# Implementing MPLS VPNs over IP Tunnels

The MPLS VPNs over IP Tunnels feature lets you deploy Layer 3 Virtual Private Network (L3VPN) services, over an IP core network, using L2TPv3 multipoint tunneling instead of MPLS. This allows L2TPv3 tunnels to be configured as multipoint tunnels to transport IP VPN services across the core IP network.

**Feature History for Implementing MPLS VPNs over IP Tunnels on Cisco IOS XR**

| Release | Modification |
|---|---|
| Release 3.5.0 | This feature was introduced. |
| Release 3.8.0 | The Multiple Tunnel Source Address feature was supported. |



# Prerequisites for Configuring MPLS VPNs over IP Tunnels

The following prerequisites are required to implement MPLS VPNs over IP Tunnels:

- 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

# Restrictions for Configuring MPLS VPNs over IP Tunnels

The following restriction applies when you configure MPLS VPNs over IP tunnels:

- MPLS forwarding cannot be enabled on a provider edge (PE) router.

# Information About MPLS VPNs over IP Tunnels

To implement MPLS VPNs over IP Tunnels, you must understand the following concepts:

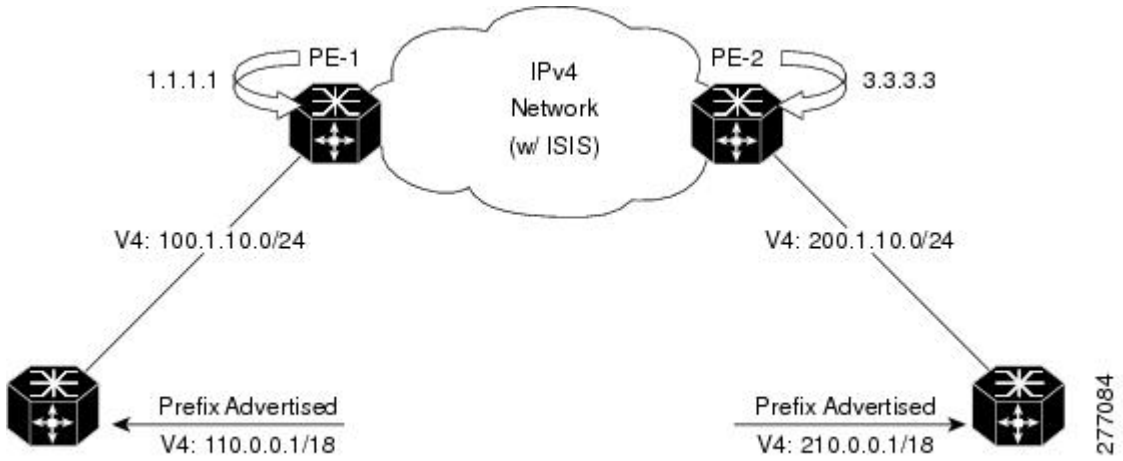
## Overview: MPLS VPNs over IP Tunnels

Traditionally, VPN services are deployed over IP core networks using MPLS, *or* L2TPv3 tunnels using point-to-point links. However, an L2TPv3 multipoint tunnel network allows L3VPN services to be carried through the core without the configuration of MPLS.

L2TPv3 multipoint tunneling supports multiple tunnel endpoints, which creates a full-mesh topology that requires only one tunnel to be configured on each PE router. This permits VPN traffic to be carried from enterprise networks across cooperating service provider core networks to remote sites.

The following figure below illustrates the topology used for the configuration steps.

***Figure 1: Basic MPLS VPN over IP Topology***



# Advertising Tunnel Type and Tunnel Capabilities Between PE Routers—BGP

Border Gateway Protocol (BGP) is used to advertise the tunnel endpoints and the subaddress family identifier (SAFI) specific attributes (which contains the tunnel type, and tunnel capabilities). This feature introduces the tunnel SAFI and the BGP SAFI-Specific Attribute (SSA) attribute.

These attributes allow BGP to distribute tunnel encapsulation information between PE routers. VPNv4 traffic is routed through these tunnels. The next hop, advertised in BGP VPNv4 updates, determines which tunnel to use for routing tunnel traffic.

### SAFI

The tunnel SAFI defines the tunnel endpoint and carries the endpoint IPv4 address and next hop. It is identified by the SAFI number 64.

### BGP SSA

The BGP SSA carries the BGP preference and BGP flags. It also carries the tunnel cookie, tunnel cookie length, and session ID. It is identified by attribute number 19.

# PE Routers and Address Space

One multipoint L2TPv3 tunnel must be configured on each PE router. To create the VPN, you must configure a unique Virtual Routing and Forwarding (VRF) instance. The tunnel that transports the VPN traffic across the core network resides in its own address space.

# Packet Validation Mechanism

The MPLS VPNs over IP Tunnels feature provides a simple mechanism to validate received packets from appropriate peers. The multipoint L2TPv3 tunnel header is automatically configured with a 64-bit cookie and L2TPv3 session ID. This packet validation mechanism protects the VPN from illegitimate traffic sources. The cookie and session ID are not user-configurable, but they are visible in the packet as it is routed between the two tunnel endpoints. Note that this packet validation mechanism does not protect the VPN from hackers who are able to monitor legitimate traffic between PE routers.

# Quality of Service Using the Modular QoS CLI

To configure the bandwidth on the encapsulation and decapsulation interfaces, use the modular QoS CLI (MQC).

**Note** This task is optional.

Use the MQC to configure the IP precedence or Differentiated Services Code Point (DSCP) value set in the IP carrier header during packet encapsulation. To set these values, enter a standalone **set** command or a **police** command using the keyword **tunnel**. In the input policy on the encapsulation interface, you can set the precedence or DSCP value in the IP payload header by using MQC commands without the keyword **tunnel**.

**Note** You must attach a QoS policy to the physical interface—*not* to the tunnel interface.

If Modified Deficit Round Robin (MDRR)/Weighted Random Early Detection (WRED) is configured for the encapsulation interface in the input direction, the final value of the precedence or DSCP field in the IP carrier header is used to determine the precedence class for which the MDRR/WRED policy is applied. On the decapsulation interface in the input direction, you can configure a QoS policy based on the precedence or DSCP value in the IP carrier header of the received packet. In this case, an MQC policy with a class to match on precedence or DSCP value will match the precedence or DSCP value in the received IP carrier header. Similarly, the precedence class for which the MDRR/WRED policy is applied on the decapsulation input direction is also determined by precedence or DSCP value in the IP carrier header.

# BGP Multipath Load Sharing for MPLS VPNs over IP Tunnels

BGP Multipath Load Sharing for EBGP and IBGP lets you configure multipath load balancing with both external BGP and internal BGP paths in BGP networks that are configured to use MPLS VPNs. (When faced with multiple routes to the same destination, BGP chooses the best route for routing traffic toward the destination so that no individual router is overburdened.)

BGP Multipath Load Sharing is useful for multihomed autonomous systems and PE routers that import both EBGP and IBGP paths from multihomed and stub networks.

# Inter-AS over IP Tunnels

The L3VPN Inter-AS feature provides a method of interconnecting VPNs between different VPN service providers. Inter-AS supports connecting different VPN service providers to provide native IP L3VPN services. For more information about Inter-AS, see Implementing MPLS VPNs over IP Tunnels.

**Note** The Cisco CRS-1 router supports only the Inter-AS option A.

# Multiple Tunnel Source Address

Currently, L2TPv3 tunnel encapsulation transports the VPN traffic across the IP core network between PEs with a /32 loopback addresses of PEs, and ingress PE uses a single /32 loopback address as the source IP address of tunnel encapsulation. This results in an imbalance on the load. In order to achieve load balance in the core, the ingress PE sends the VPN traffic with the source IP address of a L2TPv3 tunnel header taken from the pool for a /28 IP address instead of a single /32 address. This is called the Multiple Tunnel Source Address.

To support the /28 IP address, a keyword **source-pool** is used as an optional configuration command for the tunnel template. This keyword is located in the source address configuration. The source address is published to remote PEs through the BGP's tunnel SAFI messages.

Once the optional source-pool address is configured, it is sent to the forwarding information base (FIB). FIB uses a load balancing algorithm to get one address from the pool, and uses that address to call the tunnel infra DLL API to construct the tunnel encapsulation string.

The Multiple Tunnel Source Address infrastructure uses two primary models:

### Tunnel MA

The Tunnel MA tunnel is used for the tunnel-template configuration and communicating with the BGP. It supports the /28 IP address by performing these basic tasks:

- Verifies and applies the /28 address pool configuration
- Extends the tunnel information to include the new address pool
- Sends the address pool information to Tunnel EA through the data path control (DPC)

**Note** Sending the address pool information to BGP is not mandatory.

### Tunnel EA

Tunnel EA sends the address pool information to FIB and also supports the /28 IP address by performing these basic tasks:

- Processes the address pool information in the DPC from tunnel MA
- Saves the address pool information in the tunnel IDB in EA
- Sends the source address pool information to FIB

# 6PE/6VPE over L2TPv3

The 6PE/6VPE over L2TPv3 feature supports native IPv6 (6PE) and IPv6 VPN services (6VPE) (described in RFC 2547) over L2TPv3 tunnels across an IPv4 core network. The 6PE/6VPE over L2TPv3 feature is supported for label, IPv6 VPN (6VPE) and 6PE traffic.

When an IP VPN service is deployed, VPN traffic is typically transported across the core network between service provider edge routers (PEs) using MPLS label switched paths (LSPs).

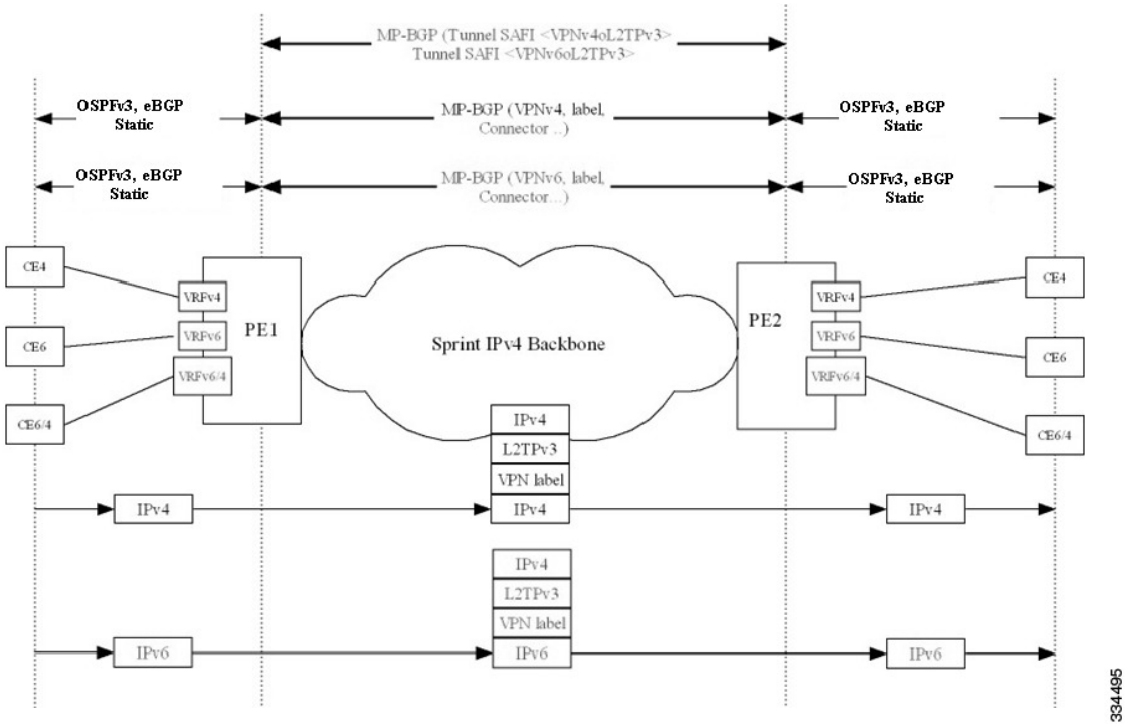
Native IP Layer 3 VPNs (based on generalized RFC 2547) eliminate the need for MPLS between the participating core routers by implementing L2TPv3 tunnel encapsulation over IP. Such tunnels may be used to transport VPN traffic between participating edge routers.

The 6VPE over L2TPv3 feature uses IPv6 VRFs, and the multi-protocol BGP advertises VPNv6 service advertisement framework (SAF) or advertisement framework (AF) between PE routers. The customer edge IPv6 VPN packets are transported across the provider's IP backbone. Additionally, the customer edge IPv6 VPN packets employ the same encapsulation (L2TPv3 + IPv4 delivery header) as is currently supported in L2TPv3 for IPv4 VPN services.

The following figure depicts the key elements that are used to extend multi-protocol BGP to distribute VPNv6 prefixes along with the appropriate next hop (IPv4 address) and tunnel attributes. The data encapsulations remain the same except that the payload is now an IPv6 packet.

For more information on configuring L2TPv3, see the Implementing Layer 2 Tunnel Protocol Version 3 module.

***Figure 2: IPv4/6VPE over L2TPv3***




# How to Configure MPLS VPNs over IP Tunnels

The following procedures are required to configure MPLS VPN over IP:

**Note** All procedures occur on the local PE (PE1). Corresponding procedures must be configured on the remote PE (PE2).

## Configuring the Global VRF Definition

Perform this task to configure the global VRF definition.

## SUMMARY STEPS

1. **configure**
2. **vrf** *vrf-name*
3. **address-family ipv4 unicast**
4. **import route-target [***0-65535.0-65535:0-65535* | *as-number:nn* | *ip-address:nn*]
5. **export route-target [***0-65535.0-65535:0-65535* | *as-number:nn* | *ip-address:nn*]
6. **exit**
7. **address-family ipv6 unicast**
8. **import route-target [***0-65535.0-65535:0-65535* | *as-number:nn* | *ip-address:nn*]
9. **export route-target [***0-65535.0-65535:0-65535* | *as-number:nn* | *ip-address:nn*]
10. Use the **commit** or **end** command.

## DETAILED STEPS

**Step 1** **configure**

**Example:**
```
RP/0/RP0/CPU0:router# configure
```
Enters the Global Configuration mode.

**Step 2** **vrf** *vrf-name*

**Example:**

```
RP/0/RP0/CPU0:router(config)# vrf vrf-name
```
Specifies a name assigned to a VRF.

**Step 3** **address-family ipv4 unicast**

**Example:**

```
RP/0/RP0/CPU0:router(config-vrf)# address-family ipv4 unicast
```
Specifies an IPv4 address-family address.

**Step 4** **import route-target [***0-65535.0-65535:0-65535* | *as-number:nn* | *ip-address:nn*]

**Example:**

```
RP/0/RP0/CPU0:router(config-vrf-af)# import route-target 500:99
```
Configures a VPN routing and forwarding (VRF) import route-target extended community.

**Step 5** **export route-target [***0-65535.0-65535:0-65535* | *as-number:nn* | *ip-address:nn*]

**Example:**

```
RP/0/RP0/CPU0:router(config-vrf-af)# export route-target 700:44
```
Configures a VPN routing and forwarding (VRF) export route-target extended community.

**Step 6** **exit**

**Example:**

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

Exits interface configuration mode.

**Step 7** **address-family ipv6 unicast**

**Example:**

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

Specifies an IPv4 address-family address.

**Step 8** **import route-target [***0-65535.0-65535:0-65535* | *as-number:nn* | *ip-address:nn*]

**Example:**

```
RP/0/RP0/CPU0:router(config-vrf-af)# import route-target 500:99
```

Configures a VPN routing and forwarding (VRF) import route-target extended community.

**Step 9** **export route-target [***0-65535.0-65535:0-65535* | *as-number:nn* | *ip-address:nn*]

**Example:**

```
RP/0/RP0/CPU0:router(config-vrf-af)# import route-target 700:88
```

Configures a VPN routing and forwarding (VRF) export route-target extended community.

**Step 10** 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 a Route-Policy Definition

Perform this task to configure a route-policy definition for CE-PE EBGP.

## SUMMARY STEPS

1. **configure**
2. **route-policy** *name* **pass**
3. **end policy**

### DETAILED STEPS

**Step 1** **configure**

**Example:**
```
RP/0/RP0/CPU0:router# configure
```
Enters the Global Configuration mode.

**Step 2** **route-policy** *name* **pass**

**Example:**

```
RP/0/RP0/CPU0:router(config)# route-policy ottawa_admin pass
```
Defines and passes a route policy.

**Step 3** **end policy**

**Example:**

```
RP/0/RP0/CPU0:router(config-rpl)# end policy
```
End of route-policy definition.

# Configuring a Static Route

Perform this task to add more than 4K static routes (Global/VRF).

### SUMMARY STEPS

1. **configure**
2. **router static**
3. **maximum path ipv4** *1-140000*
4. **maximum path ipv6** *1-140000*
5. Use the **commit** or **end** command.

### DETAILED STEPS

**Step 1** **configure**

**Example:**
```
RP/0/RP0/CPU0:router# configure
```
Enters the Global Configuration mode.

**Step 2** **router static**

**Example:**

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

Enters static route configuration subcommands.

**Step 3** **maximum path ipv4** *1-140000*

**Example:**

```
RP/0/RP0/CPU0:router(config-static)# maximum path ipv4 1-140000
```

Enters the maximum number of static ipv4 paths that can be configured.

**Step 4** **maximum path ipv6** *1-140000*

**Example:**

```
RP/0/0/CPU0:router(config-static)# maximum path ipv6 1-140000
```

**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 an IPv4 Loopback Interface

The following task describes how to configure an IPv4 Loopback interface.

## SUMMARY STEPS

1. **configure**
2. **interface** *type interface-path-id*
3. **ipv4 address** *ipv4-address*
4. Use the **commit** or **end** command.

## DETAILED STEPS

**Step 1** **configure**

**Example:**

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

Enters Global Configuration mode.

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

**Example:**

```
RP/0/RP0/CPU0:router(config)# interface Loopback0
```

Enters interface configuration mode and enables a Loopback interface.

**Step 3** **ipv4 address** *ipv4-address*

**Example:**

```
RP/0/RP0/CPU0:router(config-if)# ipv4 address 1.1.1.1 255.255.255.255
```

Enters an IPv4 address and mask for the associated IP subnet. The network mask can be specified in either of two ways:

- The network mask can be a four-part dotted decimal address. For example, 255.0.0.0 indicates that each bit equal to 1 means that the corresponding address bit belongs to the network address.
- The network mask can be indicated as a slash (/) and number. For example, /8 indicates that the first 8 bits of the mask are ones, and the corresponding bits of the address are the network address.

**Step 4** 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 a CFI VRF Interface

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

## SUMMARY STEPS

1. **configure**
2. **interface** *type interface-path-id*
3. **vrf** *vrf-name*
4. **ipv4 address** *ipv4-address*
5. **ipv6 address** *ipv6-address*
6. **dot1q native vlan** *vlan-id*
7. Use the **commit** or **end** command.

## DETAILED STEPS

**Step 1** **configure**

**Example:**
```
RP/0/RP0/CPU0:router# configure
```
Enters the Global Configuration mode.

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

**Example:**

```
RP/0/RP0/CPU0:router(config)# interface GigabitEthernet0/0/0/1.1
```
Enters interface configuration mode and enables a GigabitEthernet interface.

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

**Example:**

```
RP/0/RP0/CPU0:router(config-if)# vrf v1
```
Specifies a VRF name.

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

**Example:**

```
RP/0/RP0/CPU0:router(config-if)# ipv4 address 100.1.10.2 255.255.255.0
```
Enters an IPv4 address and mask for the associated IP subnet. The network mask can be specified in either of two ways:

- The network mask can be a four-part dotted decimal address. For example, 255.0.0.0 indicates that each bit equal to 1 means that the corresponding address bit belongs to the network address.
- The network mask can be indicated as a slash (/) and number. For example, /8 indicates that the first 8 bits of the mask are ones, and the corresponding bits of the address are network address.

**Step 5** **ipv6 address** *ipv6-address*

**Example:**

```
RP/0/0/CPU0:router(config-if)# ipv6 100::1:10:2/64
```
Enters an IPv6 address.

This argument must be in the form documented in RFC 2373, where the address is specified in hexadecimal using 16-bit values between colons, as follows:

- IPv6 name or address: Hostname or X:X::X%zone
- IPv6 prefix: X:X::X%zone/<0-128>

**Step 6** **dot1q native vlan** *vlan-id*

**Example:**

```
RP/0/RP0/CPU0:router(config-if)# dot1q native vlan 665
```

(Optional) Enters the trunk interface ID. Range is from 1 to 4094 inclusive (0 and 4095 are reserved).

**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 the Core Network

Configuring the core network includes the following tasks:

# Configuring Inter-AS over IP Tunnels

These tasks describe how to configure Inter-AS over IP tunnels:

## Configuring the ASBRs to Exchange VPN-IPv4 Addresses for IP Tunnels

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** { **ipv4 tunnel** }
4. **address-family** { **vpnv4 unicast** }
5. **retain route-target** { **all** | **route-policy** *route-policy-name* }
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. **neighbor** *ip-address*
12. **remote-as** *autonomous-system-number*
13. **update-source** *type interface-path-id*
14. **address-family** { **ipv4 tunnel** }
15. **address-family** { **vpnv4 unicast** }
16. Use the **commit** or **end** command.

## DETAILED STEPS

**Step 1** **configure**

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

Enters the Global Configuration mode.

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

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

Enters Border Gateway Protocol (BGP) configuration mode allowing you to configure the BGP routing process.

**Step 3** **address-family** { **ipv4 tunnel** }

**Example:**
```
RP/0/RP0/CPU0:router(config-bgp)# address-family ipv4 tunnel
RP/0/RP0/CPU0:router(config-bgp-af)#
```

Configures IPv4 tunnel address family.

**Step 4** **address-family** { **vpnv4 unicast** }

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

Configures VPNv4 address family.

**Step 5** **retain route-target** { **all** | **route-policy** *route-policy-name* }

**Example:**
```
RP/0/RP0/CPU0:router(config-bgp-af)# retain route-target route-policy policy1
```

Retrieves VPNv4 table from PE routers.

The **retain route-target** command is required on an Inter-AS option B ASBR. You can use this command with either **all** or **route-policy** keyword

**Step 6** **neighbor** *ip-address*

**Example:**
```
RP/0/RP0/CPU0:router(config-bgp-af)# neighbor 172.168.40.24
RP/0/RP0/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 7** **remote-as** *autonomous-system-number*

**Example:**
```
RP/0/RP0/CPU0:router(config-bgp-nbr)# remote-as 2002
```

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

**Step 8** **address-family** { **vpnv4 unicast** }

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

Configures VPNv4 address family.

**Step 9** **route-policy** *route-policy-name* { **in** }

**Example:**
```
RP/0/RP0/CPU0:router(config-bgp-nbr-af)# route-policy pass-all in
```

Applies a routing policy to updates that are received from a BGP neighbor.

- Use the *route-policy-name* 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.

**Step 10** **route-policy** *route-policy-name* { **out** }

**Example:**
```
RP/0/RP0/CPU0:router(config-bgp-nbr-af)# route-policy pass-all out
```

Applies a routing policy to updates that are sent from a BGP neighbor.

- Use the *route-policy-name* argument to define the name of the 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 11** **neighbor** *ip-address*

**Example:**
```
RP/0/RP0/CPU0:router(config-bgp-nbr-af)# neighbor 175.40.25.2
RP/0/RP0/CPU0:router(config-bgp-nbr)#
```

Places the router in neighbor configuration mode for BGP routing and configures the neighbor IP address 175.40.25.2 as an VPNv4 iBGP peer.

**Step 12** **remote-as** *autonomous-system-number*

**Example:**
```
RP/0/RP0/CPU0:router(config-bgp-nbr)# remote-as 2002
```

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

**Step 13** **update-source** *type interface-path-id*

**Example:**
```
RP/0/RP0/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.

**Step 14** **address-family** { **ipv4 tunnel** }

**Example:**
```
RP/0/RP0/CPU0:router(config-bgp-nbr)# address-family ipv4 tunnel
RP/0/RP0/CPU0:router(config-bgp-nbr-af)#
```

Configures IPv4 tunnel address family.

**Step 15** **address-family** { **vpnv4 unicast** }

**Example:**
```
RP/0/RP0/CPU0:router(config-bgp-nbr-af)# address-family vpnv4 unicast
```
Configures VPNv4 address family.

**Step 16** 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 the Backbone Carrier Core for IP Tunnels

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.
- Configure IP tunnels in the core.
- Configure VRFs .
- Configure multiprotocol BGP for VPN connectivity in the backbone carrier.

## Verifying MPLS VPN over IP

To verify the configuration of end-end (PE-PE) MPLS VPN over IP provisioning, use the following **show** commands:

- **show cef recursive-nexthop**
- **show bgp ipv4 tunnel**
- **show bgp vpnv4 unicast summary**
- **show bgp vrf v1 ipv4 unicast summary**
- **show bgp vrf v1 ipv4 unicast** *prefix*
- **show cef vrf v1 ipv4** *prefix*
- **show cef ipv6 recursive-nexthop**
- **show bgp vpnv6 unicast summary**
- **show bgp vrf v1 ipv6 unicast summary**
- **show bgp vrf v1 ipv6 unicast** *prefix*
- **show cef vrf v1 ipv6** *prefix*

### Configuring Source Pool Address for MPLS VPNs over IP Tunnels

Perform this task to configure the Multiple Tunnel Source Address.

## SUMMARY STEPS

1. **configure**
2. **tunnel-template** *name*
3. **mtu** [ *mtu-value* ]
4. **ttl** [ *ttl-value* ]
5. **tos** [ *tos-value* ]
6. **source** *loopback type interface-path-id*
7. **source-pool** *A.B.C.D/prefix*
8. **encapsulation** *l2tp*
9. Use the **commit** or **end** command.

## DETAILED STEPS

**Step 1** **configure**

**Example:**

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

Enters the Global Configuration mode.

**Step 2** **tunnel-template** *name*

**Example:**

```
RP/0/RP0/CPU0:router(config)# tunnel-template test
RP/0/RP0/CPU0:router(config-tuntem)#
```

Configures the tunnel template for source address.

**Step 3** **mtu** [ *mtu-value* ]

**Example:**

```
RP/0/RP0/CPU0:router(config-tuntem) mtu 600
RP/0/RP0/CPU0:router(config-tuntem)#
```

Configures the maximum transmission unit for the tunnel.

**Step 4** **ttl** [ *ttl-value* ]

**Example:**

```
RP/0/RP0/CPU0:router(config-tuntem)ttl 64
RP/0/RP0/CPU0:router(config-tuntem)#
```

Configures the IP time to live (TTL).

**Step 5** **tos** [ *tos-value* ]

**Example:**

```
RP/0/RP0/CPU0:router(config-tuntem)tos 7
RP/0/RP0/CPU0:router(config-tuntem)#
```

Configures the tunnel header. By default, the TOS bits for the tunnel header are set to zero.

**Step 6** **source** *loopback type interface-path-id*

**Example:**

```
RP/0/RP0/CPU0:router(config-tuntem)source loopback0
```

Configures the loopback interface.

**Step 7** **source-pool** *A.B.C.D/prefix*

**Example:**

```
RP/0/RP0/CPU0:router(config-tuntem)# source-pool 10.10.10.0/28
```

Configures the source pool address.

**Step 8** **encapsulation** *l2tp*

**Example:**

```
RP/0/RP0/CPU0:router(config-tuntem)# encapsulation l2tp
RP/0/RP0/CPU0:router(config-config-tunencap-l2tp)#
```

Configures the Layer 2 Tunnel Protocol encapsulation.

**Step 9** 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.

# Configuration Examples for MPLS VPNs over IP Tunnels

This section provides the following examples:

## Configuring an L2TPv3 Tunnel: Example

The following example shows how to configure an L2TPv3 tunnel:

```
tunnel-template t1
 encapsulation l2tp
 !
 source Loopback0
!
```

# Configuring the Global VRF Definition: Example

The following example shows how to configure an L2TPv3 tunnel:

```
vrf v1
 address-family ipv4 unicast
 import route-target
   1:1
  !
  export route-target
   1:1
  !
```

# Configuring a Route-Policy Definition: Example

The following example shows how to configure a route-policy definition:

```
configure
  route-policy pass-all
  pass
end-policy
!
```

# Configuring a Static Route: Example

The following example shows how to configure a static route:

```
configure
  router static
  maximum path ipv4 <1-140000>
  maximum path ipv6 <1-140000>
end-policy
!
```

# Configuring an IPv4 Loopback Interface: Example

The following example shows how to configure an IPv4 Loopback Interface:

```
configure
 interface Loopback0
 ipv4 address 1.1.1.1 255.255.255.255
!
```

# Configuring a CFI VRF Interface: Example

The following example shows how to configure an L2TPv3 tunnel:

```
configure
  interface GigabitEthernet0/0/0/1.1
  vrf v1
   ipv4 address 100.1.10.2 255.255.255.0

  encapsulation  dot1q 101
!
```

## Configuring Source Pool Address for MPLS VPNs over IP Tunnels: Example

```
configure
tunnel-template test
 mtu 1500
ttl 64
ttl 7
source Loopback0
 source-pool 10.10.10.0/28
 encapsulation l2tp
 !
```