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.

Contents

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, page VPC-235
- Advertising Tunnel Type and Tunnel Capabilities Between PE Routers—BGP, page VPC-235
- PE Routers and Address Space, page VPC-236
- Packet Validation Mechanism, page VPC-236
- Quality of Service Using the Modular QoS CLI, page VPC-236
- BGP Multipath Load Sharing for MPLS VPNs over IP Tunnels, page VPC-237
- Inter-AS and CSC Support over IP Tunnels, page VPC-237
- Multiple Tunnel Source Address, page VPC-237

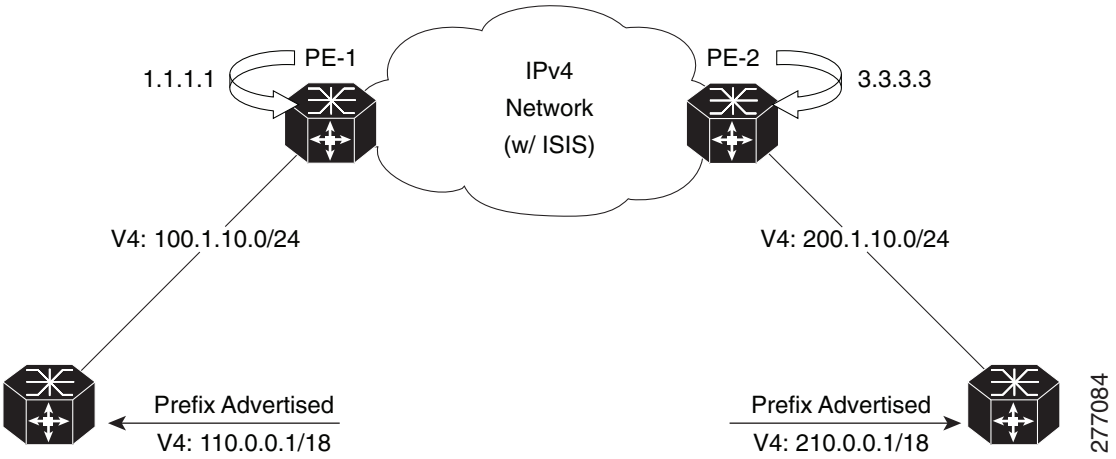
Overview: MPLS VPNs over IP Tunnels

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.

Figure 24 illustrates the topology used for the configuration steps.

Figure 24 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. A special purpose VRF called a *Resolve in VRF* (RiV) is created to manage the tunnel address space. You also configure the address space under the RiV that is associated with the tunnel and a static route in the RiV to route outgoing traffic through the tunnel.

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 and CSC Support 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.

Carrier Supporting Carrier (CSC) is implemented in circumstances in which one service provider needs to use the transport services provided by another service provider. The service provider that provides the transport is called the backbone carrier. The service provider, which uses the services provided by the backbone carrier, is called a customer carrier. Backbone carriers with CSC, bridge two or more customer carrier sites through an MPLS VPN/MPLS VPN over IP tunnels backbone.

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, page VPC-238
- Tunnel EA, page VPC-238

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 FIBand 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

How to Configure MPLS VPNs over IP Tunnels

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

- Configuring the Global VRF Definition, page VPC-239 (required)
- Configuring a Route-Policy Definition, page VPC-241 (required)
- Configuring a Static Route, page VPC-241 (required)
- Configuring an IPv4 Loopback Interface, page VPC-243 (required)
- Configuring a CFI VRF Interface, page VPC-245 (required)
- Configuring the Core Network, page VPC-246 (required)
- Configuring Inter-AS and CSC Support over IP Tunnels, page VPC-247
- Verifying MPLS VPN over IP, page VPC-254 (optional)
- Configuring Source Pool Address for MPLS VPNs over IP Tunnels, page VPC-255 (optional)

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. **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** *vrf-name* **Example:** `RP/0/0/CPU0:router(config)# vrf vrf-name`	Specifies a name assigned to a VRF.
Step 3	**address-family ipv4 unicast** **Example:** `RP/0/0/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/0/0/CPU0:router(config-vrf-af)# import route-target 500:99`	Configures a VPN routing and forwarding (VRF) import route-target extended community.

	Command or Action	Purpose
Step 5	**export route-target [***0-65535.0-65535:0-65535* | *as-number:nn* | *ip-address:nn*] **Example:** `RP/0/0/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/0/0/CPU0:router(config-vrf-af)# exit`	Exits interface configuration mode.
Step 7	**address-family ipv6 unicast** **Example:** `RP/0/0/CPU0:router(config-vrf)# address-family ipv6 unicast`	Specifies an IPv6 address-family address.
Step 8	**import route-target [***0-65535.0-65535:0-65535* | *as-number:nn* | *ip-address:nn*] **Example:** `RP/0/0/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/0/0/CPU0:router(config-vrf-af)# import route-target 700:88`	Configures a VPN routing and forwarding (VRF) export route-target extended community.

Step 10	**end**
	or
	commit
	
	Example:
	`RP/0/0/CPU0:router(config-vrf-af)# end`
	or
	`RP/0/0/CPU0:router(config-vrf-af)# commit`
		Saves configuration changes.
		• When you issue the **end** command, the system prompts you to commit changes:
		`Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:`
		– 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 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

	Command or Action	Purpose
Step 1	**configure** **Example:** `RP/0/0/CPU0:router# configure`	Enters global configuration mode.
Step 2	**route-policy** *name* **pass** **Example:** `RP/0/0/CPU0:router(config)# route-policy ottawa_admin pass`	Defines and passes a route policy.
Step 3	**end policy** **Example:** `RP/0/0/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. **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 route configuration subcommands.
Step 3	**maximum path ipv4** *1-140000* **Example:** `RP/0/0/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`	Enters the maximum number of static ipv6 paths that can be configured.

Step 5	**end**
	or
	commit
	
	Example:
	`RP/0/0/CPU0:router(config-static)# end`
	or
	`RP/0/0/CPU0:router(config-static)# commit`
		Saves configuration changes.
		• When you issue the **end** command, the system prompts you to commit changes:
		`Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:`
		– 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 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. **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	**interface** *type interface-path-id* **Example:** `RP/0/0/CPU0:router(config)# interface Loopback0`	Enters interface configuration mode and enables a Loopback interface.

	Command or Action	Purpose
Step 3	**ipv4 address** *ipv4-address* **Example:** `RP/0/0/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	**end**
	or
	commit
	
	Example:
	`RP/0/0/CPU0:router(config-if)# end`
	or
	`RP/0/0/CPU0:router(config-if)# commit`
		Saves configuration changes.
		• When you issue the **end** command, the system prompts you to commit changes:
		`Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:`
		– 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 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 vlan** *vlan-id*
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	**interface** *type interface-path-id* **Example:** `RP/0/0/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/0/0/CPU0:router(config-if)# vrf v1`	Specifies a VRF name.
Step 4	**ipv4 address** *ipv4-address* **Example:** `RP/0/0/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.

	Command or Action	Purpose
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/0/0/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	**end**
	or
	commit
	
	Example:
	`RP/0/0/CPU0:router(config-if)# end`
	or
	`RP/0/0/CPU0:router(config-if)# commit`
		Saves configuration changes.
		• When you issue the **end** command, the system prompts you to commit changes:
		`Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:`
		– 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 Core Network

To configure the core network, refer to the procedures documented in *Implementing MPLS Layer 3 VPNs on Cisco IOS XR Software.*

The tasks are presented as follows:

- Assessing the needs of MPLS VPN customers
- Configuring routing protocols in the core
- Configuring MPLS in the core
- Enabling FIB in the core
- Configuring BGP on the PE routers and route reflectors

Configuring Inter-AS and CSC Support over IP Tunnels

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

- Configuring the ASBRs to Exchange VPN-IPv4 Addresses for IP Tunnels, page VPC-247 (required)
- Configuring the Backbone Carrier Core for IP Tunnels, page VPC-250
- Configuring CSC-PE Routers for IP Tunnels, page VPC-250

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 for IP tunnels

SUMMARY STEPS

1. **configure**
2. **router bgp** *autonomous-system-number*
3. **address-family** {**ipv4 tunnel**}
4. **address-family** {**vpnv4 unicast**}
5. **neighbor** *ip-address*
6. **remote-as** *autonomous-system-number*
7. **address-family** {**vpnv4 unicast**}
8. **route-policy** *route-policy-name* {**in**}
9. **route-policy** *route-policy-name* {**out**}
10. **neighbor** *ip-address*
11. **remote-as** *autonomous-system-number*
12. **update-source** *type interface-path-id*
13. **address-family** {**ipv4 tunnel**}
14. **address-family** {**vpnv4 unicast**}
15. **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** *autonomous-system-number*
	
	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 tunnel**}
	
	Example:
	`RP/0/0/CPU0:router(config-bgp)# address-family ipv4 tunnel`
	`RP/0/0/CPU0:router(config-bgp-af)#`
		Configures IPv4 tunnel address family.

Step 4	**address-family** {**vpnv4 unicast**}
	
	Example:
	`RP/0/0/CPU0:router(cconfig-bgp-af)#`
	`address-family vpnv4 unicast`
		Configures VPNv4 address family.

Step 5	**neighbor** *ip-address*
	
	Example:
	`RP/0/0/CPU0:router(config-bgp-af)# neighbor 172.168.40.24`
	`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	**remote-as** *autonomous-system-number* **Example:** `RP/0/0/CPU0:router(config-bgp-nbr)# remote-as 2002`	Creates a neighbor and assigns it a remote autonomous system number.

Step 7	**address-family** {**vpnv4 unicast**}
	
	Example:
	`RP/0/0/CPU0:router(config-bgp-nbr)#`
	`address-family vpnv4 unicast`
	`RP/0/0/CPU0:router(config-bgp-nbr-af)#`
		Configures VPNv4 address family.

Step 8	**route-policy** *route-policy-name* {**in**}
	
	Example:
	`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.
		• 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.

	Command or Action	Purpose
Step 9	**route-policy** *route-policy-name* {**out**} **Example:** `RP/0/0/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 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	**neighbor** *ip-address*
	
	Example:
	`RP/0/0/CPU0:router(config-bgp-nbr-af)# neighbor 175.40.25.2`
	`RP/0/0/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 11	**remote-as** *autonomous-system-number* **Example:** `RP/0/0/CPU0:router(config-bgp-nbr)# remote-as 2002`	Creates a neighbor and assigns it a remote autonomous system number.
Step 12	**update-source** *type interface-path-id* **Example:** `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.

Step 13	**address-family** {**ipv4 tunnel**}
	
	Example:
	`RP/0/0/CPU0:router(config-bgp-nbr)# address-family ipv4 tunnel`
	`RP/0/0/CPU0:router(config-bgp-nbr-af)#`
		Configures IPv4 tunnel address family.

	Command or Action	Purpose
Step 14	**address-family** {**vpnv4 unicast**} **Example:** `RP/0/0/CPU0:router(config-bgp-nbr-af)# address-family vpnv4 unicast`	Configures VPNv4 address family.

Step 15	**end**
	or
	commit
	
	Example:
	`RP/0/0/CPU0:router(config-bgp-nbr-af)# end`
	or
	`RP/0/0/CPU0:router(config-bgp-nbr-af)# commit`
		Saves configuration changes.
		• When you issue the **end** command, the system prompts you to commit changes:
		`Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:`
		– 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 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 for CSC-PE routers.
- Configure multiprotocol BGP for VPN connectivity in the backbone carrier.

Configuring CSC-PE Routers for IP Tunnels

Perform this task to configure a CSC-PE for IP tunnels.

For information on how to configure CSC-CE routers, see the Implementing MPLS Layer 3 VPNs module.

SUMMARY STEPS

1. **configure**
2. **router bgp** *as-number*
3. **address-family** {**vpnv4 unicast**}
4. **address-family** {**ipv4 tunnel**}
5. **neighbor** *A.B.C.D*
6. **remote-as** *as-number*
7. **update-source** *interface-type interface-number*
8. **address-family** {**vpnv4 unicast**}
9. **address-family** {**ipv4 tunnel**}
10. **vrf** *vrf-name*
11. **rd** {*as-number:nn* | *ip-address:nn* | **auto**}
12. **address-family** {**ipv4 unicast**}
13. **allocate-label all**
14. **neighbor** *A.B.C.D*
15. **remote-as** *as-number*
16. **address-family** {**ipv4 labeled-unicast**}
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** *as-number*
	
	Example:
	`RP/0/0/CPU0:router(config)# router bgp 2`
	`RP/0/0/CPU0:router(config-bgp)#`
		Configures a BGP routing process and enters router configuration mode.
		• Range for 2-byte numbers is 1 to 65535. Range for 4-byte numbers is 1.0 to 65535.65535.

Step 3	**address-family** {**vpnv4 unicast**}
	
	Example:
	`RP/0/0/CPU0:router(config-bgp)# address-family vpnv4 unicast`
	`RP/0/0/CPU0:router(config-bgp-af)#`
		Configures VPNv4 address family.

	Command or Action	Purpose
Step 4	**address-family** {**ipv4 tunnel**} **Example:** `RP/0/0/CPU0:router(config-bgp-af)# address-family ipv4 tunnel`	Configures IPv4 tunnel address family.

Step 5	**neighbor** *A.B.C.D*
	
	Example:
	`RP/0/0/CPU0:router(config-bgp-af)# neighbor 10.10.10.0`
	`RP/0/0/CPU0:router(config-bgp-nbr)#`
		Configures the IP address for the BGP neighbor.

Step 6	**remote-as** *as-number* **Example:** `RP/0/0/CPU0:router(config-bgp-nbr)# remote-as 888`	Configures the AS number for the BGP neighbor.
Step 7	**update-source** *interface-type interface-number* **Example:** `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.

Step 8	**address-family** {**vpnv4 unicast**}
	
	Example:
	`RP/0/0/CPU0:router(config-bgp-nbr)# address-family vpnv4 unicast`
	`RP/0/0/CPU0:router(config-bgp-nbr-af)#`
		Configures VPNv4 unicast address family.

Step 9	**address-family** {**ipv4 tunnel**} **Example:** `RP/0/0/CPU0:router(config-bgp-nbr-af)# address-family ipv4 tunnel`	Configures IPv4 tunnel address family.

Step 10	**vrf** *vrf-name*
	
	Example:
	`RP/0/0/CPU0:router(config-bgp-nbr-af)# vrf 9999`
	`RP/0/0/CPU0:router(config-bgp-vrf)#`
		Configures a VRF instance.

Step 11	**rd** {*as-number:nn* | *ip-address:nn* | **auto**} **Example:** `RP/0/0/CPU0:router(config-bgp-vrf)# rd auto`	Configures a route distinguisher. **Note** Use the **auto** keyword to automatically assign a unique route distinguisher.

Step 12	**address-family** {**ipv4 unicast**}
	
	Example:
	`RP/0/0/CPU0:router(config-bgp-vrf)# address-family ipv4 unicast`
	`RP/0/0/CPU0:router(config-bgp-vrf-af)#`
		Configures IPv4 unicast address family.

	Command or Action	Purpose
Step 13	**allocate-label all** **Example:** `RP/0/0/CPU0:router(config-bgp-vrf-af)# allocate-label all`	Allocate labels for all local prefixes and prefixes received with labels.

Step 14	**neighbor** *A.B.C.D*
	
	Example:
	`RP/0/0/CPU0:router(config-bgp-vrf-af)# neighbor 10.10.10.0`
	`RP/0/0/CPU0:router(config-bgp-vrf-nbr)#`
		Configures the IP address for the BGP neighbor.

Step 15	**remote-as** *as-number* **Example:** `RP/0/0/CPU0:router(config-bgp-vrf-nbr)# remote-as 888`	Enables the exchange of information with a neighboring BGP router.

Step 16	**address-family** {**ipv4 labeled-unicast**}
	
	Example:
	`RP/0/0/CPU0:router(config-bgp-vrf-nbr)# address-family ipv4 labeled-unicast`
	`RP/0/0/CPU0:router(config-bgp-vrf-nbr-af)#`
		Configures IPv4 labeled-unicast address family.

Step 17	**route-policy** *route-policy-name* **in** **Example:** `RP/0/0/CPU0:router(config-bgp-vrf-nbr-af)# route-policy pass-all in`	Applies the pass-all policy to all inbound routes.

	Command or Action	Purpose
Step 18	**route-policy** *route-policy-name* **out** **Example:** `RP/0/0/CPU0:router(config-bgp-vrf-nbr-af)# route-policy pass-all out`	Applies the pass-all policy to all outbound routes.

Step 19	**end**
	or
	commit
	
	Example:
	`RP/0/0/CPU0:router(config-bgp-vrf-nbr-af)# end`
	or
	`RP/0/0/CPU0:router(config-bgp-vrf-nbr-af)# commit`
		Saves configuration changes.
		• When you issue the **end** command, the system prompts you to commit changes:
		`Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:`
		– 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.

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. **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	**tunnel-template** *name*
	
	Example:
	`RP/0/0/CPU0:router(config)#tunnel-template test`
	`RP/0/0/CPU0:router(config-tuntem)#`
		Configures the tunnel template for source address.

Step 3	**mtu** [*mtu-value*]
	
	Example:
	`RP/0/0/CPU0:router(config-tuntem) mtu 600`
	`RP/0/0/CPU0:router(config-tuntem)#`
		Configures the maximum transmission unit for the tunnel.

Step 4	**ttl** [*ttl-value*]
	
	Example:
	`RP/0/0/CPU0:router(config-tuntem)ttl 64`
	`RP/0/0/CPU0:router(config-tuntem)`
		Configures the IP time to live (TTL).

Step 5	**tos** [*tos-value*]
	
	Example:
	`RP/0/0/CPU0:router(config-tuntem)tos 7`
	`RP/0/0/CPU0:router(config-tuntem)`
		Configures the tunnel header. By default, the TOS bits for the tunnel header are set to zero.

	Command or Action	Purpose
Step 6	**source** *loopback type interface-path-id* **Example:** `RP/0/0/CPU0:router(config-tuntem)source loopback0`	Configures the loopback interface.
Step 7	**source-pool** *A.B.C.D/prefix* **Example:** `RP/0/0/CPU0:router(config-tuntem)# source-pool 10.10.10.0/28`	Configures the source pool address.

Step 8	**encapsulation** *l2tp*
	
	Example:
	`RP/0/0/CPU0:router(config-tuntem)# encapsulation l2tp`
	`RP/0/0/CPU0:router(config-config-tunencap-l2tp)#`
		Configures the Layer 2 Tunnel Protocol encapsulation.

Step 9	**end**
	or
	commit
	
	Example:
	`RP/0/0/CPU0:router(config-tuntem)# end`
	or
	`RP/0/0/CPU0:router(config-tuntem)# commit`
		Saves configuration changes.
		• When you issue the **end** command, the system prompts you to commit changes:
		`Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:`
		– 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 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
  !
 address-family ipv6 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
   ipv6 address 100::1:10:2/64
   dot1q vlan 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
 !
```

Additional References

For additional information related to this feature, refer to the following references:

Related Documents

Related Topic	Document Title
Cisco IOS XR L2VPN command reference document	*MPLS Virtual Private Network Commands on Cisco IOS XR Software*
Layer 2 Tunnel Protocol Version 3	*Layer 2 Tunnel Protocol Version 3 on Cisco IOS XR Software*
Routing (BGP, EIGRP, OSPF, and RIP) commands: complete command syntax, command modes, command history, defaults, usage guidelines, and examples	*Cisco IOS XR Routing Command Reference*
Routing (BGP, EIGRP, OSPF, and RIP) configuration	*Cisco IOS XR Routing Configuration Guide*
MPLS LDP configuration: configuration concepts, task, and examples	*Implementing MPLS Label Distribution Protocol on Cisco IOS XR Software*
MPLS Traffic Engineering Resource Reservation Protocol configuration: configuration concepts, task, and examples	*Implementing RSVP for MPLS-TE and MPLS O-UNI on Cisco IOS XR Software*
Cisco CRS router getting started material	Cisco IOS XR *Getting Started Guide*
Information about user groups and task IDs	*Configuring AAA Services on Cisco IOS XR Software* module of the *Cisco IOS XR System Security Configuration Guide*

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 3931	*Layer Two Tunneling Protocol - Version 3 (L2TPv3)*
RFC 2547	*BGP/MPLS VPNs*

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