



## L2VPN Interworking

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Layer 2 VPN (L2VPN) Interworking allows you to connect disparate attachment circuits. This feature module explains how to configure the following L2VPN Interworking features:

- Ethernet/VLAN to ATM adaptation layer 5 (AAL5) Interworking
  - Ethernet/VLAN to Frame Relay Interworking
  - Ethernet/VLAN to PPP Interworking
  - Ethernet to VLAN Interworking
  - Frame Relay to ATM AAL5 Interworking
  - Frame Relay to PPP Interworking
  - Ethernet/VLAN to ATM virtual path identifier (VPI) and virtual channel identifier (VCI) Interworking
  - L2VPN Interworking: VLAN Enable/Disable Option for Any Transport over MPLS (AToM)
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## Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see [Bug Search Tool](#) and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to [www.cisco.com/go/cfn](http://www.cisco.com/go/cfn). An account on Cisco.com is not required.

## Prerequisites for L2VPN Interworking

Before you configure L2VPN Interworking on a device, do the following:

- You must enable Cisco Express Forwarding.
- On Cisco 12000 series Internet routers, before you configure Layer 2 Tunnel Protocol Version 3 (L2TPv3) for L2VPN Interworking on an IP Services Engine (ISE), such as an Engine 3 or Engine 5 interface, you must enable the L2VPN feature bundle on the line card.  
To enable the feature bundle, enter the **hw-module slot np mode feature** command in global configuration mode as follows:

```
Device# configure terminal
Device(config)# hw-module slot slot-number np mode feature
```

## Restrictions for L2VPN Interworking

### General Restrictions

This section lists the general restrictions that apply to L2VPN Interworking. Other restrictions that are platform-specific or device-specific are listed in the subsequent sections.

- The interworking type on one provider edge (PE) router must match the interworking type on the peer PE router.
- The following quality of service (QoS) features are supported with L2VPN Interworking:
  - Static IP type of service (ToS) or Multiprotocol Label Switching (MPLS) experimental (EXP) bit setting in tunnel header
  - IP ToS reflection in the tunnel header (Layer 2 Tunnel Protocol Version 3 [L2TPv3] only)
  - Frame Relay policing
  - Frame Relay data-link connection identifier (DLCI)-based congestion management (Cisco 7500/Versatile Interface Processor [VIP])
  - One-to-one mapping of VLAN priority bits to MPLS EXP bits
- Only ATM AAL5 virtual circuit (VC) mode is supported. ATM virtual path (VP) and port mode are not supported.
- In Cisco IOS Release 12.2(52)SE and Cisco IOS Release 12.2(33)SRE, the **encapsulation** command supports only the **mpls** keyword. The **l2tpv3** keyword is not supported. The **interworking** command supports only the **ethernet** and **vlan** keywords. The **ip** keyword is not supported.

## Cisco 7600 Series Routers Restrictions

The table below lists the line cards that are supported on Cisco 7600 series routers. These line cards are supported on the WAN (ATM, Frame Relay, or PPP) side of the interworking link. The second table below shows the line cards that are supported on the Ethernet side of the interworking link. For more details about shared port adapters and line cards supported on Cisco 7600 series routers, see the *Cross-Platform Release Notes for Cisco IOS Release 12.2SR* document for Cisco 7600 series routers.

**Table 1: Cisco 7600 Series Routers: Supported Line Cards for the WAN Side**

| Interworking Type                        | Core-Facing Line Cards | Customer-Edge Line Cards |
|--|------------------------|--------------------------|
| Ethernet (bridged) (ATM and Frame Relay) | Any                    | EflexWAN SIP-200 SIP-400 |
| IP (routed) (ATM, Frame Relay, and PPP)  | Any                    | EflexWAN SIP-200         |

**Table 2: Cisco 7600 Series Routers: Supported Line Cards for the Ethernet Side**

| Interworking Type  | Ethernet over MPLS Mode                | Core-Facing Line Cards                                     | Customer-Edge Line Cards  |
|--------------------|--|--|---|
| Ethernet (bridged) | Policy feature card (PFC)-based        | Any, except optical service module (OSM) and ES40          | Catalyst LAN SIP-600  |
|                    | Switched virtual interface (SVI)-based | EflexWAN<br>ES20<br>ES+40<br>SIP-200<br>SIP-400<br>SIP-600 | Catalyst LAN<br>EflexWAN (with Multipoint Bridging [MPB])<br>ES20<br>ES+40<br>SIP-200 (with MPB)<br>SIP-400 (with MPB)<br>SIP-600 |
|                    | Scalable (with E-MPB)                  | Any, except OSM  | ES20<br>SIP-600 and SIP-400 with Gigabit Ethernet (GE) shared port adapter (SPA)  |

| Interworking Type | Ethernet over MPLS Mode | Core-Facing Line Cards  | Customer-Edge Line Cards   |
|-------------------|-------------------------|---|--|
| IP (routed)       | PFC-based               | Catalyst LAN<br>SIP-600<br><br><b>Note:</b> PFC-based mode is not supported with routed interworking in Cisco IOS Release 12.2(33)SRD. Use SVI, Scalable, or Ethernet virtual connection (EVC)-based Ethernet over MPLS (EoMPLS) instead. | Catalyst LAN<br>SIP-600<br><br><b>Note:</b> PFC-based mode is not supported with routed interworking in Cisco IOS Release 12.2(33)SRD. Use SVI, Scalable, or EVC-based EoMPLS instead. |
|                   | SVI-based               | Any, except Catalyst LAN and OSM.   | Catalyst LAN<br>EflexWAN (with MPB)<br>ES20<br>SIP-200 (with MPB)<br>SIP-400 (with MPB)<br>SIP-600   |

The following restrictions apply to Cisco 7600 series routers and L2VPN Interworking:

- Operation, Administration, and Management (OAM) emulation is not required with L2VPN Interworking on the SIP-200, SIP-400, and Flexwan2 line cards.
- Cisco 7600 series routers support the L2VPN Interworking: VLAN Enable/Disable Option for ATOM feature starting in Cisco IOS Release 12.2(33)SRE. This feature has the following restrictions:
  - PFC-based EoMPLS is not supported.
  - Scalable and SVI-based EoMPLS are supported with the SIP-400 line card.
- Cisco 7600 series routers do not support L2VPN Interworking over L2TPv3.
- Cisco 7600 series routers support only the following interworking types:
  - Ethernet/VLAN to Frame Relay (IP and Ethernet modes)
  - Ethernet/VLAN to ATM AAL5SNAP (IP and Ethernet modes)
  - Ethernet/VLAN to PPP (IP only)
  - Ethernet to VLAN Interworking
- Cisco 7600 series routers do not support the following interworking types:
  - Ethernet/VLAN to ATM AAL5MUX
  - Frame Relay to PPP Interworking

- Frame Relay to ATM AAL5 Interworking
- Both ends of the interworking link must be configured with the same encapsulation and interworking type, as described below:
  - If you use Ethernet encapsulation, you must use the Ethernet (bridged) interworking type. If you are not using Ethernet encapsulation, you can use a bridging mechanism such as routed bridge encapsulation (RBE).
  - If you use an IP encapsulation (such as ATM or Frame Relay), you must use the IP (routed) interworking type. The PE routers negotiate the process for learning and resolving addresses.
  - You must use the same maximum transmission unit (MTU) size on the attachment circuits at each end of the pseudowire.
- Frame Relay interworking does not pass the IEEE spanning tree bridge protocol data units (BPDUs) when Cisco 7600 series routers are used as PEs.
- PFC-based EoMPLS is not supported on ES40 line cards. SVI and EVC/scalable EoMPLS are the alternative options.
- PFC-based EoMPLS is not supported for routed/IP interworking in Cisco IOS Release 12.2(33)SRD and later releases. The alternative routed/IP interworking options are SVI and EVC or scalable EoMPLS. However, PFC-based EoMPLS is supported for Ethernet/Bridged interworking and for like-to-like over AToM.

## Cisco 12000 Series Internet Routers Restrictions

For more information about hardware requirements on Cisco 12000 series Internet routers, see the *Cross-Platform Release Notes for Cisco IOS Release 12.0S* document.

For quality of service (QoS) support on Cisco 12000 series Internet routers, see the *Any Transport over MPLS (AToM): Layer 2 QoS for the Cisco 12000 Series Router (Quality of Service)* configuration guide.

### Frame Relay to PPP and High-Level Data Link Control Interworking

Cisco 12000 series Internet routers do not support L2VPN Interworking with PPP and high-level data link control (HDLC) transport types in Cisco IOS releases earlier than Cisco IOS Release 12.0(32)S.

In Cisco IOS Release 12.0(32)S and later releases, Cisco 12000 series Internet routers support L2VPN interworking for Frame Relay over MPLS and PPP and HDLC over MPLS only on the following shared port adapters (SPAs):

- ISE/Engine 3 SPAs:
  - SPA-2XCT3/DS0 (2-port channelized T3 to DS0)
  - SPA-4XCT3/DS0 (4-port channelized T3 to DS0)
- Engine 5 SPAs:
  - SPA-1XCHSTM1/OC-3 (1-port channelized STM-1c/OC-3c to DS0)
  - SPA-2XOC-48-POS/RPR (2-port OC-48/STM16 POS/RPR)

- SPA-8XCHT1/E1 (8-port channelized T1/E1)
- SPA-OC-192POS-LR (1-port OC-192/STM64 POS/RPR)
- SPA-OC-192POS-XFP (1-port OC-192/STM64 POS/RPR)

## L2VPN Interworking over L2TPv3

On Cisco 12000 series Internet routers, Ethernet (bridged) interworking is not supported for L2TPv3. Only IP (routed) interworking is supported.

IP (routed) interworking is not supported in an L2TPv3 pseudowire that is configured for data sequencing (using the **sequencing** command).

In Cisco IOS Release 12.0(32)SY and later releases, Cisco 12000 series Internet routers support L2VPN Interworking over L2TPv3 tunnels in IP mode on ISE and Engine 5 line cards as follows:

- On an ISE interface configured for L2TPv3 tunneling, the following Layer 2 encapsulations are supported:
  - 802.1q (VLAN)
  - ATM adaptation layer type-5 (AAL5)
  - Ethernet
  - Frame Relay DLCI
- On an Engine 5 interface configured for L2TPv3 tunneling, the following Layer 2 encapsulations are supported:
  - 802.1q (VLAN)
  - Ethernet
  - Frame Relay DLCI

For more information, refer to the “Layer 2 Tunneling Protocol Version 3” module.

The only frame format supported for L2TPv3 interworking on Engine 5 Ethernet SPAs is Ethernet Version 2 (also known as Ethernet II) with the Ether type 0x0800 value set as Internet Protocol Payload and optionally, 802.1q VLAN. Ethernet packets with other Ethernet frame formats are dropped.

## Remote Ethernet Port Shutdown Support

The Cisco Remote Ethernet Port Shutdown feature (which minimizes potential data loss after a remote link failure) is supported only on the following Engine 5 Ethernet SPAs:

- SPA-8XFE (8-port Fast Ethernet)
- SPA-2X1GE (2-port Gigabit Ethernet)
- SPA-5X1GE (5-port Gigabit Ethernet)
- SPA-10X1GE (10-port Gigabit Ethernet)
- SPA-1X10GE (1-port 10-Gigabit Ethernet)

For more information about this feature, refer to the *Any Transport over MPLS (AToM): Remote Ethernet Port Shutdown* configuration guide.

## L2VPN Any-to-Any Interworking on Engine 5 Line Cards

For more information about hardware requirements on Cisco 12000 series Internet routers, see the *Cross-Platform Release Notes for Cisco IOS Release 12.0S* document.

For quality of service (QoS) support on Cisco 12000 series Internet routers, see the *Any Transport over MPLS (AToM): Layer 2 QoS for the Cisco 12000 Series Router (Quality of Service)* configuration guide.

### L2VPN Any-to-Any Interworking on Engine 5 Line Cards

The table below shows the different combinations of transport types supported for L2VPN Interworking on Engine 3 and Engine 5 SPA interfaces connected through an attachment circuit over MPLS or L2TPv3.

**Table 3: Engine 3 and Engine 5 Line Cards/SPAs Supported for L2VPN Interworking**

| Attachment Circuit 1 (AC1) | Attachment Circuit 2 (AC2) | Interworking Mode | AC1 Engine Type and Line Card/SPA                | AC2 Engine Type and Line Card/SPA |
|----------------------------|----------------------------|-------------------|--|-----------------------------------|
| Frame Relay                | Frame Relay                | IP                | Engine 5 Packet over SONET (POS) and channelized | Engine 3 ATM line cards           |
| Frame Relay                | ATM                        | Ethernet          | Engine 5 POS and channelized                     | Engine 3 ATM line cards           |
| Frame Relay                | ATM                        | IP                | Engine 5 POS and channelized                     | Engine 3 ATM line cards           |
| Frame Relay                | Ethernet                   | Ethernet          | Engine 5 POS and channelized                     | Engine 5 Gigabit Ethernet         |
| Frame Relay                | Ethernet                   | IP                | Engine 5 POS and channelized                     | Engine 5 Gigabit Ethernet         |
| Frame Relay                | VLAN                       | Ethernet          | Engine 5 POS and channelized                     | Engine 5 Gigabit Ethernet         |
| Frame Relay                | VLAN                       | IP                | Engine 5 POS and channelized                     | Engine 5 Gigabit Ethernet         |
| Ethernet                   | Ethernet                   | Ethernet          | Engine 5 Gigabit Ethernet                        | Engine 5 Gigabit Ethernet         |
| Ethernet                   | Ethernet                   | IP                | Engine 5 Gigabit Ethernet                        | Engine 5 Gigabit Ethernet         |
| Ethernet                   | VLAN                       | Ethernet          | Engine 5 Gigabit Ethernet                        | Engine 5 Gigabit Ethernet         |

| Attachment Circuit 1 (AC1) | Attachment Circuit 2 (AC2) | Interworking Mode | AC1 Engine Type and Line Card/SPA | AC2 Engine Type and Line Card/SPA |
|----------------------------|----------------------------|-------------------|-----------------------------------|-----------------------------------|
| Ethernet                   | VLAN                       | IP                | Engine 5 Gigabit Ethernet         | Engine 5 Gigabit Ethernet         |
| ATM                        | Ethernet                   | Ethernet          | Engine 3 ATM line cards           | Engine 5 Gigabit Ethernet         |
| ATM                        | Ethernet                   | IP                | Engine 3 ATM line cards           | Engine 5 Gigabit Ethernet         |

On the Cisco 12000 series Engine 3 line card, Network Layer Protocol ID (NLPID) encapsulation is not supported in routed mode; neither NLPID nor AAL5MUX is supported in bridged mode. On Cisco 12000 series Internet routers, Ethernet (bridged) interworking is not supported for L2TPv3.

In an L2VPN Interworking configuration, after you configure L2TPv3 tunnel encapsulation for a pseudowire using the **encapsulation l2tpv3** command, you cannot enter the **interworking ethernet** command.

On Ethernet SPAs on Cisco 12000 series Internet routers, the only frame format supported for L2TPv3 interworking is Ethernet Version 2 (also known as Ethernet II) with the Ether type 0x0800 value set as Internet Protocol Payload and optionally, 802.1q VLAN. Ethernet packets with other Ethernet frame formats are dropped.

## ATM AAL5 Interworking Restrictions

The following restrictions apply to ATM AAL5 Interworking:

- Switched virtual circuits (SVCs) are not supported.
- Inverse Address Resolution Protocol (ARP) is not supported with IP interworking.
- Customer edge (CE) routers must use point-to-point subinterfaces or static maps.
- In the Ethernet end-to-end over ATM scenario, the translations listed below are supported. Everything else is dropped.
  - Ethernet without LAN frame check sequence (FCS) (AAAA030080C200070000)
  - Spanning tree (AAAA030080c2000E)
- In the IP over ATM scenario, the IPv4 (AAAA030000000800) translation is supported. Everything else is dropped.
- Operation, Administration, and Management (OAM) emulation for L2VPN Interworking is the same as like-to-like. The end-to-end F5 loopback cells are looped back on the PE router. When the pseudowire is down, an F5 end-to-end segment Alarm Indication Signal (AIS)/Remote Defect Identification (RDI) is sent from the PE router to the CE router.
- Interim Local Management Interface (ILMI) can manage virtual circuits (VCs) and permanent virtual circuits (PVCs).



- To enable ILMI management, configure ILMI PVC 0/16 on the PE router's ATM interface. If a PVC is provisioned or deleted, an `ilmiVCCChange` trap is sent to the CE router.
- Only the user side of the User-Network Interface (UNI) is supported; the network side of the UNI is not supported.

## Ethernet VLAN Interworking Restrictions

The following restrictions apply to Ethernet/VLAN interworking:

- When you configure VLAN to Ethernet interworking, VLAN to Frame Relay (routed) interworking, or ATM using Ethernet (bridged) interworking, the PE router on the Ethernet side that receives a VLAN tagged frame from the CE router removes the VLAN tag. In the reverse direction, the PE router adds the VLAN tag to the frame before sending the frame to the CE router.  
(If you enable the L2VPN Interworking: VLAN Enable/Disable Option for AToM feature with the **interworking vlan** command, the VLAN ID is included as part of the Ethernet frame. See the "VLAN Interworking" section for more information.)
- In bridged interworking from VLAN to Frame Relay, the Frame Relay PE router does not strip off VLAN tags from the Ethernet traffic it receives.
- Cisco 10720 series Internet routers support Ethernet to VLAN Interworking Ethernet only over L2TPv3.
- Ethernet interworking for a raw Ethernet port or a VLAN trunk is not supported. Traffic streams are not kept separate when traffic is sent between transport types.
- In routed mode, only one CE router can be attached to an Ethernet PE router.
- There must be a one-to-one relationship between an attachment circuit and the pseudowire. Point-to-multipoint or multipoint-to-point configurations are not supported.
- Ensure that you configure routing protocols for point-to-point operation on the CE routers when configure Ethernet to non-Ethernet.
- In the IP interworking mode, the IPv4 (0800) translation is supported. The PE router captures ARP (0806) packets and responds with its own MAC address (proxy ARP). Everything else is dropped.
- The Ethernet or VLAN must contain only two IP devices: a PE router and a CE router. The PE router performs proxy ARP and responds to all ARP requests it receives. Therefore, only one CE and one PE router should be on the Ethernet or VLAN segment.
- If CE routers are configured for static routing, perform the following tasks:
  - The PE router needs to learn the MAC address of the CE router to correctly forward traffic to it. The Ethernet PE router sends an Internet Control Message Protocol (ICMP) Router discovery protocol (RDP) solicitation message with the source IP address as zero. The Ethernet CE router responds to this solicitation message. To configure Cisco CE router's Ethernet or VLAN interface to respond to the ICMP RDP solicitation message, use the **ip irdp** command in interface configuration mode. If you do not configure the CE router, traffic is dropped until the CE router sends traffic towards the PE router.
  - To disable the CE routers from running the router discovery protocol, issue the **ip irdp maxadvertinterval 0** command in interface mode.

- Ethernet interworking between an Ethernet port and a VLAN supports spanning tree protocol only on VLAN 1. Configure VLAN 1 as a nonnative VLAN. This restriction applies if you configure interworking between Ethernet and VLAN with Catalyst switches as the CE routers. The spanning tree protocol is supported for Ethernet interworking.
- When you change the interworking configuration on an Ethernet PE router, clear the ARP entry on the adjacent CE router so that it can learn the new MAC address. Otherwise, you might experience traffic drops.

## L2VPN Interworking VLAN Enable/Disable Option for AToM Restrictions

The following restrictions apply to the L2VPN Interworking: VLAN Enable/Disable Option for AToM feature, which allows the VLAN ID to be included as part of the Ethernet frame:

- The L2VPN Interworking: VLAN Enable/Disable Option for AToM feature is supported in the following releases:
  - Cisco IOS Release 12.2(52)SE for Cisco Catalyst 3750 Metro switches
  - Cisco IOS Release 12.2(33)SRE for Cisco 7600 series routers
- The L2VPN Interworking: VLAN Enable/Disable Option for AToM feature is not supported with L2TPv3. You can configure the feature only with AToM.
- If the interface on the PE router is a VLAN interface, the **interworking vlan** command need not be specified on that PE router.
- The L2VPN Interworking: VLAN Enable/Disable Option for AToM feature works only with the following attachment circuit combinations:
  - Ethernet to Ethernet
  - Ethernet to VLAN
  - VLAN to VLAN
- If you specify an interworking type on a PE router, that interworking type must be enforced. The interworking type must match on both PE routers. Otherwise, the VC may be in an incompatible state and remain in the down state. If the attachment circuit (AC) is VLAN, the PE router can negotiate (autosense) the VC type using the Label Distribution Protocol (LDP). For example, both PE1 and PE2 use Ethernet interfaces, and VLAN interworking is specified on PE1 only. PE2 is not configured with an interworking type and cannot autosense the interworking type. The result is an incompatible state where the VC remains in the down state.  
  
However, if PE1 uses an Ethernet interface and VLAN interworking is enabled (which will enforce VLAN as the VC type), and PE2 uses a VLAN interface and interworking is not enabled (which causes PE2 to use Ethernet as its default VC type), PE2 can autosense and negotiate the interworking type and select VLAN as the VC type.

The table below shows the AC types, interworking options, and VC types after negotiation.

**Table 4: Negotiating Ethernet and VLAN Interworking Types**

| PE1 AC Type | Interworking Option | PE2 AC Type | Interworking Option | VC Type after Negotiation |
|-------------|---------------------|-------------|---------------------|---------------------------|
| Ethernet    | None                | Ethernet    | None                | Ethernet                  |
| VLAN        | None                | Ethernet    | None                | Ethernet                  |
| Ethernet    | None                | VLAN        | None                | Ethernet                  |
| VLAN        | None                | VLAN        | None                | Ethernet                  |
| Ethernet    | VLAN                | Ethernet    | None                | Incompatible              |
| VLAN        | VLAN                | Ethernet    | None                | Incompatible              |
| Ethernet    | VLAN                | VLAN        | None                | VLAN                      |
| VLAN        | VLAN                | VLAN        | None                | VLAN                      |
| Ethernet    | None                | Ethernet    | VLAN                | Incompatible              |
| VLAN        | None                | Ethernet    | VLAN                | VLAN                      |
| Ethernet    | None                | VLAN        | VLAN                | Incompatible              |
| VLAN        | None                | VLAN        | VLAN                | VLAN                      |
| Ethernet    | VLAN                | Ethernet    | VLAN                | VLAN                      |
| VLAN        | VLAN                | Ethernet    | VLAN                | VLAN                      |
| Ethernet    | VLAN                | VLAN        | VLAN                | VLAN                      |
| VLAN        | VLAN                | VLAN        | VLAN                | VLAN                      |

## Frame Relay Interworking Restrictions

The following restrictions apply to Frame Relay interworking:

- The attachment circuit maximum transmission unit (MTU) sizes must match when you connect them over MPLS. By default, the MTU size associated with a Frame Relay DLCI is the interface MTU. This may cause problems, for example, when connecting some DLCIs on a Packet over SONET (POS) interface (with a default MTU of 4470 bytes) to Ethernet or VLAN (with a default MTU of 1500 bytes) and other DLCIs on the same PoS interface to ATM (with a default MTU of 4470 bytes). To avoid reducing all the interface MTUs to the lowest common denominator (1500 bytes in this case), you can specify the MTU for individual DLCIs using the **mtu** command.

- Only DLCI mode is supported. Port mode is not supported.
- Configure Frame Relay switching to use DCE or Network-to-Network Interface (NNI). DTE mode does not report status in the Local Management Interface (LMI) process. If a Frame Relay over MPLS circuit goes down and the PE router is in DTE mode, the CE router is never informed of the disabled circuit. You must configure the **frame-relay switching** command in global configuration mode in order to configure DCE or NNI.
- Frame Relay policing is non-distributed on the Cisco 7500 series routers. If you enable Frame Relay policing, traffic is sent to the Route Switch Processor for processing.
- Inverse ARP is not supported with IP interworking. CE routers must use point-to-point subinterfaces or static maps.
- The PE router automatically supports translation of both Cisco and IETF encapsulations that come from the CE but translates only to IETF when sending to the CE router. This is not a problem for the Cisco CE router because it can handle IETF encapsulation on receipt even if it is configured to send Cisco encapsulation.
- With Ethernet interworking, the following translations are supported:
  - Ethernet without LAN FCS (0300800080C20007 or 6558)
  - Spanning tree (0300800080C2000E or 4242)

All other translations are dropped.

- With IP interworking, IPv4 (03CC or 0800) translation is supported. All other translations are dropped.
- Frame Relay interworking does not pass the IEEE spanning tree bridge protocol data units (BPDUs) when Cisco 7600 series routers are used as PEs.
- PVC status signaling works the same way as in like-to-like case. The PE router reports the PVC status to the CE router based on the availability of the pseudowire. PVC status detected by the PE router will also be reflected into the pseudowire. LMI to OAM interworking is supported when you connect Frame Relay to ATM.

## PPP Interworking Restrictions

The following restrictions apply to PPP interworking:

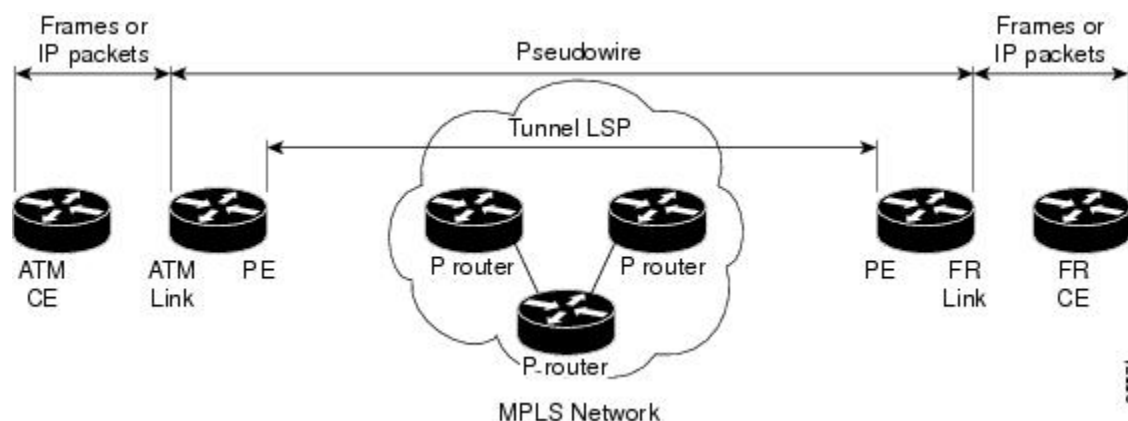
- There must be a one-to-one relationship between a PPP session and the pseudowire. Multiplexing of multiple PPP sessions over the pseudowire is not supported.
- There must be a one-to-one relationship between a PPP session and a Frame Relay DLCI. Each Frame Relay PVC must have only one PPP session.
- Only IP (IPv4 (0021) interworking is supported. Link Control Protocol (LCP) packets and Internet Protocol Control Protocol (IPCP) packets are terminated at the PE router. Everything else is dropped.
- Proxy IPCP is automatically enabled on the PE router when IP interworking is configured on the pseudowire.
- By default, the PE router assumes that the CE router knows the remote CE router's IP address.
- Password Authentication Protocol (PAP) and Challenge-Handshake Authentication Protocol (CHAP) authentication are supported.

# Information About L2VPN Interworking

## Overview of L2VPN Interworking

Layer 2 transport over MPLS and IP already exists for like-to-like attachment circuits, such as Ethernet-to-Ethernet or PPP-to-PPP. L2VPN Interworking builds on this functionality by allowing disparate attachment circuits to be connected. An interworking function facilitates the translation between the different Layer 2 encapsulations. The figure below is an example of Layer 2 interworking, where ATM and Frame Relay packets travel over the MPLS cloud.

**Figure 1: Example of ATM to Frame Relay Interworking**



The L2VPN Interworking feature supports 802.1Q (VLAN), ATM AAL5, Ethernet, Frame Relay, and PPP attachment circuits over MPLS and L2TPv3. The features and restrictions for like-to-like functionality also apply to L2VPN Interworking.



### Note

Both AAL5MUX and AAL5SNAP encapsulations are supported. In the case of AAL5MUX, no translation is needed.

## L2VPN Interworking Modes

L2VPN Interworking works in either Ethernet (bridged) mode, IP (routed), or Ethernet VLAN mode. You specify the mode by issuing the **interworking {ethernet | ip | vlan}** command in pseudowire class configuration mode.

### Ethernet Interworking

The **ethernet** keyword causes Ethernet frames to be extracted from the attachment circuit and sent over the pseudowire. Ethernet end-to-end transmission is assumed. Attachment circuit frames that are not Ethernet are dropped. In the case of VLAN, the VLAN tag is removed, leaving an untagged Ethernet frame.

Ethernet Interworking is also called bridged interworking. Ethernet frames are bridged across the pseudowire. The CE routers can natively bridge Ethernet or route using a bridged encapsulation model, such as Bridge Virtual Interface (BVI) or RBE. The PE routers operate in Ethernet like-to-like mode. This mode is used to offer the following services:

- LAN services—An example is an enterprise that has several sites, where some sites have Ethernet connectivity to the service provider (SP) network and others have ATM connectivity. The enterprise needs LAN connectivity to all its sites. In this case, traffic from the Ethernet or VLAN of one site can be sent through the IP/MPLS network and encapsulated as bridged traffic over an ATM VC of another site.
- Connectivity services—An example is an enterprise that has different sites that are running an Internal Gateway Protocol (IGP), which has incompatible procedures on broadcast and nonbroadcast links. The enterprise has several sites that are running an IGP, such as Open Shortest Path First (OSPF) or Intermediate System to Intermediate System (IS-IS), between the sites. In this scenario, some of the procedures (such as a route advertisement or a designated router) depend on the underlying Layer 2 protocol and are different for a point-to-point ATM connection versus a broadcast Ethernet connection. Therefore, the bridged encapsulation over ATM can be used to achieve a homogenous Ethernet connectivity between the CE routers running the IGP.

## IP Interworking

The **ip** keyword causes IP packets to be extracted from the attachment circuit and sent over the pseudowire. Attachment circuit frames that do not contain IPv4 packets are dropped.

IP Interworking is also called routed interworking. The CE routers encapsulate IP on the link between the CE and PE routers. A new VC type is used to signal the IP pseudowire in MPLS and L2TPv3. Translation between the Layer 2 and IP encapsulations across the pseudowire is required. Special consideration needs to be given to address resolution and routing protocol operation because these are handled differently on different Layer 2 encapsulations.

IP Interworking is used to provide IP connectivity between sites, regardless of the Layer 2 connectivity to these sites. It is different from a Layer 3 VPN because it is point-to-point in nature, and the service provider does not maintain any customer routing information.

Address resolution is encapsulation-dependent, as explained by the following:

- Ethernet uses ARP.
- Frame Relay and ATM use Inverse ARP.
- PPP uses IPCP.

Therefore, address resolution must be terminated on the PE router. End-to-end address resolution is not supported. Routing protocols operate differently over broadcast and point-to-point media. For Ethernet, the CE routers must either use static routing or configure the routing protocols to treat the Ethernet side as a point-to-point network.

## VLAN Interworking

The **vlan** keyword allows the VLAN ID to be included as part of the Ethernet frame. In Cisco IOS Release 12.2(52)SE, you can configure Catalyst 3750 Metro switches to use Ethernet VLAN for Ethernet (bridged) interworking. You can specify the Ethernet VLAN (type 4) by issuing the **interworking vlan** command in pseudowire class configuration mode, which allows the VLAN ID to be included as part of the Ethernet frame.

In releases earlier than Cisco IOS Release 12.2(52)SE, the only way to achieve VLAN encapsulation is to ensure that the CE router is connected to the PE router through an Ethernet VLAN interface or subinterface.

## L2VPN Interworking Support Matrix

The supported L2VPN Interworking features are listed in the table below.

**Table 5: L2VPN Interworking Supported Features**

| Feature   | MPLS or L2TPv3 Support          | IP or Ethernet Support   |
|---|---------------------------------|--------------------------|
| Ethernet/VLAN to ATM AAL5                               | MPLS L2TPv3 (12000 series only) | IP Ethernet              |
| Ethernet/VLAN to Frame Relay                            | MPLS L2TPv3                     | IP Ethernet              |
| Ethernet/VLAN to PPP                                    | MPLS                            | IP                       |
| Ethernet to VLAN  | MPLS L2TPv3                     | IP Ethernet <sup>1</sup> |
| Frame Relay to ATM AAL5                                 | MPLS L2TPv3 (12000 series only) | IP                       |
| Frame Relay to Ethernet or VLAN                         | MPLS L2TPv3                     | IP Ethernet              |
| Frame Relay to PPP                                      | MPLS L2TPv3                     | IP                       |
| L2VPN Interworking: VLAN Enable/Disable Option for AToM | MPLS                            | Ethernet VLAN            |

<sup>1</sup> With the L2VPN Interworking: VLAN Enable/Disable Option for AToM feature, VLAN interworking can also be supported. For more information, see the “VLAN Interworking” section.



### Note

On Cisco 12000 series Internet routers:

- Ethernet (bridged) interworking is not supported for L2TPv3.
- IP (routed) interworking is not supported in an L2TPv3 pseudowire that is configured for data sequencing (using the **sequencing** command).

## Static IP Addresses for L2VPN Interworking for PPP

For a PE router to perform address resolution with the local CE router for PPP, you can configure the remote CE router's IP address on the PE router. Configure the **ppp ipcp address proxy** command with the remote CE router's IP address on the PE router's xconnect PPP interface. The following is a sample configuration:

```
pseudowire-class ip-interworking
 encapsulation mpls
 interworking ip
 interface Serial2/0
```

```
encapsulation ppp
xconnect 10.0.0.2 200 pw-class ip-interworking
ppp ipcp address proxy 10.65.32.14
```

You can also configure the remote CE router's IP address on the local CE router by using the **peer default ip address** command if the local CE router performs address resolution.

# How to Configure L2VPN Interworking

## Configuring L2VPN Interworking

The L2VPN Interworking feature allows you to connect disparate attachment circuits. Configuring the L2VPN Interworking feature requires that you add the **interworking** command to the list of commands that make up the pseudowire. The steps for configuring the pseudowire for L2VPN Interworking are included in this section. You use the **interworking** command as part of the overall AToM or L2TPv3 configuration. For specific instructions about configuring AToM or L2TPv3, see the following documents:

- *Any Transport over MPLS*
- *Layer 2 Tunneling Protocol Version 3*

### SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **hw-module slot *slot-number* np mode feature**
4. **pseudowire-class *name***
5. **encapsulation {mpls | l2tpv3}**
6. **interworking {ethernet | ip | vlan}**
7. **end**

### DETAILED STEPS

|               | Command or Action  | Purpose   |
|---------------|--|---|
| <b>Step 1</b> | <b>enable</b><br><br><b>Example:</b><br>Device> enable                         | Enables privileged EXEC mode.<br><br><ul style="list-style-type: none"> <li>• Enter your password if prompted.</li> </ul> |
| <b>Step 2</b> | <b>configure terminal</b><br><br><b>Example:</b><br>Device# configure terminal | Enters global configuration mode.   |
| <b>Step 3</b> | <b>hw-module slot <i>slot-number</i> np mode feature</b>                       | (Optional) Enables the L2VPN Interworking feature on the Cisco 12000 series Internet router.                              |



|               | Command or Action  | Purpose  |
|---------------|--|--|
|               | <b>Example:</b><br><pre>Device(config)# hw-module slot 3 np mode feature</pre>                                     | <b>Note</b> Enter this command only on a Cisco 12000 series Internet router if you use L2TPv3 for L2VPN Interworking on an ISE (Engine 3) or Engine 5 interface. In this case, you must first enable the L2VPN feature bundle on the line card by entering the <b>hw-module slot slot-number np mode feature</b> command.  |
| <b>Step 4</b> | <b>pseudowire-class</b> <i>name</i><br><br><b>Example:</b><br><pre>Device(config)# pseudowire-class class1</pre>   | Establishes a pseudowire class with the specified name and enters pseudowire class configuration mode.   |
| <b>Step 5</b> | <b>encapsulation</b> {mpls   l2tpv3}<br><br><b>Example:</b><br><pre>Device(config-pw)# encapsulation mpls</pre>    | Specifies the tunneling encapsulation.   |
| <b>Step 6</b> | <b>interworking</b> {ethernet   ip   vlan}<br><br><b>Example:</b><br><pre>Device(config-pw)# interworking ip</pre> | Specifies the type of pseudowire and the type of traffic that can flow across it.<br><br><b>Note</b> On the Cisco 12000 series router, Ethernet (bridged) interworking is not supported for L2TPv3. After you configure the L2TPv3 tunnel encapsulation for the pseudowire using the <b>encapsulation l2tpv3</b> command, you cannot enter the <b>interworking ethernet</b> command. |
| <b>Step 7</b> | <b>end</b><br><br><b>Example:</b><br><pre>Device(config-pw)# end</pre>   | Exits pseudowire class configuration mode and returns to privileged EXEC mode.   |

## Verifying the L2VPN Interworking Configuration

Use the commands listed in the task below as required. You the commands in the order specified.

### SUMMARY STEPS

1. **enable**
2. **show l2tun session all**
3. **show arp**
4. **ping**
5. **show l2tun session interworking**
6. **show mpls l2transport vc detail**

## DETAILED STEPS

**Step 1**      **enable**  
Enables privileged EXEC mode. Enter your password if prompted.

**Step 2**      **show l2tun session all**  
For L2TPv3, you can verify the L2VPN Interworking configuration by using the **show l2tun session all** command on the PE routers.

The following is sample output from the **show l2tun session all** command, and the interworking type is shown in bold.

| PE1  | PE2  |
|--|--|
| <pre> Device# show l2tun session all  Session Information Total tunnels 1 sessions 1 Session id 15736 is up, tunnel id 35411 Call serial number is 4035100045 Remote tunnel name is PE2   Internet address is 10.9.9.9   Session is L2TP signalled   Session state is established, time since change 1d22h   16 Packets sent, 16 received   1518 Bytes sent, 1230 received   Receive packets dropped:     out-of-order:          0     total:                  0   Send packets dropped:     exceeded session MTU:   0     total:                  0   Session vcid is 123   Session Layer 2 circuit, type is Ethernet, name is FastEthernet1/1/0   Circuit state is UP   Remote session id is 26570, remote tunnel id 46882   DF bit off, ToS reflect disabled, ToS value 0, TTL value 255   No session cookie information available   FS cached header information:     encap size = 24 bytes     00000000 00000000 00000000 00000000     00000000 00000000   Sequencing is off </pre> | <pre> Device# show l2tun session all  Session Information Total tunnels 1 sessions 1 Session id 26570 is up, tunnel id 46882 Call serial number is 4035100045 Remote tunnel name is PE1   Internet address is 10.8.8.8   Session is L2TP signalled   Session state is established, time since change 1d22h   16 Packets sent, 16 received   1230 Bytes sent, 1230 received   Receive packets dropped:     out-of-order:          0     total:                  0   Send packets dropped:     exceeded session MTU:   0     total:                  0   Session vcid is 123   Session Layer 2 circuit, type is Ethernet Vlan, name is FastEthernet2/0.1:10   Circuit state is UP, <b>interworking type is Ethernet</b>   Remote session id is 15736, remote tunnel id 35411   DF bit off, ToS reflect disabled, ToS value 0, TTL value 255   No session cookie information available   FS cached header information:     encap size = 24 bytes     00000000 00000000 00000000 00000000     00000000 00000000   Sequencing is off </pre> |

**Step 3**      **show arp**  
You can issue the **show arp** command between the CE routers to ensure that data is being sent.

**Example:**

```
Device# show arp
```

| Protocol | Address  | Age (min) | Hardware Addr  | Type | Interface       |
|----------|----------|-----------|----------------|------|-----------------|
| Internet | 10.1.1.5 | 134       | 0005.0032.0854 | ARPA | FastEthernet0/0 |
| Internet | 10.1.1.7 | -         | 0005.0032.0000 | ARPA | FastEthernet0/0 |

**Step 4****ping**

You can issue the **ping** command between the CE routers to ensure that data is being sent.

**Example:**

```
Device# ping 10.1.1.5
```

```
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.5, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/4 ms
```

**Step 5****show l2tun session interworking**

For L2TPv3, you can verify that the interworking type is correctly set by using the **show l2tun session interworking** command. Enter the command on the PE routers that are performing the interworking translation.

- In the example below, the PE router performs the raw Ethernet translation. The command output displays the interworking type with a dash (-).

**Example:**

```
Device# show l2tun session interworking
```

```
Session Information Total tunnels 1 sessions 1
LocID      TunID      Peer-address  Type IWrk Username, Intf/Vcid, Circuit
15736      35411      10.9.9.9      ETH  -   123,      Fa1/1/0
```

- In the example below, the PE router performs the Ethernet VLAN translation. The command output displays the interworking type as ETH.

**Example:**

```
Device# show l2tun session interworking
```

```
Session Information Total tunnels 1 sessions 1
LocID      TunID      Peer-address  Type IWrk Username, Intf/Vcid, Circuit
26570      46882      10.8.8.8      VLAN ETH 123,      Fa2/0.1:10
```

**Step 6****show mpls l2transport vc detail**

You can verify the AToM configuration by using the **show mpls l2transport vc detail** command. In the following example, the interworking type is shown in bold.

| PE1  | PE2  |
|--|--|
| <pre> Device# show mpls l2transport vc detail  Local interface: Fa1/1/0 up, line protocol up, Ethernet up   Destination address: 10.9.9.9, VC ID: 123, VC status: up     Preferred path: not configured     Default path: active     Tunnel label: 17, next hop 10.1.1.3     Output interface: Fa4/0/0, imposed label stack {17 20}     Create time: 01:43:50, last status change time: 01:43:33     Signaling protocol: LDP, peer 10.9.9.9:0 up     MPLS VC labels: local 16, remote 20     Group ID: local 0, remote 0     MTU: local 1500, remote 1500     Remote interface description: Sequencing: receive disabled, send disabled VC statistics:   packet totals: receive 15, send 4184   byte totals:   receive 1830, send 309248   packet drops:  receive 0, send 0 </pre> | <pre> Device# show mpls l2transport vc detail  Local interface: Fa2/0.3 up, line protocol up, Eth VLAN 10 up   MPLS VC type is Ethernet, <b>interworking type is Ethernet</b>   Destination address: 10.8.8.8, VC ID: 123, VC status: up     Preferred path: not configured     Default path: active     Tunnel label: 16, next hop 10.1.1.3     Output interface: Fa6/0, imposed label stack {16 16}     Create time: 00:00:26, last status change time: 00:00:06     Signaling protocol: LDP, peer 10.8.8.8:0 up     MPLS VC labels: local 20, remote 16     Group ID: local 0, remote 0     MTU: local 1500, remote 1500     Remote interface description: Sequencing: receive disabled, send disabled VC statistics:   packet totals: receive 5, send 0   byte totals:   receive 340, send 0   packet drops:  receive 0, send 0 </pre> |

## Configuring L2VPN Interworking VLAN Option for AToM

You can specify the Ethernet VLAN (type 4) by issuing the **interworking vlan** command in pseudowire class configuration mode, which allows the VLAN ID to be included as part of the Ethernet frame. In releases earlier than Cisco IOS Release 12.2(52)SE and Cisco IOS Release 12.2(33)SRE, the only way to achieve VLAN encapsulation is to ensure that the CE router is connected to the PE router through an Ethernet link.

### Before You Begin

For complete instructions on configuring AToM, see the *Any Transport over MPLS* document.

## SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **pseudowire-class** *name*
4. **encapsulation** {mpls | l2tpv3}
5. **interworking** {ethernet | ip | vlan}
6. **end**
7. **show mpls l2transport vc** [**vcid** *vc-id* | **vcid** *vc-id-min* *vc-id-max*] [**interface** *type number* [*local-circuit-id*]] [**destination** { *ip-address* | *name*}] [**detail**]

## DETAILED STEPS

|               | Command or Action   | Purpose  |
|---------------|---|--|
| <b>Step 1</b> | <b>enable</b><br><br><b>Example:</b><br>Device> enable  | Enables privileged EXEC mode.<br><br>• Enter your password if prompted.                                |
| <b>Step 2</b> | <b>configure terminal</b><br><br><b>Example:</b><br>Device# configure terminal  | Enters global configuration mode.  |
| <b>Step 3</b> | <b>pseudowire-class</b> <i>name</i><br><br><b>Example:</b><br>Device(config)# pseudowire-class class1   | Establishes a pseudowire class with the specified name and enters pseudowire class configuration mode. |
| <b>Step 4</b> | <b>encapsulation</b> {mpls   l2tpv3}<br><br><b>Example:</b><br>Device(config-pw)# encapsulation mpls  | Specifies the tunneling encapsulation.   |
| <b>Step 5</b> | <b>interworking</b> {ethernet   ip   vlan}<br><br><b>Example:</b><br>Device(config-pw)# interworking vlan   | Specifies the type of pseudowire and the type of traffic that can flow across it.                      |
| <b>Step 6</b> | <b>end</b><br><br><b>Example:</b><br>Device(config-pw)# end   | Exits pseudowire class configuration mode and enters privileged EXEC mode.                             |
| <b>Step 7</b> | <b>show mpls l2transport vc</b> [ <b>vcid</b> <i>vc-id</i>   <b>vcid</b> <i>vc-id-min</i> <i>vc-id-max</i> ] [ <b>interface</b> <i>type number</i> [ <i>local-circuit-id</i> ]] [ <b>destination</b> { <i>ip-address</i>   <i>name</i> }] [ <b>detail</b> ] | Displays information about AToM VCs.   |

|  | Command or Action  | Purpose |
|--|--|---------|
|  | <b>Example:</b><br>Device# show mpls l2transport vc detail |         |

### Example

When the pseudowire on an interface is different from the VC type, the interworking type is displayed in the **show mpls l2transport vc detail** command output. In the example below, the pseudowire is configured on an Ethernet port and VLAN interworking is configured in the pseudowire class. The relevant output is shown in bold.

Device# **show mpls l2transport vc 34 detail**

```

Local interface: Et0/1 up, line protocol up, Ethernet up
MPLS VC type is Ethernet, interworking type is Eth VLAN
  Destination address: 10.1.1.2, VC ID: 34, VC status: down
    Output interface: if-?(0), imposed label stack {}
    Preferred path: not configured
    Default path: no route
    No adjacency
  Create time: 00:00:13, last status change time: 00:00:13
  Signaling protocol: LDP, peer unknown
    Targeted Hello: 10.1.1.1(LDP Id) -> 10.1.1.2
    Status TLV support (local/remote)   : enabled/None (no remote binding)
    LDP route watch                     : enabled
    Label/status state machine           : local standby, AC-ready, LnuRnd
    Last local dataplane status rcvd: No fault
    Last local SSS circuit status rcvd: No fault
    Last local SSS circuit status sent: Not sent
    Last local LDP TLV status sent: None
    Last remote LDP TLV status rcvd: None (no remote binding)
    Last remote LDP ADJ status rcvd: None (no remote binding)
  MPLS VC labels: local 2003, remote unassigned
  Group ID: local 0, remote unknown
  MTU: local 1500, remote unknown
  Remote interface description:
  Sequencing: receive disabled, send disabled
  VC statistics:
    packet totals: receive 0, send 0
    byte totals:   receive 0, send 0
    packet drops:  receive 0, seq error 0, send 0

```

# Configuration Examples for L2VPN Interworking

## Example: Ethernet to VLAN over L2TPv3 (Bridged)

| PE1   | PE2  |
|---|--|
| <pre> ip cef ! l2tp-class interworking-class authentication hostname PE1 password 0 lab ! pseudowire-class inter-ether-vlan encapsulation l2tpv3 interworking ethernet protocol l2tpv3 interworking-class ip local interface Loopback0 ! interface Loopback0 ip address 10.8.8.8 255.255.255.255 ! interface FastEthernet1/0 xconnect 10.9.9.9 1 pw-class inter-ether-vlan </pre> | <pre> ip cef ! l2tp-class interworking-class authentication hostname PE2 password 0 lab ! pseudowire-class inter-ether-vlan encapsulation l2tpv3 interworking ethernet protocol l2tpv3 interworking-class ip local interface Loopback0 ! interface Loopback0 ip address 10.9.9.9 255.255.255.255 ! interface FastEthernet0/0 no ip address ! interface FastEthernet0/0.3 encapsulation dot1Q 10 xconnect 10.8.8.8 1 pw-class inter-ether-vlan </pre> |

## Example: Ethernet to VLAN over AToM (Bridged)

| PE1   | PE2   |
|---|---|
| <pre> ip cef ! mpls label protocol ldp mpls ldp router-id Loopback0 force ! pseudowire-class atom-eth-iw encapsulation mpls interworking ethernet ! interface Loopback0 ip address 10.8.8.8 255.255.255.255 ! interface FastEthernet1/0.1 encapsulation dot1q 100 xconnect 10.9.9.9 123 pw-class atom-eth-iw </pre> | <pre> ip cef ! mpls label protocol ldp mpls ldp router-id Loopback0 force ! pseudowire-class atom encapsulation mpls ! interface Loopback0 ip address 10.9.9.9 255.255.255.255 ! interface FastEthernet0/0 no ip address ! interface FastEthernet1/0 xconnect 10.9.9.9 123 pw-class atom </pre> |

## Example: Frame Relay to VLAN over L2TPv3 (Routed)

| PE1  | PE2  |
|--|--|
| <pre> configure terminal ip cef frame-relay switching ! interface loopback 0 ip address 10.8.8.8 255.255.255.255 no shutdown ! pseudowire-class ip  encapsulation l2tpv3  interworking ip  ip local interface loopback0 ! interface POS1/0  encapsulation frame-relay  clock source internal  logging event dlci-status-change  no shutdown  no fair-queue ! connect fr-vlan POS1/0 206 l2transport  xconnect 10.9.9.9 6 pw-class ip ! router ospf 10  network 10.0.0.2 0.0.0.0 area 0  network 10.8.8.8 0.0.0.0 area 0 </pre> | <pre> configure terminal ip routing ip cef frame-relay switching ! interface loopback 0 ip address 10.9.9.9 255.255.255.255 no shutdown ! pseudowire-class ip  encapsulation l2tpv3  interworking ip  ip local interface loopback0 ! interface FastEthernet1/0/1  speed 10  no shutdown ! interface FastEthernet1/0/1.6  encapsulation dot1Q 6  xconnect 10.8.8.8 6 pw-class ip  no shutdown ! router ospf 10  network 10.0.0.2 0.0.0.0 area 0  network 10.9.9.9 0.0.0.0 area 0 </pre> |

## Example: Frame Relay to VLAN over AToM (Routed)

| PE1   | PE2   |
|---|---|
| <pre> configure terminal ip cef frame-relay switching ! mpls label protocol ldp mpls ldp router-id loopback0 mpls ip ! pseudowire-class atom  encapsulation mpls  interworking ip ! interface loopback 0 ip address 10.8.8.8 255.255.255.255 no shutdown ! connect fr-vlan POS1/0 206 l2transport  xconnect 10.9.9.9 6 pw-class atom </pre> | <pre> configure terminal ip routing ip cef frame-relay switching ! mpls label protocol ldp mpls ldp router-id loopback0 mpls ip ! pseudowire-class atom  encapsulation mpls  interworking ip ! interface loopback 0 ip address 10.9.9.9 255.255.255.255 no shutdown ! interface FastEthernet1/0/1.6  encapsulation dot1Q 6  xconnect 10.8.8.8 6 pw-class atom  no shutdown </pre> |



## Example: Frame Relay to ATM AAL5 over AToM (Routed)



**Note** Frame Relay to ATM AAL5 is available only with AToM in IP mode.

| PE1   | PE2   |
|---|---|
| <pre> ip cef frame-relay switching mpls ip mpls label protocol ldp mpls ldp router-id loopback0 force pseudowire-class fratmip encapsulation mpls interworking ip interface Loopback0 ip address 10.33.33.33 255.255.255.255 interface serial 2/0 encapsulation frame-relay ietf frame-relay intf-type dce connect fr-eth serial 2/0 100 l2transport xconnect 10.22.22.22 333 pw-class fratmip interface POS1/0 ip address 10.1.7.3 255.255.255.0 crc 32 clock source internal mpls ip mpls label protocol ldp router ospf 10 passive-interface Loopback0 network 10.33.33.33 0.0.0.0 area 10 network 10.1.7.0 0.0.0.255 area 10 </pre> | <pre> ip cef mpls ip mpls label protocol ldp mpls ldp router-id loopback0 force pseudowire-class fratmip encapsulation mpls interworking ip interface Loopback0 ip address 10.22.22.22 255.255.255.255 interface ATM 2/0 pvc 0/203 l2transport encapsulation aa5snap xconnect 10.33.33.33 333 pw-class fratmip interface POS1/0 ip address 10.1.1.2 255.255.255.0 crc 32 clock source internal mpls ip mpls label protocol ldp router ospf 10 passive-interface Loopback0 network 10.22.22.22 0.0.0.0 area 10 network 10.1.1.0 0.0.0.255 area 10 </pre> |

## Example: VLAN to ATM AAL5 over AToM (Bridged)

| PE1  | PE2  |
|--|--|
| <pre> ip cef ! mpls ip mpls label protocol ldp mpls ldp router-id Loopback0 ! pseudowire-class inter-ether encapsulation mpls interworking ethernet ! interface Loopback0  ip address 10.8.8.8 255.255.255.255 ! interface ATM1/0.1 point-to-point  pvc 0/100 l2transport  encapsulation aal5snap  xconnect 10.9.9.9 123 pw-class inter-ether ! interface FastEthernet1/0  xconnect 10.9.9.9 1 pw-class inter-ether ! router ospf 10  log-adjacency-changes  network 10.8.8.8 0.0.0.0 area 0  network 10.1.1.1 0.0.0.0 area 0 </pre> | <pre> ip cef ! mpls ip mpls label protocol ldp mpls ldp router-id Loopback0 ! pseudowire-class inter-ether encapsulation mpls interworking ethernet ! interface Loopback0  ip address 10.9.9.9 255.255.255.255 ! interface FastEthernet0/0  no ip address ! interface FastEthernet0/0.1  encapsulation dot1Q 10  xconnect 10.8.8.8 123 pw-class inter-ether ! router ospf 10  log-adjacency-changes  network 10.9.9.9 0.0.0.0 area 0  network 10.1.1.2 0.0.0.0 area 0 </pre> |

## Example: Frame Relay to PPP over L2TPv3 (Routed)

| PE1   | PE2   |
|---|---|
| <pre> ip cef ip routing pseudowire-class ppp-fr ! encapsulation l2tpv3 interworking ip ip local interface Loopback0 ! interface Loopback0  ip address 10.1.1.1 255.255.255.255 ! interface FastEthernet1/0/0  ip address 10.16.1.1 255.255.255.0 ! interface Serial3/0/0  no ip address  encapsulation ppp  ppp authentication chap ! ip route 10.0.0.0 255.0.0.0 10.16.1.2 ! xconnect 10.2.2.2 1 pw-class ppp-fr ppp ipcp address proxy 10.65.32.14 </pre> | <pre> ip cef ip routing ! frame-relay switching ! pseudowire-class ppp-fr encapsulation l2tpv3 interworking ip ip local interface Loopback0 ! interface Loopback0  ip address 10.2.2.2 255.255.255.255 ! interface FastEthernet1/0/0  ip address 10.16.2.1 255.255.255.0 ! interface Serial3/0/0  no ip address  encapsulation frame-relay  frame-relay intf-type dce ! ip route 10.0.0.0 255.0.0.0 10.16.2.2 ! connect ppp-fr Serial3/0/0 100 l2transport xconnect 10.1.1.1 100 pw-class ppp-fr </pre> |

## Example: Frame Relay to PPP over AToM (Routed)

| PE1   | PE2   |
|---|---|
| <pre> ip cef ip routing mpls label protocol ldp mpls ldp router-id loopback0 force ! pseudowire-class ppp-fr encapsulation mpls interworking ip ip local interface Loopback0 ! interface Loopback0  ip address 10.1.1.1 255.255.255.255 ! interface FastEthernet1/0/0  ip address 10.16.1.1 255.255.255.0 mpls ip label protocol ldp ! interface Serial3/0/0  no ip address  encapsulation ppp  ppp authentication chap  xconnect 10.2.2.2 1 pw-class ppp-fr  ppp ipcp address proxy 10.65.32.14 ! ip route 10.0.0.0 255.0.0.0 10.16.1.2 </pre> | <pre> ip cef ip routing mpls label protocol ldp mpls ldp router-id loopback0 force ! frame-relay switching ! pseudowire-class ppp-fr encapsulation mpls interworking ip ip local interface Loopback0 ! interface Loopback0  ip address 10.2.2.2 255.255.255.255 ! interface FastEthernet1/0/0  ip address 10.16.2.1 255.255.255.0 mpls ip mpls label protocol ldp ! interface Serial3/0/0  no ip address  encapsulation frame-relay  frame-relay intf-type dce ! ip route 10.0.0.0 255.0.0.0 10.16.2.2 ! connect ppp-fr Serial3/0/0 100 l2transport  xconnect 10.1.1.1 100 pw-class ppp-fr </pre> |

## Example: Ethernet/VLAN to PPP over AToM (Routed)

| PE1   | PE2   |
|---|---|
| <pre> configure terminal mpls label protocol ldp mpls ldp router-id Loopback0 mpls ip ! pseudowire-class ppp-ether   encapsulation mpls   interworking ip ! interface Loopback0   ip address 10.8.8.8 255.255.255.255   no shutdown ! interface POS2/0/1   no ip address   encapsulation ppp   no peer default ip address   ppp ipcp address proxy 10.10.10.1   xconnect 10.9.9.9 300 pw-class ppp-ether   no shutdown </pre> | <pre> configure terminal mpls label protocol ldp mpls ldp router-id Loopback0 mpls ip !   encapsulation mpls pseudowire-class ppp-ether   interworking ip ! interface Loopback0   ip address 10.9.9.9 255.255.255.255   no shutdown ! interface vlan300   mtu 4470   no ip address   xconnect 10.8.8.8 300 pw-class ppp-ether   no shutdown ! interface GigabitEthernet6/2   switchport   switchport trunk encapsulation dot1q   switchport trunk allowed vlan 300   switchport mode trunk   no shutdown </pre> |

## Additional References

### Related Documents

| Related Topic  | Document Title   |
|--|--|
| Cisco IOS commands   | <a href="#">Master Commands List, All Releases</a>               |
| WAN commands: complete command syntax, command mode, defaults, usage guidelines and examples | <a href="#">Wide-Area Networking Command Reference</a>           |
| Layer 2 Tunnel Protocol Version 3  | <i>Layer 2 Tunneling Protocol Version 3</i>                      |
| Any Transport over MPLS  | <i>Any Transport over MPLS</i>                                   |
| Cisco 12000 series routers hardware support  | <i>Cross-Platform Release Notes for Cisco IOS Release 12.0S</i>  |
| Cisco 7600 series routers hardware support   | <i>Cross-Platform Release Notes for Cisco IOS Release 12.2SR</i> |
| Cisco 3270 series routers hardware support   | <i>Release Notes for Cisco IOS Software Release 12.2SE</i>       |

### Standards and RFCs

| Standard/RFC                                | Title  |
|---|--|
| draft-ietf-l2tpext-l2tp-base-03.txt         | <i>Layer Two Tunneling Protocol (Version 3) 'L2TPv3'</i>                               |
| draft-martini-l2circuit-trans-mpls-09.txt   | <i>Transport of Layer 2 Frames Over MPLS</i>   |
| draft-ietf-pwe3-frame-relay-03.txt.         | <i>Encapsulation Methods for Transport of Frame Relay over MPLS Networks</i>           |
| draft-martini-l2circuit-encap-mpls-04.txt.  | <i>Encapsulation Methods for Transport of Layer 2 Frames Over IP and MPLS Networks</i> |
| draft-ietf-pwe3-ethernet-encap-08.txt.      | <i>Encapsulation Methods for Transport of Ethernet over MPLS Networks</i>              |
| draft-ietf-pwe3-hdlc-ppp-encap-mpls-03.txt. | <i>Encapsulation Methods for Transport of PPP/HDLC over MPLS Networks</i>              |
| draft-ietf-ppvpn-l2vpn-00.txt.              | <i>An Architecture for L2VPNs</i>  |

### MIBs

| MIBs  | MIBs Link  |
|---|--|
| No new or modified MIBs are supported by this feature, and support for existing MIBs has not been modified by this feature. | To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL:<br><br><a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a> |

### Technical Assistance

| Description   | Link  |
|---|---|
| The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password. | <a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a> |

## Feature Information for L2VPN Interworking

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to [www.cisco.com/go/cfn](http://www.cisco.com/go/cfn). An account on Cisco.com is not required.

**Table 6: Feature Information for L2VPN Interworking**

| Feature Name       | Releases   | Feature Information |
|--------------------|--|---------------------|
| L2VPN Interworking | 12.0(26)S<br>12.0(30)S<br>12.0(32)S<br>12.0(32)SY<br>12.2(33)SRA<br>12.2(33)SRD<br>12.2(33)SRE<br>12.2(33)SXH<br>12.2(52)SE<br>12.4(11)T |                     |

| Feature Name | Releases | Feature Information   |
|--------------|----------|---|
|              |          | <p>This feature allows disparate attachment circuits to be connected. An interworking function facilitates the translation between the different Layer 2 encapsulations.</p> <p>This feature was introduced in Cisco IOS Release 12.0(26)S.</p> <p>In Cisco IOS Release 12.0(30)S, support was added for Cisco 12000 series Internet routers.</p> <p>In Cisco IOS Release 12.0(32)S, support was added on Engine 5 line cards (SIP-401, SIP-501, SIP-600, and SIP-601) on Cisco 12000 series Internet routers for the following four transport types:</p> <ul style="list-style-type: none"> <li>• Ethernet/VLAN to Frame Relay Interworking</li> <li>• Ethernet/VLAN to ATM AAL5 Interworking</li> <li>• Ethernet to VLAN Interworking</li> <li>• Frame Relay to ATM AAL5 Interworking</li> </ul> <p>On the Cisco 12000 series Internet router, support was added for IP Services Engine (ISE) and Engine 5 line cards that are configured for L2TPv3 tunneling (see the “Layer 2 Tunneling Protocol Version 3” module in <i>Wide-Area Networking Configuration Guide: Layer 2 Services</i>).</p> <p>In Cisco IOS Release 12.2(33)SRA, support was added for Cisco 7600 series routers.</p> <p>In Cisco IOS Release 12.4(11)T, support was added for the following transport types:</p> <ul style="list-style-type: none"> <li>• Ethernet to VLAN Interworking</li> <li>• Ethernet/VLAN to Frame Relay Interworking</li> </ul> |



| Feature Name | Releases | Feature Information  |
|--------------|----------|--|
|              |          | <p>This feature was integrated into Cisco IOS Release 12.2(33)SXH.</p> <p>In Cisco IOS Release 12.2(33)SRD, support for routed and bridged interworking on SIP-400 was added for Cisco 7600 series routers.</p> <p>In Cisco IOS Release 12.2(52)SE, the L2VPN Interworking: VLAN Enable/Disable Option for AToM feature was added for the Cisco 3750 Metro switch.</p> <p>In Cisco IOS Release 12.2(33)SRE, the L2VPN Interworking: VLAN Enable/Disable Option for AToM feature was added for Cisco 7600 series router.</p> <p>The following commands was introduced or modified:<br/><b>interworking.</b></p> |

