the configuration changes and remains within the configuration session.

end - Prompts user to take one of these actions:

- **Yes** - Saves configuration changes and exits the configuration session.
- **No** - Exits the configuration session without committing the configuration changes.
- **Cancel** - Remains in the configuration mode, without committing the configuration changes.

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

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. Use the `commit` or `end` command.

DETAILED STEPS

Step 1 `configure`

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters XR Config mode.

Step 2 `vrf vrf-name`**Example:**

```
RP/0/RP0/CPU0:router(config)# vrf vrf_1
```

Configures a VRF instance and enters VRF configuration mode.

Step 3 `address-family ipv4 unicast`**Example:**

```
RP/0/RP0/CPU0:router(config-vrf)# address-family ipv4 unicast
```

Enters VRF address family configuration mode for the IPv4 address family.

Step 4 `import route-policy policy-name`**Example:**

```
RP/0/RP0/CPU0:router(config-vrf-af)# import route-policy policy_A
```

Specifies a route policy that can be imported into the local VPN.

Step 5 `import route-target [as-number:nn | ip-address:nn]`**Example:**

```
RP/0/RP0/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 policy-name`**Example:**

```
RP/0/RP0/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 [as-number:nn | ip-address:nn]`**Example:**

```
RP/0/RP0/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/RP0/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/RP0/CPU0:router(config-vrf)# exit
```

Exits VRF configuration mode and returns the router to XR Config mode.

Step 10 **router bgp** *autonomous-system-number***Example:**

```
RP/0/RP0/CPU0:router(config)# router bgp 120
```

Enters BGP configuration mode allowing you to configure the BGP routing process.

Step 11 **vrf** *vrf-name***Example:**

```
RP/0/RP0/CPU0:router(config-bgp)# vrf vrf_1
```

Configures a VRF instance and enters VRF configuration mode for BGP routing.

Step 12 **rd** { *as-number* | *ip-address* | **auto** }**Example:**

```
RP/0/RP0/CPU0:router(config-bgp-vrf)# rd auto
```

Automatically assigns a unique route distinguisher (RD) to vrf_1.

Step 13 Use the **commit** or **end** command.

commit - Saves the configuration changes and remains within the configuration session.

end - Prompts user to take one of these actions:

- **Yes** - Saves configuration changes and exits the configuration session.
- **No** - Exits the configuration session without committing the configuration changes.
- **Cancel** - Remains in the configuration mode, without committing the configuration changes.

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. Use the **commit** or **end** command.

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters XR Config mode.

Step 2 **interface** *type interface-path-id*

Example:

```
RP/0/RP0/CPU0:router(config)# interface TenGigE 0/3/0/0
```

Enters interface configuration mode.

Step 3 **vrf** *vrf-name*

Example:

```
RP/0/RP0/CPU0:router(config-if)# vrf vrf_A
```

Configures a VRF instance and enters VRF configuration mode.

Step 4 **ipv4 address** *ipv4-address mask*

Example:

```
RP/0/RP0/CPU0:router(config-if)# ipv4 address 192.168.1.27 255.255.255.0
```

Configures a primary IPv4 address for the specified interface.

Step 5 Use the **commit** or **end** command.

commit - Saves the configuration changes and remains within the configuration session.

end - Prompts user to take one of these actions:

- **Yes** - Saves configuration changes and exits the configuration session.
- **No** - Exits the configuration session without committing the configuration changes.
- **Cancel** - Remains in the configuration mode, without committing the configuration changes.

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. **address-family ipv4 unicast**
6. **label mode per-ce**
7. Do one of the following:
 - **redistribute connected** [**metric** *metric-value*] [**route-policy** *route-policy-name*]
 - **redistribute ospf** *process-id* [**match** { **external** [**1** | **2**] | **internal** | **nssa-external** [**1** | **2**] }] [**metric** *metric-value*] [**route-policy** *route-policy-name*]
 - **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** [*ttl-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. Use the **commit** or **end** command.

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters XR Config mode.

Step 2 **router bgp** *autonomous-system-number*

Example:

```
RP/0/RP0/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** {*ip-address*}

Example:

```
RP/0/RP0/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** *vrf-name*

Example:

```
RP/0/RP0/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 **address-family ipv4 unicast**

Example:

```
RP/0/RP0/CPU0:router(config-bgp-vrf)# address-family ipv4 unicast
```

Enters VRF address family configuration mode for the IPv4 address family.

Step 6 **label mode per-ce**

Example:

```
RP/0/RP0/CPU0:router(config-bgp-vrf-af)# label 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 7 Do one of the following:

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

Example:

```
RP/0/RP0/CPU0:router(config-bgp-vrf-af)# redistribute connected
```

Causes routes to be redistributed into BGP. The routes that can be redistributed into BGP are:

- Connected
- Intermediate System-to-Intermediate System (IS-IS)
- Open Shortest Path First (OSPF)
- Static

Step 8 **aggregate-address** *address/mask-length* [**as-set**] [**as-confed-set**] [**summary-only**] [**route-policy** *route-policy-name*]

Example:

```
RP/0/RP0/CPU0:router(config-bgp-vrf-af)# aggregate-address 10.0.0.0/8 as-set
```

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.

- 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** *route-policy-name* keyword and argument specify the route policy used to set the attributes of the aggregate route.

Step 9 **network** {*ip-address/prefix-length* | *ip-address mask* } [**route-policy** *route-policy-name*]

Example:

```
RP/0/RP0/CPU0:router(config-bgp-vrf-af)# network 172.20.0.0/16
```

Configures the local router to originate and advertise the specified network.

Step 10 **exit**

Example:

```
RP/0/RP0/CPU0:router(config-bgp-vrf-af)# exit
```

Exits VRF address family configuration mode and returns the router to VRF configuration mode for BGP routing.

Step 11 **neighbor** *ip-address*

Example:

```
RP/0/RP0/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** *autonomous-system-number*

Example:

```
RP/0/RP0/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** } *password*

Example:

```
RP/0/RP0/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** [*ttl-value*]

Example:

```
RP/0/RP0/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/RP0/CPU0:router(config-bgp-vrf-nbr)# address-family ipv4 unicast
```

Enters VRF neighbor address family configuration mode for BGP routing.

Step 16 **allowas-in** [*as-occurrence-number*]

Example:

```
RP/0/RP0/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** *route-policy-name* **in**

Example:

```
RP/0/RP0/CPU0:router(config-bgp-vrf-nbr-af)# route-policy In-Ipv4 in
```

Applies the In-Ipv4 policy to inbound IPv4 unicast routes.

Step 18 **route-policy** *route-policy-name* **out**

Example:

```
RP/0/RP0/CPU0:router(config-bgp-vrf-nbr-af)# route-policy In-Ipv4 in
```

Applies the In-Ipv4 policy to outbound IPv4 unicast routes.

Step 19 Use the **commit** or **end** command.

commit - Saves the configuration changes and remains within the configuration session.

end - Prompts user to take one of these actions:

- **Yes** - Saves configuration changes and exits the configuration session.
- **No** - Exits the configuration session without committing the configuration changes.
- **Cancel** - Remains in the configuration mode, without committing the configuration changes.

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

1. **configure**
2. **router rip**
3. **vrf** *vrf-name*
4. **interface** *type instance*
5. **site-of-origin** { *as-number : number* | *ip-address : number* }
6. **exit**
7. Do one of the following:
 - **redistribute bgp** *as-number* [[**external** | **internal** | **local**] [**route-policy** *name*]
 - **redistribute connected** [**route-policy** *name*]
 - **redistribute isis** *process-id* [**level-1** | **level-1-2** | **level-2**] [**route-policy** *name*]
 - **redistribute eigrp** *as-number* [**route-policy** *name*]
 - **redistribute ospf** *process-id* [**match** { **external** [**1** | **2**] | **internal** | **nssa-external** [**1** | **2**] }] [**route-policy** *name*]
 - **redistribute static** [**route-policy** *name*]
8. Use the **commit** or **end** command.

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters XR Config mode.

Step 2 **router rip**

Example:

```
RP/0/RP0/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/RP0/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/RP0/CPU0:router(config-rip-vrf)# interface TenGigE 0/3/0/0
```

Enters VRF interface configuration mode.

Step 5 **site-of-origin** { *as-number : number* | *ip-address : number* }

Example:

```
RP/0/RP0/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/RP0/CPU0:router(config-rip-vrf-if)# exit
```

Exits VRF interface configuration mode, and returns the router to VRF configuration mode for RIP routing.

Step 7 Do one of the following:

- **redistribute bgp** *as-number* [[**external** | **internal** | **local**] [**route-policy name**]
- **redistribute connected** [**route-policy name**]
- **redistribute isis** *process-id* [**level-1** | **level-1-2** | **level-2**] [**route-policy name**]
- **redistribute eigrp** *as-number* [**route-policy name**]
- **redistribute ospf** *process-id* [**match** { **external** [**1** | **2**] | **internal** | **nssa-external** [**1** | **2**] }] [**route-policy name**]
- **redistribute static** [**route-policy name**]

Example:

```
RP/0/RP0/CPU0:router(config-rip-vrf)# redistribute connected
```

Causes routes to be redistributed into RIP. The routes that can be redistributed into RIP are:

- Border Gateway Protocol (BGP)
- Connected
- Enhanced Interior Gateway Routing Protocol (EIGRP)
- Intermediate System-to-Intermediate System (IS-IS)
- Open Shortest Path First (OSPF)
- Static

Step 8 Use the **commit** or **end** command.

commit - Saves the configuration changes and remains within the configuration session.

end - Prompts user to take one of these actions:

- **Yes** - Saves configuration changes and exits the configuration session.
- **No** - Exits the configuration session without committing the configuration changes.
- **Cancel** - Remains in the configuration mode, without committing the configuration changes.

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. Use the **commit** or **end** command.

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters XR Config mode.

Step 2 **router static**

Example:

```
RP/0/RP0/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/RP0/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/RP0/CPU0:router(config-static-vrf)# address-family ipv4 unicast
```

Enters VRF address family configuration mode for the IPv4 address family.

Step 5 `prefix/mask [vrf vrf-name] { ip-address | type interface-path-id }`

Example:

```
RP/0/RP0/CPU0:router(config-static-vrf-afi)# 172.168.40.24/24 vrf vrf_1 10.1.1.1
```

Assigns the static route to vrf_1.

Step 6 `prefix/mask [vrf vrf-name] bfd fast-detect`

Example:

```
RP/0/RP0/CPU0:router(config-static-vrf-afi)# 172.168.40.24/24 vrf vrf_1 bfd fast-detect
```

Enables bidirectional forwarding detection (BFD) to detect failures in the path between adjacent forwarding engines.

This option is available is when the forwarding router address is specified in Step 5 .

Step 7 Use the **commit** or **end** command.

commit - Saves the configuration changes and remains within the configuration session.

end - Prompts user to take one of these actions:

- **Yes** - Saves configuration changes and exits the configuration session.
- **No** - Exits the configuration session without committing the configuration changes.
- **Cancel** - Remains in the configuration mode, without committing the configuration changes.

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

1. **configure**
2. **router ospf** *process-name*
3. **vrf** *vrf-name*
4. **router-id** {*router-id* | type interface-path-id}
5. Do one of the following:
 - **redistribute bgp** *process-id* [**metric** *metric-value*] [**metric-type** {1 | 2}] [**route-policy** *policy-name*] [**tag** *tag-value*]
 - **redistribute connected** [**metric** *metric-value*] [**metric-type** {1 | 2}] [**route-policy** *policy-name*] [**tag** *tag-value*]
 - **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*]
 - **redistribute static** [**metric** *metric-value*] [**metric-type** {1 | 2}] [**route-policy** *policy-name*] [**tag** *tag-value*]
 - **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*]
 - **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. Use the **commit** or **end** command.

DETAILED STEPS**Step 1** **configure****Example:**

```
RP/0/RP0/CPU0:router# configure
```

Enters XR Config mode.

Step 2 **router ospf** *process-name***Example:**

```
RP/0/RP0/CPU0:router(config)# router ospf 109
```

Enters OSPF configuration mode allowing you to configure the OSPF routing process.

Step 3 **vrf** *vrf-name***Example:**

```
RP/0/RP0/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** {*router-id* | type interface-path-id}

Example:

```
RP/0/RP0/CPU0:router(config-ospf-vrf)# router-id 172.20.10.10
```

Configures the router ID for the OSPF routing process.

Step 5 Do one of the following:

- **redistribute bgp** *process-id* [**metric** *metric-value*] [**metric-type** {1 | 2}] [**route-policy** *policy-name*] [**tag** *tag-value*]
- **redistribute connected** [**metric** *metric-value*] [**metric-type** {1 | 2}] [**route-policy** *policy-name*] [**tag** *tag-value*]
- **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*]
- **redistribute static** [**metric** *metric-value*] [**metric-type** {1 | 2}] [**route-policy** *policy-name*] [**tag** *tag-value*]
- **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*]
- **redistribute rip** [**metric** *metric-value*] [**metric-type** {1 | 2}] [**route-policy** *policy-name*] [**tag** *tag-value*]

Example:

```
RP/0/RP0/CPU0:router(config-ospf-vrf)# redistribute connected
```

Causes routes to be redistributed into OSPF. The routes that can be redistributed into OSPF are:

- Border Gateway Protocol (BGP)
- Connected
- Enhanced Interior Gateway Routing Protocol (EIGRP)
- OSPF
- Static
- Routing Information Protocol (RIP)

Step 6 **area** *area-id*

Example:

```
RP/0/RP0/CPU0:router(config-ospf-vrf)# area 0
```

Configures the OSPF area as area 0.

Step 7 **interface** type interface-path-id

Example:

```
RP/0/RP0/CPU0:router(config-ospf-vrf-ar)# interface TenGigE 0/3/0/0
```

Associates interface TenGigE 0/3/0/0 with area 0.

Step 8 Use the **commit** or **end** command.

commit - Saves the configuration changes and remains within the configuration session.

end - Prompts user to take one of these actions:

- **Yes** - Saves configuration changes and exits the configuration session.

- **No** - Exits the configuration session without committing the configuration changes.
- **Cancel** - Remains in the configuration mode, without committing the configuration changes.

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.

Before you begin

BGP is configured in the network. See the *Implementing BGP* module in the *Routing Configuration Guide for Cisco NCS 6000 Series 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. **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** | **ospf** | **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. Use the **commit** or **end** command.

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters XR Config mode.

Step 2 **router eigrp** *as-number*

Example:

```
RP/0/RP0/CPU0:router(config)# router eigrp 24
```

Enters EIGRP configuration mode allowing you to configure the EIGRP routing process.

Step 3 **vrf vrf-name****Example:**

```
RP/0/RP0/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/RP0/CPU0:router(config-eigrp-vrf)# address family ipv4
```

Enters VRF address family configuration mode for the IPv4 address family.

Step 5 **router-id router-id****Example:**

```
RP/0/RP0/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.

Step 6 **autonomous-system as-number****Example:**

```
RP/0/RP0/CPU0:router(config-eigrp-vrf-af)# autonomous-system 6
```

Configures the EIGRP routing process to run within a VRF.

Step 7 **default-metric bandwidth delay reliability loading mtu****Example:**

```
RP/0/RP0/CPU0:router(config-eigrp-vrf-af)# default-metric 100000 4000 200 45 4470
```

Sets the metrics for an EIGRP.

Step 8 **redistribute { { bgp | connected | isis | ospf | rip | static } [as-number | instance-name] } [route-policy name]****Example:**

```
RP/0/RP0/CPU0:router(config-eigrp-vrf-af)# redistribute connected
```

Causes connected routes to be redistributed into EIGRP.

Step 9 `interface type interface-path-id`

Example:

```
RP/0/RP0/CPU0:router(config-eigrp-vrf-af)# interface TenGigE 0/3/0/0
```

Associates interface TenGigE 0/3/0/0 with the EIGRP routing process.

Step 10 `site-of-origin { as-number:number | ip-address : number }`

Example:

```
RP/0/RP0/CPU0:router(config-eigrp-vrf-af-if)# site-of-origin 201:1
```

Configures site of origin (SoO) on interface TenGigE 0/3/0/0.

Step 11 Use the **commit** or **end** command.

commit - Saves the configuration changes and remains within the configuration session.

end - Prompts user to take one of these actions:

- **Yes** - Saves configuration changes and exits the configuration session.
- **No** - Exits the configuration session without committing the configuration changes.
- **Cancel** - Remains in the configuration mode, without committing the configuration changes.

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.

Before you begin

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* module in the *Routing Configuration Guide for Cisco NCS 6000 Series Routers*.



Restriction

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. Use the **commit** or **end** command.

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters XR Config mode.

Step 2 **router eigrp** *as-number*

Example:

```
RP/0/RP0/CPU0:router(config)# router eigrp 24
```

Enters EIGRP configuration mode allowing you to configure the EIGRP routing process.

Step 3 **vrf** *vrf-name*

Example:

```
RP/0/RP0/CPU0:router(config-eigrp)# vrf vrf_1
```

Configures a VRF instance and enters VRF configuration mode for EIGRP routing.

Step 4 **address-family ipv4**

Example:

```
RP/0/RP0/CPU0:router(config-eigrp-vrf)# address family ipv4
```

Enters VRF address family configuration mode for the IPv4 address family.

Step 5 **redistribute bgp** [*as-number*] [**route-policy** *policy-name*]

Example:

```
RP/0/RP0/CPU0:router(config-eigrp-vrf-af)# redistribute bgp 24 route-policy policy_A
```

Causes Border Gateway Protocol (BGP) routes to be redistributed into EIGRP.

Step 6 Use the **commit** or **end** command.

commit - Saves the configuration changes and remains within the configuration session.

end - Prompts user to take one of these actions:

- **Yes** - Saves configuration changes and exits the configuration session.
- **No** - Exits the configuration session without committing the configuration changes.

- **Cancel** - Remains in the configuration mode, without committing the configuration changes.

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 vrf** *vrf-name*
15. **show bgp vrf** *vrf-name imported-routes*
16. **show route vrf** *vrf-name ip-address*
17. **show cef vrf** *vrf-name ip-address*
18. **show cef vrf** *vrf-name ip-address location node-id*
19. **show bgp vrf** *vrf-name ip-address*
20. **show ospf vrf** *vrf-name database*

DETAILED STEPS

Step 1 **show running-config router bgp** *as-number vrf vrf-name*

Example:

```
RP/0/RP0/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 **show running-config routes**

Example:

```
RP/0/RP0/CPU0:router# show running-config routes
```

Displays the Open Shortest Path First (OSPF) routes table in the currently running configuration.

Step 3 **show ospf vrf *vrf-name* database****Example:**

```
RP/0/RP0/CPU0:router# show ospf vrf vrf_A database
```

Displays lists of information related to the OSPF database for a specified VRF.

Step 4 **show running-config router bgp *as-number* vrf *vrf-name* neighbor *ip-address*****Example:**

```
RP/0/RP0/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 **show bgp vrf *vrf-name* summary****Example:**

```
RP/0/RP0/CPU0:router# show bgp vrf vrf_A summary
```

Displays the status of the specified BGP VRF connections.

Step 6 **show bgp vrf *vrf-name* neighbors *ip-address*****Example:**

```
RP/0/RP0/CPU0:router# show bgp vrf vrf_A neighbors 172.168.40.24
```

Displays information about BGP VRF connections to the specified neighbors.

Step 7 **show bgp vrf *vrf-name*****Example:**

```
RP/0/RP0/CPU0:router# show bgp vrf vrf_A
```

Displays information about a specified BGP VRF.

Step 8 **show route vrf *vrf-name* *ip-address*****Example:**

```
RP/0/RP0/CPU0:router# show route vrf vrf_A 10.0.0.0
```

Displays the current routes in the Routing Information Base (RIB) for a specified VRF.

Step 9 **show bgp vpn unicast summary****Example:**

```
RP/0/RP0/CPU0:router# show bgp vpn unicast summary
```

Displays the status of all BGP VPN unicast connections.

Step 10 **show running-config router isis****Example:**

```
RP/0/RP0/CPU0:router# show running-config router isis
```

Displays the Intermediate System-to-Intermediate System (IS-IS) content of the currently running configuration.

Step 11 **show running-config mpls****Example:**

```
RP/0/RP0/CPU0:router# show running-config mpls
```

Displays the MPLS content of the currently running-configuration.

Step 12 **show isis adjacency****Example:**

```
RP/0/RP0/CPU0:router# show isis adjacency
```

Displays IS-IS adjacency information.

Step 13 **show mpls ldp forwarding****Example:**

```
RP/0/RP0/CPU0:router# show mpls ldp forwarding
```

Displays the Label Distribution Protocol (LDP) forwarding state installed in MPLS forwarding.

Step 14 **show bgp vpnv4 unicast** or **show bgp vrf *vrf-name*****Example:**

```
RP/0/RP0/CPU0:router# show bgp vpnv4 unicast
```

Displays entries in the BGP routing table for VPNv4 or VPNv6 unicast addresses.

Step 15 **show bgp vrf *vrf-name* imported-routes****Example:**

```
RP/0/RP0/CPU0:router# show bgp vrf vrf_A imported-routes
```

Displays BGP information for routes imported into specified VRF instances.

Step 16 **show route vrf *vrf-name* ip-address****Example:**

```
RP/0/RP0/CPU0:router# show route vrf vrf_A 10.0.0.0
```

Displays the current specified VRF routes in the RIB.

Step 17 **show cef vrf** *vrf-name ip-address*

Example:

```
RP/0/RP0/CPU0:router# show cef vrf vrf_A 10.0.0.1
```

Displays the IPv4 Cisco Express Forwarding (CEF) table for a specified VRF.

Step 18 **show cef vrf** *vrf-name ip-address location node-id*

Example:

```
RP/0/RP0/CPU0:router# show cef vrf vrf_A 10.0.0.1 location 0/1/cpu0
```

Displays the IPv4 CEF table for a specified VRF and location.

Step 19 **show bgp vrf** *vrf-name ip-address*

Example:

```
RP/0/RP0/CPU0:router# show bgp vrf vrf_A 10.0.0.0
```

Displays entries in the BGP routing table for VRF vrf_A.

Step 20 **show ospf vrf** *vrf-name database*

Example:

```
RP/0/RP0/CPU0:router# show ospf vrf vrf_A database
```

Displays lists of information related to the OSPF database for a specified VRF.

Configuration Examples for Implementing MPLS Layer 3 VPNs

The following section provides sample configurations for MPLS L3VPN features:

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 TenGigE 0/1/0/0
  vrf vpn1
  ipv4 address 10.0.0.2 255.0.0.0
!
interface TenGigE 0/1/0/1
  ipv4 address 10.0.0.1 255.0.0.0
!
router ospf 100
  area 100
    interface loopback0
    interface TenGigE 0/1/0/1
!
!
router bgp 100
  address-family vpnv4 unicast
  retain route-target route-policy policy1
  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 TenGigE 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 TenGigE 0/1/0/0  
  vrf vpn1  
  ipv4 address 10.0.0.2 255.0.0.0  
!  
  
router rip  
  vrf vpn1  
  interface TenGigE 0/1/0/0  
  !  
  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 TenGigE 0/6/0/0
```