Implementing Point to Point Layer 2 services

This module provides the conceptual and configuration information for Point to Point Layer 2 services on Cisco IOS XR software.

For the functionality of MPLS VPNs over IP Tunnels, see Implementing MPLS VPNs over IP Tunnels in Cisco IOS XR Virtual Private Network Configuration Guide.

To locate documentation for other commands that might appear while executing a configuration task, search online in the Cisco IOS XR software master command index.

Note

Point to Point Layer 2 services are also called as MPLS Layer 2 VPNs.

Feature History for Implementing Point to Point Layer 2 services Configuration Module

<table>
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<tr>
<th>Release</th>
<th>Modification</th>
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<tr>
<td>Release 3.4.0</td>
<td>This feature was introduced.</td>
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<tr>
<td>Release 3.4.1</td>
<td>Support was added for:</td>
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<tr>
<td></td>
<td>• Virtual Circuit Connection Verification (VCCV) on L2VPN</td>
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<td></td>
<td>• Layer 2 VPN (L2VPN) Quality of Service (QoS) for Ethernet-over-MPLS (EoMPLS)</td>
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<td>Release 3.5.0</td>
<td>Support was added for:</td>
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<td>• EoMPLS Inter-AS mode</td>
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<td>• Mac-in-Mac protocol</td>
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<td>Release 3.6.0</td>
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<td>• Ethernet Remote Port Shutdown</td>
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<tr>
<td>Release 3.7.0</td>
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<td>• ATM over MPLS (ATMoMPLS) with Layer 2VPN capability.</td>
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| Release 3.8.0| Support was added for Any Transport over MPLS (AToM) for:  
  - IP Interworking on Engine 3 and 5 Line Cards  
  - PPP/HDLC Like-to-Like Pseudowires on Engine 3 and Engine 5 Line Cards  
  - ATM Like-to-Like Pseudowires on Engine 3 and Engine 5 Line Cards  
  - Frame Relay DLCI, and MLFR Like-to-Like Pseudowires on Engine 3 Line Cards  
  - Ethernet Port Mode and VLAN Like-to-Like Pseudowires on Engine 3 Line Cards  
  - Local Switching Support with L2TPv3 on Engine 3 and Engine 5 Line Cards |
| Release 4.0.1| Support was added for the ATM Interworking feature. |
| Release 4.2.0| Support was added for Any Transport over MPLS (AToM) for:  
  - IP Interworking support on cHDLC and PPP attachment circuits  
  - FR-to-Ethernet bridged interworking  
  - Local switching for PPP and cHDLC  
  Support was added for Circuit Emulation (CEM) over Packet |
| Release 4.3.0| Support was added for these features:  
  - L2VPN nonstop routing (NSR)  
  - Pseudowire Grouping |

- Prerequisites for Implementing Point to Point Layer 2 Services, page 3
- Information About Implementing Point to Point Layer 2 Services, page 3
- How to Implement Point to Point Layer 2 Services, page 21
- Configuration Examples for Point to Point Layer 2 Services, page 55
Prerequisites for Implementing Point to Point Layer 2 Services

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.

Information About Implementing Point to Point Layer 2 Services

To implement Point to Point Layer 2 Services, you should understand these concepts:

L2VPN Overview

Layer 2 VPN (L2VPN) emulates the behavior of a LAN across an IP or MPLS-enabled IP network allowing Ethernet devices to communicate with each other as they would when connected to a common LAN segment. As Internet service providers (ISPs) look to replace their Asynchronous Transfer Mode (ATM) infrastructures with an IP infrastructure, there is a need for to provide standard methods of using an IP infrastructure to provide a serviceable L2 interface to customers; specifically, to provide standard ways of using an IP infrastructure to provide virtual circuits between pairs of customer sites.

Building a L2VPN system requires coordination between the ISP and the customer. The ISP provides L2 connectivity; the customer builds a network using data link resources obtained from the ISP. In an L2VPN service, the ISP does not require information about a the customer's network topology, policies, routing information, point-to-point links, or network point-to-point links from other ISPs.

The ISP requires provider edge (PE) routers with the following capabilities:

- Encapsulation of L2 protocol data units (PDU) into Layer 3 (L3) packets.
- Interconnection of any-to-any L2 transports.
- Emulation of L2 quality-of-service (QoS) over a packet switch network.
- Ease of configuration of the L2 service.
- Support for different types of tunneling mechanisms (MPLS, L2TPv3, IPSec, GRE, and others).
- L2VPN process databases include all information related to circuits and their connections.

ATMoMPLS with L2VPN Capability

These topics describe the ATM over MPLS (ATMoMPLS) with L2VPN feature:

ATMoMPLS with L2VPN Overview

The ATMoMPLS feature supports ATM Adaptation Layer 5 (AAL5) transport. ATMoMPLS is a type of Layer 2 point-to-point connection over an MPLS core. ATMoMPLS and ATM local switching are supported only for ATM-to-ATM interface-to-interface switching combinations.
To implement the ATMoMPLS feature, the Cisco CRS-1 Router plays the role of provider edge (PE) router at the edge of a provider network in which customer edge (CE) devices are connected to the Cisco CRS-1 Router.

**Layer 2 Local Switching Overview**

Local switching lets you to switch Layer 2 data between two interfaces of the same type (for example, ATM-to-ATM, or Frame Relay-to-Frame Relay) or between interfaces of different types (for example, Frame Relay to ATM) on the same router, over an IP core network. The interfaces are on the same line card or on two different cards. During these types of switching, Layer 2 address is used instead of the Layer 3 address. In addition, same-port local switching lets you to switch Layer 2 data between two circuits on the same interface.

**ATM Adaptation Layer 5**

AAL5 lets you transport AAL5 PDUs from various customers over an MPLS backbone. ATM AAL5 extends the usability of the MPLS backbone by enabling it to offer Layer 2 services in addition to already existing Layer 3 services. You can enable the MPLS backbone network to accept AAL5 PDUs by configuring the provider edge (PE) routers at both ends of the MPLS backbone.

To transport AAL5 PDUs over MPLS, a virtual circuit is set up from the ingress PE router to the egress PE router. This virtual circuit transports the AAL5 PDUs from one PE router to the other. Each AAL5 PDU is transported as a single packet.

**Virtual Circuit Connection Verification on L2VPN**

Virtual Circuit Connection Verification (VCCV) is an L2VPN Operations, Administration, and Maintenance (OAM) feature that allows network operators to run IP-based provider edge-to-provider edge (PE-to-PE) keepalive protocol across a specified pseudowire to ensure that the pseudowire data path forwarding does not contain any faults. The disposition PE receives VCCV packets on a control channel, which is associated with the specified pseudowire. The control channel type and connectivity verification type, which are used for VCCV, are negotiated when the pseudowire is established between the PEs for each direction.

Two types of packets can arrive at the disposition egress:

- Type 1—Specifies normal Ethernet-over-MPLS (EoMPLS) data packets.
- Type 2—Specifies VCCV packets.

Cisco IOS XR software supports Label Switched Path (LSP) VCCV Type 1, which uses an inband control word if enabled during signaling. The VCCV echo reply is sent as IPv4 that is the reply mode in IPv4. The reply is forwarded as IP, MPLS, or a combination of both.

VCCV pings counters that are counted in MPLS forwarding on the egress side. However, on the ingress side, they are sourced by the route processor and do not count as MPLS forwarding counters.
Ethernet over MPLS

Ethernet-over-MPLS (EoMPLS) provides a tunneling mechanism for Ethernet traffic through an MPLS-enabled L3 core and encapsulates Ethernet protocol data units (PDUs) inside MPLS packets (using label stacking) to forward them across the MPLS network.

EoMPLS features are described in these subsections:

**Ethernet Port Mode**

In Ethernet port mode, both ends of a pseudowire are connected to Ethernet ports. In this mode, the port is tunneled over the pseudowire or, using local switching (also known as an *attachment circuit-to-attachment circuit cross-connect*) switches packets or frames from one attachment circuit (AC) to another AC attached to the same PE node.

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**VLAN Mode**

In VLAN mode, each VLAN on a customer-end to provider-end link can be configured as a separate L2VPN connection using virtual connection (VC) type 4 or VC type 5. VC type 4 is the default mode.
As illustrated in the following figure, the Ethernet PE associates an internal VLAN-tag to the Ethernet port for switching the traffic internally from the ingress port to the pseudowire; however, before moving traffic into the pseudowire, it removes the internal VLAN tag.

Figure 2: VLAN Mode Packet Flow

At the egress VLAN PE, the PE associates a VLAN tag to the frames coming off of the pseudowire and after switching the traffic internally, it sends out the traffic on an Ethernet trunk port.

Note Because the port is in trunk mode, the VLAN PE doesn't remove the VLAN tag and forwards the frames through the port with the added tag.

Note L2VPN forwarding using GRE tunnels is supported in the VLAN mode.

Inter-AS Mode

Inter-AS is a peer-to-peer type model that allows extension of VPNs through multiple provider or multi-domain networks. This lets service providers peer up with one another to offer end-to-end VPN connectivity over extended geographical locations.

EoMPLS support can assume a single AS topology where the pseudowire connecting the PE routers at the two ends of the point-to-point EoMPLS cross-connects resides in the same autonomous system; or multiple AS topologies in which PE routers can reside on two different ASs using iBGP and eBGP peering.
The following figure illustrates MPLS over Inter-AS with a basic double AS topology with iBGP/LDP in each AS.

**Figure 3: EoMPLS over Inter-AS: Basic Double AS Topology**

QinQ Mode

QinQ is an extension of 802.1Q for specifying multiple 802.1Q tags (IEEE 802.1QinQ VLAN Tag stacking). Layer 3 VPN service termination and L2VPN service transport are enabled over QinQ sub-interfaces. The Cisco XR 12000 Series Routers implement the Layer 2 tunneling or Layer 3 forwarding depending on the subinterface configuration at provider edge routers. This function only supports up to two QinQ tags on the SPA and fixed PLIM:

- **Layer 2 QinQ VLANs in L2VPN attachment circuit**: QinQ L2VPN attachment circuits are configured under the Layer 2 transport subinterfaces for point-to-point EoMPLS based cross-connects using both virtual circuit type 4 and type 5 pseudowires and point-to-point local-switching-based cross-connects including full interworking support of QinQ with 802.1q VLANs and port mode.
- **Layer 3 QinQ VLANs**: Used as a Layer 3 termination point, both VLANs are removed at the ingress provider edge and added back at the remote provider edge as the frame is forwarded.

Layer 3 services over QinQ include:

- IPv4 unicast and multicast
- IPv6 unicast and multicast
- MPLS
- Connectionless Network Service (CLNS) for use by Intermediate System-to-Intermediate System (IS-IS) Protocol

**Note**

The Cisco CRS-1 router does not support: bundle attachment circuits and Hot Standby Router Protocol (HSRP) or Virtual Router Redundancy Protocol (VRRP) on QinQ subinterfaces.
In QinQ mode, each CE VLAN is carried into an SP VLAN. QinQ mode should use VC type 5, but VC type 4 is also supported. On each Ethernet PE, you must configure both the inner (CE VLAN) and outer (SP VLAN).

The following figure illustrates QinQ using VC type 4.

**Figure 4: EoMPLS over QinQ Mode**

QinAny Mode

In the QinAny mode, the service provider VLAN tag is configured on both the ingress and the egress nodes of the provider edge VLAN. QinAny mode is similar to QinQ mode using a Type 5 VC, except that the customer edge VLAN tag is carried in the packet over the pseudowire, as the customer edge VLAN tag is unknown.

**Mac-in-Mac Protocol (Provide Backbone Bridging)**

The Mac-in-Mac (or, Provider Backbone Bridging) protocol lets service providers scale networks using Ethernet technology to maintain management and operational simplicity, and reduce operating costs.

Mac-In-Mac encapsulates the customer MAC header with a service provider MAC header. Instead of using additional Q-tags to separate end customers, a 24-bit service tag in the service provider encapsulating MAC header is used, which provides support for up to 16-million service instances.

**Note**

Mac-In-Mac is standardized as IEEE 802.1ah.

**Quality of Service**

Using L2VPN technology, you can assign a quality of service (QoS) level to both Port and VLAN modes of operation.
L2VPN technology requires that QoS functionality on PE routers be strictly L2-payload-based on the edge-facing interfaces (also known as attachment circuits). The following figure illustrates L2 and L3 QoS service policies in a typical L2VPN network.

**Figure 5: L2VPN QoS Feature Application**

The following figure shows four packet processing paths within a provider edge device where a QoS service policy can be attached. In an L2VPN network, packets are received and transmitted on the edge-facing interfaces as L2 packets and transported on the core-facing interfaces as MPLS (EoMPLS) or IP (L2TP) packets.

**Figure 6: L2VPN QoS Reference Model**

### High Availability

L2VPN uses control planes in both route processors and line cards, as well as forwarding plane elements in the line cards.

Note: The l2tp_mgr process does not support high availability.
The availability of L2VPN meets these requirements:

- A control plane failure in either the route processor or the line card will not affect the circuit forwarding path.
- The router processor control plane supports failover without affecting the line card control and forwarding planes.
- L2VPN integrates with existing Label Distribution Protocol (LDP) graceful restart mechanism.

**Preferred Tunnel Path**

Preferred tunnel path functionality lets you map pseudowires to specific traffic-engineering tunnels. Attachment circuits are cross-connected to specific MPLS traffic engineering tunnel interfaces instead of remote PE router IP addresses (reachable using IGP or LDP). Using preferred tunnel path, it is always assumed that the traffic engineering tunnel that transports the L2 traffic runs between the two PE routers (that is, its head starts at the imposition PE router and its tail terminates on the disposition PE router).

**Note**

- Currently, preferred tunnel path configuration applies only to MPLS encapsulation.
- The fallback enable option is supported.

**Any Transport over MPLS**

Any Transport over MPLS (AToM) transports Layer 2 packets over a Multiprotocol Label Switching (MPLS) backbone. This enables service providers to connect customer sites with existing Layer 2 networks by using a single, integrated, packet-based network infrastructure. Using this feature, service providers can deliver Layer 2 connections over an MPLS backbone, instead of using separate networks.

AToM encapsulates Layer 2 frames at the ingress PE router, and sends them to a corresponding PE router at the other end of a pseudowire, which is a connection between the two PE routers. The egress PE removes the encapsulation and sends out the Layer 2 frame.

The successful transmission of the Layer 2 frames between PE routers is due to the configuration of the PE routers. You set up a connection, called a pseudowire, between the routers. You specify this information on each PE router:

- The type of Layer 2 data that will be transported across the pseudowire, such as Ethernet and Frame Relay.
- The IP address of the loopback interface of the peer PE router, which enables the PE routers to communicate.
- A unique combination of peer PE IP address and VC ID that identifies the pseudowire.

These topics describe the AToM feature:

- **IP or Routed Interworking**
- **Like-to-Like Pseudowires**
Control Word Processing

### IP or Routed Interworking

In AToM IP Interworking, also called *routed interworking*, the carrier edge (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.

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.

These modes support IP Interworking on AToM:

- **ATM to Ethernet**: In this interworking, both ATM and Ethernet PE routers are configured for IP interworking. IP packets from an ATM CE are encapsulated using IP over MPLS and transmitted over the pseudowire. On the Ethernet side, the Ethernet PE removes the Layer 2 framing on the Ethernet packets from the Ethernet CE and forwards the IP packet on the pseudowire using IP over MPLS encapsulation. Non-IP packets are dropped in this process. At the ATM PE, after label disposition, the IP packets are encapsulated over AAL5 using IP encapsulation. In either direction, packets for which translations are not supported, are dropped.

- **Ethernet port to VLAN mode**: Using the Ethernet port mode, you can create an Ethernet virtual local area network (VLAN) among geographically separated sites. Different sites can operate together over an MPLS network as though they were on a common Ethernet network.

- **Frame Relay to Ethernet**: Multi-protocol Frame Relay packets from the Frame Relay CE are encapsulated using IP over MPLS and transmitted over the pseudowire. On the Ethernet side, the Ethernet PE removes the Layer 2 framing on the Ethernet packets from the Ethernet CE and forwards the Layer 3 packet over the pseudowire using IP over MPLS encapsulation. At the Frame Relay PE, after label disposition, the Layer 3 packets are encapsulated over Frame Relay using IP encapsulation. In either direction, packets for which translations are not supported are dropped.

- **Frame Relay to ATM AAL5**: ATM and Frame Relay links are locally terminated and IP interworking is used to transport the Layer 3 packets over the IP over MPLS pseudowire.

- **ATM AAL5**—ATM Adaptation Layer Type-5 (AAL5) allows efficient transportation of PVCs across the MPLS backbone. Multiple PVCs can be multiplexed onto a single label switched path between the provider edge routers.

- **Point-to-Point**—In this interworking, the point-to-point protocol (PPP) session is terminated at the PE while interworking with PPP attachment circuits. The PE router is responsible for negotiating LCP and IPCP with the CE router. PPP on the PE router can be configured with the `ppp ipcp address proxy ip-address` command where the remote CE router’s IP address is used. This IP address is used by the PE router during IPCP negotiations with the CE router.

- **Cisco High-Level Data Link Control (cHDLC)**—Interworking with cHDLC attachment circuits works in the same way as interworking with PPP attachment circuits. However, *keepalive* messages are sent and received between the PE and CE routers to keep the L2VPN attachment circuit active.

These types of cross connections are supported for AToM IP Interworking:

- **Ethernet**
  - **VLAN**
ATM AAL5 to Ethernet Bridged Interworking

This interworking provides interoperability between ATM attachment virtual circuit (AC) and Ethernet attachment AC connected to different provider edge (PE) routers. The bridged encapsulation is used corresponding to the bridged (Ethernet) interworking mechanism.

The interworking function is performed at the PE connected to the ATM AC.

Processing at PE connected to ATM AC

In the direction from the ATM segment to MPLS cloud, the bridged encapsulation (ATM or SNAP header) is discarded and the ethernet frame is encapsulated with the labels required to pass through the pseudowire using the VC type 5 (Ethernet). ATM side is configured with encapsulation type as aal5snap. In the opposite direction, after the label disposition from the MPLS cloud, ethernet frames are encapsulated over AAL5 using bridged encapsulation.

These translations are supported:

- Ethernet without LAN FCS
- Spanning tree
The existing QoS functionality for ATM is supported, including setting the ATM CLP bit. Non-AAL5 traffic, (e.g. OAM cells) are processed at RP level. A VC that has been configured with OAM cell emulation on the ATM PE router (with `oam-ac emulation-enable` command) can send end-to-end F5 loopback cells at configured intervals toward the customer edge (CE) router. When the pseudowire is down, an F5 end-to-end segment alarm indication signal or remote defect indication (AIS/RD) is sent from the PE router to the CE router.

**Restrictions**

These restrictions must be considered:

- Only ATM AAL5 VC mode is supported. ATM VP and port mode are not supported.
- SVCs are not supported.

**Processing at PE connected to Ethernet AC**

This section provides information on:

- Ethernet Port Mode
- Ethernet dot1q/qinq

**Ethernet Port Mode**

The Ethernet PE (connected to the Ethernet segment) operates similarly to Ethernet like-to-like services. For the packets coming from MPLS cloud, after the label disposition, the Ethernet frames are sent as is towards CE.

![Figure 7: Protocol Stack for ATM to Ethernet AToM Bridged Interworking (without VLAN tag)](image)
If the Ethernet frame arriving from Ethernet CE includes a 802.1Q header (VLAN header), due to the type of endpoint attachment (Ethernet port mode), the VLAN header stays in the frame across the pseudowire as shown in the following figure.

**Note**

Figure 8: Protocol Stack for ATM to Ethernet AToM Bridged Interworking (with Vlan tag)

**Ethernet dot1q/qinq**

The PE connected to the Ethernet side discards the VLAN tags present in the incoming packets from the VLAN CE and pushed towards the MPLS cloud. For packets coming from MPLS cloud, it inserts VLAN tags into the Ethernet frames. Therefore, the frames sent on the pseudo wire (with VC type 5) are Ethernet frames without the VLAN header.
Ethernet frames received from the VLAN CE can contain more than two tags. Therefore, the number of tags processed or removed on the PE depends on the encapsulation type (dot1q/qinq) and the remaining tags are sent towards MPLS cloud as the payload.

**Figure 9: Protocol Stack for ATM to VLAN AToM Bridged Interworking**

The functionality mentioned in the earlier sections applies to Local switching as well. The only difference is that, no PWE3 signaling is involved in bringing up the L2VPN circuit.

**Ethernet or Bridged Interworking**

Ethernet interworking is also called bridged interworking. Ethernet frames are bridged across the pseudowire. The CE routers could be natively bridging Ethernet or could be routing using a bridged encapsulation model. The PE routers operate in Ethernet like-to-like mode.
The following figure shows the reference network for Frame Relay (FR) to Ethernet bridged interworking.

**Figure 10: Reference Network for Bridged Interworking**

On the PE connected to FR attachment circuit (AC), in the direction from the FR segment to MPLS cloud, the Ethernet frames are received with the Frame Relay bridged encapsulation (FR/SNAP header). The SNAP header is discarded and the Ethernet frame is encapsulated with the labels required to pass through the pseudowire using the VC type 5 (Ethernet).

In the opposite direction, after the label disposition from the MPLS cloud, Ethernet frames are encapsulated over FR using bridged encapsulation.

**Restrictions**

These restrictions apply to the FR AC for the BRIW with Ethernet:

- At the FR AC, only these translations are supported and other translations are dropped:
  - Ethernet without LAN FCS (0300800080C20007)
  - Spanning tree (0300800080C2000E)

- The PVC status signaling works the same way as in the like-to-like case. The PE router reports the PVC status to the CE router based upon the availability of the pseudowire.

- The attachment circuit maximum transmission unit (MTU) must match when connected over MPLS.

- Only FR DLCI mode is supported. FR port mode is not supported.

- If the Ethernet frame includes a 802.1Q header (VLAN header), due to the type of endpoint attachment (Ethernet port mode), the VLAN header stays in the frame across the pseudowire.

The Ethernet PE (connected to the Ethernet segment) operates similarly to Ethernet like-to-like services. For the packets coming from MPLS cloud, after the label disposition, the Ethernet frames are sent as is towards the CE side.

The PE connected to the Ethernet side, discards the VLAN tag(s) (Service Provider's) present in the incoming packets from the VLAN CE and pushes towards the MPLS cloud after adding the PWE3 Labels. For the packets coming from MPLS cloud, VLAN tag(s) are inserted into the Ethernet frames. Therefore, the frames sent on the pseudo wire (with VC type 5) are Ethernet frames without the Service Provider VLAN header.
Ethernet frames received from the VLAN CE or MPLS cloud can contain more than 2 tags. Therefore, the number of tags processed or removed on the PE depends on the type of encapsulation (dot1q/qinq) and the remaining tags are sent towards VLAN CE or MPLS cloud as the payload.

### FR to Ethernet Local Switching

The following figure shows the local switching with bridged interworking.

#### Figure 11: Protocol Stack for FR to Ethernet(dot1Q/QinQ) Bridged Interworking

Local Switching with bridged interworking provides interoperability between Frame Relay attachment circuit and Ethernet attachment circuit connected to the same PE router. For this interworking type, bridged encapsulation is used corresponding to the bridged (Ethernet) interworking mechanism.

In the Ethernet to FR direction, the PE router forwards the Layer 2 packet without any change to the egress interface, encapsulating the L2 packet over FR using bridged encapsulation.

In the FR to Ethernet direction, the FR header and bridged encapsulation are discarded and the L2 packet is sent out with Ethernet encapsulation.

In local switching the only difference is that there is no PWE3 signaling involved in bringing up the L2VPN circuit.

### Control Word Processing

The control word contains forward explicit congestion notification (FECN), backward explicit congestion notification (BECN) and DE bits in case of frame relay connection.

Control word is mandatory for:

- Frame Relay
- ATM AAL5
- Frame Relay to Ethernet bridged interworking
- cHDLC/PPP IP interworking
- CEM (Circuit Emulation)
The system does not map bits from one transport end point to another across an AToM IP Interworking connection.

**Like-to-Like Pseudowires**

A pseudowire (PW) is a bidirectional VC connecting two Attached Circuits. In an MPLS network, PWs are carried inside an LSP tunnel.

A point-to-point (PPP) connection allows service providers to provide a transparent PPP pass-through where the customer-edge routers can exchange the traffic through an end-to-end PPP session. Service providers can offer a virtual leased-line solution, and use the PPP subinterface capability to peer with multiple providers through a single POS connection.

A High-Level Data Link control (HDLC) connection is emulated from a customer router to another customer router across an MPLS backbone. This technology allows transportation of HDLC frames across the packet networks. HDLC over MPLS also works in transparent mode.

**Circuit Emulation Over Packet Switched Network**

Circuit Emulation over Packet (CEoP) is a method of carrying TDM circuits over packet switched network. CEoP is similar to a physical connection. The goal of CEoP is to replace leased lines and legacy TDM networks.

CEoP operates in two major modes:

- **Unstructured mode** is called SAToP (Structure Agnostic TDM over Packet)
  SAToP addresses only structure-agnostic transport, i.e., unframed E1, T1, E3 and T3. It segments all TDM services as bit streams and then encapsulates them for transmission over a PW tunnel. This protocol can transparently transmit TDM traffic data and synchronous timing information. SAToP completely disregards any structure and provider edge routers (PEs) do not need to interpret the TDM data or to participate in the TDM signaling. The protocol is a simple way for transparent transmission of PDH bit-streams.

- **Structured mode** is named CESoPSN (Circuit Emulation Service over Packet Switched Network)
  Compared with SAToP, CESoPSN transmits emulated structured TDM signals. That is, it can identify and process the frame structure and transmit signaling in TDM frames. It may not transmit idle timeslot channels, but only extracts useful timeslots of CE devices from the E1 traffic stream and then encapsulates them into PW packets for transmission.CEoP SPAs are half-height (HH) Shared Port Adapters (SPA)
and the CEoP SPA family consists of 24xT1/E1, 2xT3/E3, and 1xOC3/STM1 unstructured and structured (NxDS0) quarter rate, half height SPAs.

Figure 12: Enterprise Data Convergence using Circuit Emulation over Packet

The CEM functionality is supported only on Engine 5 line cards having CEoP SPAs. CEM is supported on:

- 1-port Channelized OC3 STM1 ATM CEoP SPA (SPA-1CHOC3-CE-ATM)

CESoPSN and SAToP can use MPLS, UDP/IP, and L2TPv3 as the underlying transport mechanism. This release supports only MPLS transport mechanism.

CEoP SPA supports these modes of operation:

- Circuit Emulation Mode (CEM)
- ATM Mode
- IMA Mode

Note

Only CEM mode is supported.

Benefits of Circuit Emulation over Packet Switched Network

CEM offers these benefits to the service provider and end-users:

- Saving cost in installing equipment.
• Saving cost in network operations; as leased lines are expensive, limiting their usage to access only mode saves significant costs.
• Ensuring low maintenance cost because only the core network needs to be maintained.
• Utilizing the core network resources more efficiently with packet switched network, while keeping investment in access network intact.
• Providing cheaper services to the end-user.

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L2VPN Nonstop Routing

The L2VPN Nonstop Routing (NSR) feature avoids label distribution path (LDP) sessions from flapping on events such as process failures (crash) and route processor failover (RP FO). NSR on process failure (crash) is supported by performing RP FO, if you have enabled NSR using NSR process failure switchover.

NSR enables the router (where failure has occurred) to maintain the control plane states without a graceful restart (GR). NSR, by definition, does not require any protocol extension and typically uses Stateful Switch Over (SSO) to maintain it's control plane states.

Pseudowire Grouping

When pseudowires (PWs) are established, each PW is assigned a group ID that is common for all PWs created on the same physical port. When a physical port becomes non-functional or disabled, Automatic Protection Switching (APS) signals the peer router to get activated and L2VPN sends a single message to advertise the status change of all PWs that have the Group ID associated with the physical port. A single L2VPN signal thus avoids a lot of processing and loss in reactivity.

Note

Pseudowire grouping is disabled by default.
How to Implement Point to Point Layer 2 Services

This section describes the tasks required to implement Point to Point Layer 2 Services:

Configuring an Interface or Connection for Point to Point Layer 2 Services

Perform this task to configure an interface or a connection for Point to Point Layer 2 Services.

SUMMARY STEPS

1. configure
2. interface type interface-path-id
3. l2transport
4. exit
5. interface type interface-path-id
6. dot1q native vlan vlan-id
7. Use the commit or end command.

DETAILED STEPS

Step 1 configure

Example:

RP/0/0/CPU0:router# configure

Enters the Global Configuration mode.

Step 2 interface type interface-path-id

Example:

RP/0/0/CPU0:router(config)# interface GigabitEthernet 0/0/0/0

Enters interface configuration mode and configures an interface.

Step 3 l2transport

Example:

RP/0/0/CPU0:router(config-if)# l2transport

Enables L2 transport on the selected interface.

Step 4 exit
Example:
RP/0/0/CPU0:router(config-if-l2)# exit
Exits the current configuration mode.

**Step 5**

```
interface type interface-path-id
```

Example:
RP/0/0/CPU0:router(config)# interface GigabitEthernet0/0/0/0
Enters interface configuration mode and configures an interface.

**Step 6**

```
dot1q native vlan vlan-id
```

Example:
RP/0/0/CPU0:router(config-if)# dot1q native vlan 1
Assigns the native VLAN ID of a physical interface trunking 802.1Q VLAN traffic.

**Step 7**

Use the `commit` or `end` command.
- **commit** - Saves the configuration changes and remains within the configuration session.
- **end** - Prompts user to take one of these actions:
  - **Yes** - Saves configuration changes and exits the configuration session.
  - **No** - Exits the configuration session without committing the configuration changes.
  - **Cancel** - Remains in the configuration mode, without committing the configuration changes.

---

**Configuring Static Point-to-Point Cross-Connects**

**Note**
Consider this information about cross-connects when you configure static point-to-point cross-connects:

- An cross-connect is uniquely identified with the pair; the cross-connect name must be unique within a group.
- A segment (an attachment circuit or pseudowire) is unique and can belong only to a single cross-connect.
- A static VC local label is globally unique and can be used in one pseudowire only.
- No more than 16,000 cross-connects can be configured per router.

---

**Note**
Static pseudowire connections do not use LDP for signaling.
Perform this task to configure static point-to-point cross-connects.

SUMMARY STEPS

1. configure
2. l2vpn
3. xconnect group group-name
4. p2p xconnect-name
5. interworking ethernet
6. interface type interface-path-id
7. neighbor ip-address pw-id pseudowire-id
8. mpls static label local { value } remote { value }
9. Use the commit or end command.
10. show l2vpn xconnect group group name

DETAILED STEPS

Step 1 configure

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

Step 2 l2vpn

Example:
RP/0/0/CPU0:router(config)# l2vpn
Enters L2VPN configuration mode.

Step 3 xconnect group group-name

Example:
RP/0/0/CPU0:router(config-l2vpn)# xconnect group vlan_grp_1
Enters the name of the cross-connect group.

Step 4 p2p xconnect-name

Example:
RP/0/0/CPU0:router(config-l2vpn-xc)# p2p vlan1
Enters a name for the point-to-point cross-connect.

Step 5 interworking ethernet
Example:
RP/0/0/CPU0:router(config-l2vpn-xc)# interworking ethernet

(Optional) Configures bridged interworking.

Step 6  
interface type interface-path-id

Example:
RP/0/0/CPU0:router(config-l2vpn-xc-p2p)# interface GigabitEthernet0/0/0/0.1

Specifies the interface type and instance. The choices are:

• GigabitEthernet: GigabitEthernet/IEEE 802.3 interfaces.
• TenGigE: TenGigabitEthernet/IEEE 802.3 interfaces.

Step 7  
neighbor ip-address pw-id pseudowire-id

Example:
RP/0/0/CPU0:router(config-l2vpn-xc-p2p)# neighbor 2.2.2.2 pw-id 2000

Configures the pseudowire segment for the cross-connect.

Optionally, you can disable the control word or set the transport-type to Ethernet or VLAN.

Step 8  
mls static label local \{ value \} remote \{ value \}

Example:
RP/0/0/CPU0:router(config-l2vpn-xc-p2p-pw)# mpls static label local 699 remote 890

Configures local and remote label ID values.

Step 9  
Use the commit or end command.

commit - Saves the configuration changes and remains within the configuration session.
end - Prompts user to take one of these actions:

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

Step 10  
show l2vpn xconnect group group name

Example:
RP/0/RP0/CPU0:show l2vpn xconnect group p2p

Displays the name of the Point-to-Point cross-connect group you created.
Configuring Dynamic Point-to-Point Cross-Connects

Perform this task to configure dynamic point-to-point cross-connects.

For dynamic cross-connects, LDP must be up and running. To support MPLS Transport based PWs, configure the IGP Routing Protocol.

**SUMMARY STEPS**

1. `configure`
2. `l2vpn`
3. `xconnect group group-name`
4. `p2p xconnect-name`
5. `interworking ipv4` or `interworking ethernet`
6. `interface type interface-path-id`
7. `neighbor ip-address pw-id pseudowire-id`
8. Use the `commit` or `end` command.

**DETAILED STEPS**

**Step 1**

`configure`

**Example:**

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

Enters the Global Configuration mode.

**Step 2**

`l2vpn`

**Example:**

```
RP/0/0/CPU0:router(config)# l2vpn
```

Enters L2VPN configuration mode.

**Step 3**

`xconnect group group-name`

**Example:**

```
RP/0/0/CPU0:router(config-l2vpn)# xconnect group grp_1
```

Enters the name of the cross-connect group.

**Step 4**

`p2p xconnect-name`
Example:

```
RP/0/0/CPU0:router(config-l2vpn-xc)# p2p vlan1
```

Enters a name for the point-to-point cross-connect.

**Step 5**

**interworking ipv4** or **interworking ethernet**

Example:

```
RP/0/0/CPU0:router(config-l2vpn-xc)# interworking ipv4 or interworking ethernet
```

Configure the interworking for IPv4 or Ethernet network.

**Step 6**

**interface type interface-path-id**

Example:

```
RP/0/0/CPU0:router(config-l2vpn-xc-p2p)# interface GigabitEthernet0/0/0/0.1
```

Specifies the interface type ID. The choices are:

- GigabitEthernet: GigabitEthernet/IEEE 802.3 interfaces.
- TenGigE: TenGigabitEthernet/IEEE 802.3 interfaces.
- CEM: Circuit Emulation interface

**Step 7**

**neighbor ip-address pw-id pseudowire-id**

Example:

```
RP/0/0/CPU0:router(config-l2vpn-xc-p2p)# neighbor 2.2.2.2 pw-id 2000
```

Configures the pseudowire segment for the cross-connect.

Optionally, you can disable the control word or set the transport-type to Ethernet or VLAN.

**Step 8**

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

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

**end** - Prompts user to take one of these actions:

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

The Inter-AS configuration procedure is identical to the L2VPN cross-connect configuration tasks (see “Configuring Static Point-to-Point Cross-Connects” section and “Configuring Dynamic Point-to-Point Cross-Connects” section) except that the remote PE IP address used by the cross-connect configuration is now reachable through iBGP peering.

**Note**

You must be knowledgeable about IBGP, EBGP, and ASBR terminology and configurations to complete this configuration.

Configuring L2VPN Quality of Service

This section describes how to configure L2VPN quality of service (QoS) in port mode and mode, VLAN mode, Frame Relay and ATM sub-interfaces.

**Restrictions**

The `l2transport` command cannot be used with any IP address, L3, or CDP configuration.

Configuring an L2VPN Quality of Service Policy in Port Mode

This procedure describes how to configure an L2VPN QoS policy in port mode.

**Note**

In port mode, the interface name format does not include a subinterface number; for example, GigabitEthernet0/1/0/1.

**SUMMARY STEPS**

1. `configure`
2. `interface type interface-path-id.subinterface l2transport`
3. `service-policy [ input | output ] [ policy-map-name ]`
4. Use the commit or end command.

**DETAILED STEPS**

**Step 1** `configure`

Example:

```
RP/0/0/CPU0:router# configure
```
Status the configuration mode.

**Step 2**

```plaintext
interface type interface-path-id.subinterface l2transport
```

**Example:**

```
RP/0/0/CPU0:router(config)# interface GigabitEthernet0/0/0/0.1
```

Configures an interface or connection for L2 switching and specifies the interface attachment circuit.

**Step 3**

```plaintext
service-policy [ input | output ] [ policy-map-name ]
```

**Example:**

```
RP/0/0/CPU0:router(config-if)# service-policy input servpol1
```

Attaches a QoS policy to an input or output interface to be used as the service policy for that interface.

**Step 4**

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

- **commit** - Saves the configuration changes and remains within the configuration session.
- **end** - Prompts user to take one of these actions:
  - **Yes** - Saves configuration changes and exits the configuration session.
  - **No** - Exits the configuration session without committing the configuration changes.
  - **Cancel** - Remains in the configuration mode, without committing the configuration changes.

---

**Configuring an L2VPN Quality of Service Policy in VLAN Mode**

This procedure describes how to configure a L2VPN QoS policy in VLAN mode.

- **Note**
  - In VLAN mode, the interface name must include a subinterface. for example: GigabitEthernet0/1/0/1.1 and the l2transport command must follow the interface type on the same CLI line (for example: “interface GigabitEthernet 0/0/0.1 l2transport”).

**SUMMARY STEPS**

1. configure
2. interface type interface-path-id.subinterface l2transport
3. service-policy [ input | output ] [ policy-map-name ]
4. Use the **commit** or **end** command.

**DETAILED STEPS**

**Step 1**

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

Step 2
interface type interface-path-id.subinterface l2transport

Example:
RP/0/0/CPU0:router(config)# interface GigabitEthernet0/0/0/0.1 l2transport
Configures an interface or connection for L2 switching.

Note In VLAN Mode, you must enter the l2transport keyword on the same line as the interface.

Step 3
service-policy [ input | output ] [ policy-map-name ]

Example:
RP/0/0/CPU0:router(config-if)# service-policy input servpol1
Attaches a QoS policy to an input or output interface to be used as the service policy for that interface.

Step 4
Use the commit or end command.
commit - Saves the configuration changes and remains within the configuration session.
end - Prompts user to take one of these actions:
  • Yes - Saves configuration changes and exits the configuration session.
  • No - Exits the configuration session without committing the configuration changes.
  • Cancel - Remains in the configuration mode, without committing the configuration changes.

Configuring an L2VPN Quality of Service Policy in Frame Relay Mode
This procedure describes how to configure a L2VPN QoS policy in Frame Relay mode.

SUMMARY STEPS
1. configure
2. class-map match any new class
3. match frame-relay dlei dlei number
4. Use the commit or end command.

DETAILED STEPS

Step 1 configure
Configuring Preferred Tunnel Path

This procedure describes how to configure a preferred tunnel path.

SUMMARY STEPS

1. configure
2. l2vpn
3. pw-class \{name\}
4. encapsulation mpls
5. preferred-path \{interface\} \{tunnel-ip value | tunnel-te value | tunnel-tp value\} [fallback disable]
6. Use the commit or end command.

Example:

RP/0/0/CPU0:router# configure

Enters the configuration mode.

Step 2 class-map match any new class

Example:

RP/0/0/CPU0:router(config-cmap)# class-map match-any A

Matches the class map type to a new class map.

Step 3 match frame-relay dlci dlci number

Example:

RP/0/0/CPU0:router(config-cmap)# match frame-relay dlci 100-200 500

Applies the quality of service on the main interface with a frame relay encapsulation type.

Step 4 Use the commit or end command.

commit - Saves the configuration changes and remains within the configuration session.
end - Prompts user to take one of these actions:

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

**Step 1**  
configure

**Example:**

RP/0/RP0/CPU0:router# configure
Enters the configuration mode.

**Step 2**  
l2vpn

**Example:**

RP/0/RP0/CPU0:router(config)# l2vpn
Enters L2VPN configuration mode.

**Step 3**  
`pw-class {name}`

**Example:**

RP/0/RP0/CPU0:router(config-l2vpn)# pw-class path1
Configures the pseudowire class name.

**Step 4**  
encapsulation mpls

**Example:**

RP/0/RP0/CPU0:router(config-l2vpn-pwc)# encapsulation mpls
Configures the pseudowire encapsulation to MPLS.

**Step 5**  
`preferred-path {interface} {tunnel-ip value | tunnel-te value | tunnel-tp value} [fallback disable]`

**Example:**

RP/0/RP0/CPU0:router(config-l2vpn-pwc-encap-mpls)# preferred-path interface tunnel-te 11 fallback disable
Configures preferred path tunnel settings. If the fallback disable configuration is used and once the TE/ tunnel is configured as the preferred path goes down, the corresponding pseudowire can also go down.

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

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

**end** - Prompts user to take one of these actions:

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

To configure AToM IP interworking, you need to configure attachment circuits (AC), pseudowire class, and cross connects.

Configuring Ethernet ACs for AToM IP Interworking

Perform this task to configure an Ethernet AC for AToM IP Interworking.

SUMMARY STEPS

1. configure
2. interface type interface-path-id
3. l2transport
4. Use the commit or end command.

DETAILED STEPS

Step 1 configure

Example:
RP/0/0/CPU0:router# configure

Enters the Global Configuration mode.

Step 2 interface type interface-path-id

Example:
RP/0/0/CPU0:router(config)# interface ethernet 0/0/0/0

Configures the Ethernet interface.

Step 3 l2transport

Example:
RP/0/0/CPU0:router(config-if)# l2transport

Configures the Layer 2 Transport type for the AC.

Step 4 Use the commit or end command.
commit - Saves the configuration changes and remains within the configuration session.
end - Prompts user to take one of these actions:
  • Yes - Saves configuration changes and exits the configuration session.
  • No - Exits the configuration session without committing the configuration changes.
  • Cancel - Remains in the configuration mode, without committing the configuration changes.
Configuring Frame Relay ACs for AToM IP Interworking

Perform this task to configure a Frame Relay AC for AToM IP Interworking.

SUMMARY STEPS

1. configure
2. interface type interface-path-id
3. encapsulation frame-relay frame-relay networks
4. frame-relay [intf-type] dce
5. interface type interface-path-id l2transport
6. pvc number
7. Use the commit or end command.

DETAILED STEPS

Step 1 configure

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

Step 2 interface type interface-path-id

Example: RP/0/0/CPU0:router(config)# interface POS 0/2/0/1
Configures the Layer 2 transport sub-interface.

Step 3 encapsulation frame-relay frame-relay networks

Example: RP/0/0/CPU0:router(config-if)# encapsulation frame-relay
Encapsulates the Frame Relay network using RFC1490 or RFC2427 encapsulation.

Step 4 frame-relay [intf-type] dce

Example: RP/0/0/CPU0:router(config-if)# frame
Configures Frame Relay interface type based on the DCE mode.

Step 5 interface type interface-path-id l2transport
Configuring ATM AAL5 ACs for AToM IP Interworking

Perform this task to configure an ATM AAL5 AC for AToM IP Interworking.

SUMMARY STEPS

1. configure
2. interface type interface-path-id l2transport
3. pvc number
4. encapsulation {aal5mux} {ipv4}
5. encapsulation {aal5snap}
6. Use the commit or end command.

DETAILED STEPS

Step 1 configure

Example:
RP/0/0/CPU0:router# configure

Enters the Global Configuration mode.
**Configuring PPP ACs for AToM IP Interworking**

Perform this task to configure a PPP AC for AToM IP Interworking.
SUMMARY STEPS

1. configure
2. interface type interface-path-id
3. encapsulation ppp
4. ppp ipcp proxy-address ip_address
5. l2transport
6. Use the commit or end command.

DETAILED STEPS

Step 1 configure

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

Step 2 interface type interface-path-id

Example:
RP/0/0/CPU0:router(config)# interface POS 0/2/0/1
Configures the Layer 2 transport interface.

Step 3 encapsulation ppp

Example:
RP/0/0/CPU0:router(config-if)# encapsulation ppp
Enables PPP encapsulation.

Step 4 ppp ipcp proxy-address ip_address

Example:
RP/0/0/CPU0:router(config-if)# ppp ipcp proxy-address 1.2.3.4
Configures IP address of the remote CE router. This IP address is used by the PE router during IPCP negotiations with the CE router.

Step 5 l2transport

Example:
RP/0/0/CPU0:router(config-if)# l2transport
Configures Layer 2 transport.

Step 6 Use the commit or end command.
commit - Saves the configuration changes and remains within the configuration session.
end - Prompts user to take one of these actions:
  • Yes - Saves configuration changes and exits the configuration session.
  • No - Exits the configuration session without committing the configuration changes.
  • Cancel - Remains in the configuration mode, without committing the configuration changes.

Configuring Local Switching on PPP ACs

Perform this task to configure local switching on PPP ACs.

SUMMARY STEPS

1. configure
2. l2vpn
3. xconnect group group-name
4. p2p xconnect-name
5. interface type interface-path-id
6. interworking ipv4
7. Use the commit or end command.

DETAILED STEPS

Step 1 configure

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

Step 2 l2vpn

Example:
RP/0/0/CPU0:router(config)# l2vpn
Enters L2VPN configuration mode.

Step 3 xconnect group group-name

Example:
RP/0/0/CPU0:router(config-l2vpn)# xconnect group group1
Specifies the name of the cross-connect group.

Step 4 p2p xconnect-name
Configuring AToM IP Interworking

**Example:**
RP/0/0/CPU0:router(config-l2vpn-vc)# p2p bar

Specifies a name for the point-to-point cross-connect.

**Step 5**
interface type interface-path-id

**Example:**
RP/0/0/CPU0:router(config-l2vpn-vc-p2p)# interface POS 0/2/0/1

Specifies the interface type ID.

**Step 6**
interworking ipv4

**Example:**
RP/0/0/CPU0:router(config-l2vpn-vc-p2p-pw)# interworking ipv4

Specifies the interface type ID.

**Step 7**
Use the commit or end command.
commit - Saves the configuration changes and remains within the configuration session.
end - Prompts user to take one of these actions:
  • Yes - Saves configuration changes and exits the configuration session.
  • No - Exits the configuration session without committing the configuration changes.
  • Cancel - Remains in the configuration mode, without committing the configuration changes.

---

**Configuring IP Interworking on PPP ACs**

Perform this task to configure IP Interworking on PPP ACs.

**SUMMARY STEPS**

1. configure
2. l2vpn
3. xconnect group group-name
4. p2p xconnect-name
5. interface type interface-path-id
6. neighbor ip-address pw-id pseudowire-id
7. interworking ipv4
8. Use the commit or end command.
DETAILED STEPS

Step 1  configure

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

Step 2  l2vpn

Example:
RP/0/0/CPU0:router(config)# l2vpn
Enters L2VPN configuration mode.

Step 3  xconnect group group-name

Example:
RP/0/0/CPU0:router(config-l2vpn)# xconnect group group1
Specifies the name of the cross-connect group.

Step 4  p2p xconnect-name

Example:
RP/0/0/CPU0:router(config-l2vpn-xc)# p2p bar
Specifies a name for the point-to-point cross-connect.

Step 5  interface type interface-path-id

Example:
RP/0/0/CPU0:router(config-l2vpn-xc-p2p)# interface POS 0/2/0/1
Specifies the interface type ID.

Step 6  neighbor ip-address pw-id pseudowire-id

Example:
RP/0/0/CPU0:router(config-l2vpn-xc-p2p)# neighbor 2.2.2.2 pw-id 2000
Configures the pseudowire segment for the cross-connect.

Step 7  interworking ipv4

Example:
RP/0/0/CPU0:router(config-l2vpn-xc-p2p-pw)# interworking ipv4
Specifies the interface type ID.
Step 8  Use the commit or end command.

commit - Saves the configuration changes and remains within the configuration session.
end - Prompts user to take one of these actions:

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

---

Configuring cHDLC ACs for AToM IP Interworking

Perform this task to configure a cHDLC AC for AToM IP Interworking.

SUMMARY STEPS

1. configure
2. interface type interface-path-id
3. l2transport
4. Use the commit or end command.

DETAILED STEPS

Step 1 configure

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

Step 2 interface type interface-path-id

Example:
RP/0/0/CPU0:router(config)# interface POS 0/2/0/1
Configures the Layer 2 transport interface.

Step 3 l2transport

Example:
RP/0/0/CPU0:router(config-if)# l2transport
Configures Layer 2 transport.

Step 4 Use the commit or end command.
commit - Saves the configuration changes and remains within the configuration session.
end - Prompts user to take one of these actions:
   • Yes - Saves configuration changes and exits the configuration session.
   • No - Exits the configuration session without committing the configuration changes.
   • Cancel - Remains in the configuration mode, without committing the configuration changes.

**Configuring Local Switching on cHDLC ACs**

Perform this task to configure local switching on cHDLC ACs.

**SUMMARY STEPS**

1. configure
2. l2vpn
3. xconnect group group-name
4. p2p xconnect-name
5. interface type interface-path-id
6. interworking ipv4
7. Use the commit or end command.

**DETAILED STEPS**

**Step 1**
configure

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

**Step 2**
l2vpn

*Example:*  
RP/0/0/CPU0:router(config)# l2vpn  
Enters L2VPN configuration mode.

**Step 3**
xconnect group group-name

*Example:*  
RP/0/0/CPU0:router(config-l2vpn)# xconnect group group1  
Specifies the name of the cross-connect group.

**Step 4**
p2p xconnect-name
Configuring AToM IP Interworking

Perform this task to configure IP Interworking on cHDLC ACs.

**SUMMARY STEPS**

1. configure
2. l2vpn
3. xconnect group group-name
4. p2p xconnect-name
5. interface type interface-path-id
6. neighbor ip-address pw-id pseudowire-id
7. interworking ipv4
8. Use the commit or end command.

---

Example:

RP/0/0/CPU0:router(config-l2vpn-xc)# p2p bar

Specifies a name for the point-to-point cross-connect.

**Step 5**

interface type interface-path-id

Example:

RP/0/0/CPU0:router(config-l2vpn-xc-p2p)# interface POS 0/2/0/1

Specifies the interface type ID.

**Step 6**

interworking ipv4

Example:

RP/0/0/CPU0:router(config-l2vpn-xc-p2p-pw)# interworking ipv4

Specifies the interface type ID.

**Step 7**

Use the commit or end command.

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

date - Prompts user to take one of these actions:

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

---

Configuring IP Interworking on cHDLC ACs

Perform this task to configure IP Interworking on cHDLC ACs.

**SUMMARY STEPS**

1. configure
2. l2vpn
3. xconnect group group-name
4. p2p xconnect-name
5. interface type interface-path-id
6. neighbor ip-address pw-id pseudowire-id
7. interworking ipv4
8. Use the commit or end command.
DETAILED STEPS

Step 1 configure

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

Step 2 l2vpn

Example:
RP/0/0/CPU0:router(config)# l2vpn
Enters L2VPN configuration mode.

Step 3 xconnect group group-name

Example:
RP/0/0/CPU0:router(config-l2vpn)# xconnect group group1
Specifies the name of the cross-connect group.

Step 4 p2p xconnect-name

Example:
RP/0/0/CPU0:router(config-l2vpn-xc)# p2p bar
Specifies a name for the point-to-point cross-connect.

Step 5 interface type interface-path-id

Example:
RP/0/0/CPU0:router(config-l2vpn-xc-p2p)# interface POS 0/2/0/1
Specifies the interface type ID.

Step 6 neighbor ip-address pw-id pseudowire-id

Example:
RP/0/0/CPU0:router(config-l2vpn-xc-p2p)# neighbor 2.2.2.2 pw-id 2000
Configures the pseudowire segment for the cross-connect.

Step 7 interworking ipv4

Example:
RP/0/0/CPU0:router(config-l2vpn-xc-p2p-pw)# interworking ipv4
Specifies the type of interworking (routed or bridged interworking).
Step 8

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

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

**end** - Prompts user to take one of these actions:

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

---

**Configuring Frame Relay AC for Bridged Interworking**

Perform this task to configure a Frame Relay AC for Bridged Interworking.

**SUMMARY STEPS**

1. `configure`
2. `interface type interface-path-id`
3. `encapsulation frame-relay frame-relay networks`
4. `load-interval interval`
5. `frame-relay intf-type {dce | dte}`
6. `frame-relay lmi disable`
7. `interface type interface-path-id l2transport`
8. `pvc number`
9. Use the **commit** or **end** command.

**DETAILED STEPS**

**Step 1**

`configure`

**Example:**

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

Enters the Global Configuration mode.

**Step 2**

`interface type interface-path-id`

**Example:**

```
RP/0/0/CPU0:router(config)# interface POS 0/2/0/1
```

Configures the Layer 2 transport interface.

**Step 3**

`encapsulation frame-relay frame-relay networks`
Example:
RP/0/0/CPU0:router(config-if)# encapsulation frame-relay
Encapsulates the Frame Relay network using RFC1490 or RFC2427 encapsulation.

Step 4
load-interval interval

Example:
RP/0/0/CPU0:router(config-if)# load interval 30
Sets the length of time for which data is used for load calculations.

Step 5
frame-relay intf-type {dce | dte}

Example:
RP/0/0/CPU0:router(config-if)# frame-relay intf-type
Configures the type of support provided by the interface.

- If your router functions as a switch connected to another router, use the frame-relay intf-type dce command to configure the LMI type to support data communication equipment (DCE).
- If your router is connected to a Frame Relay network, use the frame-relay intf-type dte command to configure the LMI type to support data terminal equipment (DTE).

Note: The default interface type is DTE.

Step 6
frame-relay lmi disable

Example:
RP/0/0/CPU0:router(config-if)# frame-relay lmi disable
Disables local management interface (LMI).

Step 7
interface type interface-path-id l2transport

Example:
RP/0/0/CPU0:router(config-if)# interface POS0/2/0/1.200 l2transport
Configures the Layer 2 transport sub-interface

Step 8
pvc number

Example:
RP/0/0/CPU0:router(config-if)# pvc 20
Configures a virtual circuit.

Step 9
Use the commit or end command.
commit - Saves the configuration changes and remains within the configuration session.
end - Prompts user to take one of these actions:

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

## Configuring Pseudowire Class

Perform this task to configure a pseudowire class.

### SUMMARY STEPS

1. configure
2. l2vpn
3. pw-class class-name
4. encapsulation mpls
5. protocol ldp
6. vccv
7. commit

### DETAILED STEPS

**Step 1** configure

**Example:**

RP/0/0/CPU0:router# configure

Enters the Global Configuration mode.

**Step 2** l2vpn

**Example:**

RP/0/0/CPU0:router(config)# l2vpn

Enters Layer 2 VPN configuration mode.

**Step 3** pw-class class-name

**Example:**

RP/0/0/CPU0:router(config-l2vpn)# pw-class dynamic_mpls

Enters pseudowire class submode, allowing you to define a pseudowire class template.

**Step 4** encapsulation mpls
Example:

```
RP/0/0/CPU0:router (config-l2vpn-pwc)# encapsulation mpls
```

Sets pseudowire encapsulation to MPLS.

**Step 5**

```
protocol ldp
```

Example:

```
RP/0/0/CPU0:router (config-l2vpn-pwc-encap-mpls)# protocol ldp
```

Sets pseudowire signaling protocol to LDP.

**Step 6**

```
vccv
```

Example:

```
RP/0/0/CPU0:router (config-l2vpn-pwc-encap-mpls)# vccv ver none
```

Configures virtual circuit connection verification (VCCV) settings.

**Step 7**

```
commit
```

Example:

```
RP/0/0/CPU0:router (config-l2vpn-pwc-encap-mpls)# commit
```

Saves configuration changes to the running configuration file and remains in the configuration session.

---

**Configuring Circuit Emulation Over Packet Switched Network**

Perform these tasks to configure CEoP:

**Adding CEM attachment circuit to a Pseudowire**

Perform this task to add a CEM attachment circuit to a pseudowire:

**SUMMARY STEPS**

1. `configure`
2. `l2vpn`
3. `xconnect group group-name`
4. `p2p xconnect-name`
5. `interface type interface-path-id`
6. `neighbor A.B.C.D pw-id`
7. Use the `commit` or `end` command.
## DETAILED STEPS

### Step 1
Configure

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

### Step 2
L2VPN

**Example:**
```
RP/0/0/CPU0:router(config)# l2vpn
```
Enters L2VPN configuration mode.

### Step 3
**xconnect group** *group-name*

**Example:**
```
RP/0/0/CPU0:router(config-l2vpn)# xconnect group grp_1
```
Enters the name of the cross-connect group.

### Step 4
**p2p** *xconnect-name*

**Example:**
```
RP/0/0/CPU0:router(config-l2vpn-xc)# p2p vlan1
```
Enters a name for the point-to-point cross-connect.

### Step 5
**interface type** *interface-path-id*

**Example:**
```
RP/0/0/CPU0:router(config-l2vpn-xc-p2p)# interface CEM0/1/0/9:10
```
Specifies the interface type and instance.

### Step 6
**neighbor** *A.B.C.D* *pw-id*

**Example:**
```
RP/0/0/CPU0:router(config-l2vpn-xc-p2p)# neighbor 120.120.120.120 pw-id 3
```
Configures the pseudowire segment for the cross-connect.
Use the *A.B.C.D* argument to specify the IP address of the cross-connect peer.

**Note**
*A.B.C.D* can be a recursive or non-recursive prefix

Optionally, you can disable the control word or set the transport-type to Ethernet or VLAN

### Step 7
Use the **commit** or **end** command.
**commit** - Saves the configuration changes and remains within the configuration session.
**end** - Prompts user to take one of these actions:
- **Yes** - Saves configuration changes and exits the configuration session.
- **No** - Exits the configuration session without committing the configuration changes.
- **Cancel** - Remains in the configuration mode, without committing the configuration changes.

---

**Associating a Pseudowire Class**

Perform this task to associate the attachment circuit with a pseudowire class.

**SUMMARY STEPS**

1. `configure`
2. `l2vpn`
3. `pw-class class-name`
4. `encapsulation mpls`
5. `protocol ldp`
6. `end`
7. `xconnect group group-name`
8. `p2p xconnect-name`
9. `interface type interface-path-id`
10. `neighbor A.B.C.D pw-id pseudowire-id`
11. `pw-class class-name`
12. Use the `commit` or `end` command.

**DETAILED STEPS**

**Step 1** `configure`

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

Enters Global Configuration mode.

**Step 2** `l2vpn`

**Example:**
```
RP/0/0/CPU0:router (config)# l2vpn
```

Enters Layer 2 VPN configuration mode.

**Step 3** `pw-class class-name`
Example:

RP/0/0/CPU0:router (config-l2vpn)# pw-class class_cem

Enters pseudowire class submode, allowing you to define a pseudowire class template.

Step 4

encapsulation mpls

Example:

RP/0/0/CPU0:router (config-l2vpn-pwc)# encapsulation mpls

Sets pseudowire encapsulation to MPLS.

Step 5

protocol ldp

Example:

RP/0/0/CPU0:router (config-l2vpn-pwc-encap-mpls)# protocol ldp

Sets pseudowire signaling protocol to LDP.

Step 6

division

Example:

RP/0/0/CPU0:router(config-l2vpn-pwc-encap-mpls)# end

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.

Step 7

xconnect group group-name

Example:

RP/0/0/CPU0:router(config-l2vpn)# xconnect group grp_1

Configures a cross-connect group.

Step 8

p2p xconnect-name
Example:

RP/0/0/CPU0:router(config-l2vpn-xc)# p2p vlan1

Configures a point-to-point cross-connect.

**Step 9**  
**interface**  
*type*  
*interface-path-id*

Example:

RP/0/0/CPU0:router(config-l2vpn-xc-p2p)# interface CEM0/1/0/9:20

Specifies the interface type and instance.

**Step 10**  
**neighbor**  
*A.B.C.D*  
**pw-id**  
*pseudowire-id*

Example:

RP/0/0/CPU0:router(config-l2vpn-xc-p2p)# neighbor 10.2.2.2 pw-id 11

Configures the pseudowire segment for the cross-connect.  
Use the A.B.C.D argument to specify the IP address of the cross-connect peer.  
**Note**  
A.B.C.D can be a recursive or non-recursive prefix.  
Optionally, you can disable the control word or set the transport-type to Ethernet or VLAN.  
**Note**  
Pseudowire status (pw-status) is enabled by default, use the **pw-status disable** command to disable pseudowire status if required.

**Step 11**  
**pw-class**  
*class-name*

Example:

RP/0/0/CPU0:router(config-l2vpn-xc-p2p)# pw-class class_cem

Associates the P2P attachment circuit with the specified pseudowire class.

**Step 12**  
Use the **commit** or **end** command.  
**commit** - Saves the configuration changes and remains within the configuration session.  
**end** - Prompts user to take one of these actions:

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

---

**Configuring a Backup Pseudowire**

Perform this task to configure a backup pseudowire for a point-to-point neighbor.
SUMMARY STEPS

1. configure
2. l2vpn
3. xconnect group group-name
4. p2p xconnect-name
5. neighbor ip-address pw-id value
6. backup neighbor ip-address pw-id number
7. Use the commit or end command.

DETAILED STEPS

Step 1 configure

Example:
RP/0/0/CPU0:router# configure

Enters the Global Configuration mode.

Step 2 l2vpn

Example:
RP/0/0/CPU0:router(config)# l2vpn
RP/0/0/CPU0:router(config-l2vpn)#

Enters L2VPN configuration mode.

Step 3 xconnect group group-name

Example:
RP/0/0/CPU0:router(config-l2vpn)# xconnect group A
RP/0/0/CPU0:router(config-l2vpn-xc)#

Enters the name of the cross-connect group.

Step 4 p2p xconnect-name

Example:
RP/0/0/CPU0:router(config-l2vpn-xc)# p2p rtrX_to_rtrY
RP/0/0/CPU0:router(config-l2vpn-xc-p2p)#

Enters a name for the point-to-point cross-connect.

Step 5 neighbor ip-address pw-id value

Example:
RP/0/0/CPU0:router(config-l2vpn-xc-p2p)# neighbor 1.1.1.1 pw-id 2
RP/0/0/CPU0:router(config-l2vpn-xc-p2p-pw)#
Configures the pseudowire segment for the cross-connect.

**Step 6**

**backup neighbor ip-address pw-id number**

**Example:**

RP/0/0/CPU0:router(config-l2vpn-xc-p2p)# backup neighbor 1.1.1.1 pw-id 2
RP/0/0/CPU0:router(config-l2vpn-xc-p2p-pw-backup)#

Configures the backup pseudowire for the cross-connect.

- Use the **neighbor** keyword to specify the peer to cross-connect. The IP address argument (*A.B.C.D*) is the IPv4 address of the peer.
- Use the **pw-id** keyword to configure the pseudowire ID. The range is from 1 to 4294967295.

**Step 7**

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

- **commit** - Saves the configuration changes and remains within the configuration session.
- **end** - Prompts user to take one of these actions:
  - **Yes** - Saves configuration changes and exits the configuration session.
  - **No** - Exits the configuration session without committing the configuration changes.
  - **Cancel** - Remains in the configuration mode, without committing the configuration changes.

---

### Configuring L2VPN Nonstop Routing

Perform this task to configure L2VPN Nonstop Routing.

**SUMMARY STEPS**

1. **configure**
2. **l2vpn**
3. **nsr**
4. **logging nsr**
5. Use the **commit** or **end** command.

**DETAILED STEPS**

**Step 1**

**configure**

**Example:**

RP/0/0/CPU0:router# configure

Enters Global Configuration mode.

**Step 2**

**l2vpn**
Example:
RP/0/0/CPU0:router(config)# l2vpn
Enters the Global Configuration mode.

Step 3
nsr

Example:
RP/0/0/CPU0:router (config-l2vpn)# nsr
Enables L2VPN nonstop routing.

Step 4
logging nsr

Example:
RP/0/0/CPU0:router (config-l2vpn)# logging nsr
Enables logging of NSR events.

Step 5
Use the commit or end command.
commit - Saves the configuration changes and remains within the configuration session.
end - Prompts user to take one of these actions:
  • Yes - Saves configuration changes and exits the configuration session.
  • No - Exits the configuration session without committing the configuration changes.
  • Cancel - Remains in the configuration mode, without committing the configuration changes.

Enabling Pseudowire Grouping

Perform this task to enable pseudowire grouping.

SUMMARY STEPS
1. configure
2. l2vpn
3. pw-grouping
4. Use the commit or end command.

DETAILED STEPS

Step 1 configure
Example:
RP/0/0/CPU0:router# configure
Enters the Global Configuration mode.

Step 2  l2vpn

Example:
RP/0/0/CPU0:router(config)# l2vpn
RP/0/0/CPU0:router(config-l2vpn)#
Enters L2VPN configuration mode.

Step 3  pw-grouping

Example:
RP/0/0/CPU0:router(config-l2vpn)# pw-grouping
Enables pseudowire grouping

Step 4  Use the commit or end command.
commit - Saves the configuration changes and remains within the configuration session.
end - Prompts user to take one of these actions:
  • Yes - Saves configuration changes and exits the configuration session.
  • No - Exits the configuration session without committing the configuration changes.
  • Cancel - Remains in the configuration mode, without committing the configuration changes.

Configuration Examples for Point to Point Layer 2 Services

In the following example, two traffic classes are created and their match criteria are defined. For the first traffic class called class1, ACL 101 is used as the match criterion. For the second traffic class called class2, ACL 102 is used as the match criterion. Packets are checked against the contents of these ACLs to determine if they belong to the class.

This section includes the following configuration examples:

L2VPN Interface Configuration: Example

This example shows how to configure an L2VPN interface:

```
configure
  interface GigabitEthernet0/0/0/0.1 l2transport
dot1q vlan 1
end
```
Point-to-Point Cross-connect Configuration: Examples

This section includes configuration examples for both static and dynamic p2p cross-connects.

**Static Configuration**

This example shows how to configure a static point-to-point cross-connect:

```config
configure
l2vpn
  xconnect group vlan_grp_1
  p2p vlan1
  interworking ipv4
  interface GigabitEthernet0/0/0/0.1
  neighbor 2.2.2.2 pw-id 2000
  mpls static label local 699 remote 890
commit
```

**Dynamic Configuration**

This example shows how to configure a dynamic point-to-point cross-connect:

```config
configure
l2vpn
  xconnect group vlan_grp_1
  p2p vlan1
  interface GigabitEthernet0/0/0/0.1
  neighbor 2.2.1.1 pw-id 1
commit
```

The following example shows how to configure a dynamic point-to-point cross-connect using OSPF and MPLS LDP:

```config
configure
l2vpn
  pw-class ceop
  encapsulation mpls
  xconnect group SATOP
    p2p STP1
    interface CEM0/2/1/0/1/1/1
    neighbor 24.24.24.2 pw-id 1001
    pw-class ceop
  !
  xconnect group CESOPSN
    p2p CSPN1
    interface CEM0/2/1/0/1/1/2:0
    neighbor 24.24.24.2 pw-id 1002
    pw-class ceop
  !

show runn router ospf
router ospf 10
  router-id 21.21.21.1
  area 0
    interface Loopback0
  !
    interface GigabitEthernet0/2/2/0 Core Facing Interface
  !
! RP/0/RSP0/CPU0:CEOP-03#
RP/0/RSP0/CPU0:CEOP-03#show runn mpls ldp mpls ldp
  graceful-restart required to avoid drops during L2VPN_MGR process
  !
RP/0/RSP0/CPU0:CEOP-03#
```

Cisco IOS XR Virtual Private Network Configuration Guide for the Cisco XR 12000 Series Router, Release 5.2.x
interface GigabitEthernet0/2/2/0 <<< Core Facing Interface !

Inter-AS: Example

This example shows how to set up an AC to AC cross-connect from AC1 to AC2:

router-id Loopback0
interface Loopback0
  ipv4 address 127.0.0.1 255.255.255.0
!
interface GigabitEthernet0/1/0/0.1 l2transport dot1q vlan 1!
!
interface GigabitEthernet0/0/0/3
ipv4 address 127.0.0.1 255.255.255.0
keepalive disable
!
interface GigabitEthernet0/0/0/4
ipv4 address 127.0.0.1 255.255.255.0
keepalive disable
!
router ospf 100
log adjacency changes detail
area 0
  interface Loopback0
  !
  interface GigabitEthernet0/0/0/3
  !
  interface GigabitEthernet0/0/0/4
  !
!
router bgp 100
address-family ipv4 unicast
  allocate-label all
!
neighbor 40.0.0.5
  remote-as 100
  update-source Loopback0
  address-family ipv4 unicast
  !
  address-family ipv4 labeled-unicast
  !
!
l2vpn
xconnect group xc1
  p2p ac2ac1
    interface GigabitEthernet0/1/0/0.1
    neighbor 20.0.0.5 pw-id 101
  !
  p2p ac2ac2
    interface GigabitEthernet0/1/0/0.2
    neighbor 20.0.0.5 pw-id 102
  !
  p2p ac2ac3
    interface GigabitEthernet0/1/0/0.3
    neighbor 20.0.0.5 pw-id 103
  !
  p2p ac2ac4
    interface GigabitEthernet0/1/0/0.4
    neighbor 20.0.0.5 pw-id 104
  !
  p2p ac2ac5
    interface GigabitEthernet0/1/0/0.5
    neighbor 20.0.0.5 pw-id 105
  !
  p2p ac2ac6
    interface GigabitEthernet0/1/0/0.6
    neighbor 20.0.0.5 pw-id 106
mpls ldp
router-id Loopback0
log
neighbor
interface GigabitEthernet0/0/0/3
interface GigabitEthernet0/0/0/4
end

Preferred Path: Example

This example shows how to configure preferred tunnel path:

configure
l2vpn
pw-class path1
encapsulation mpls
preferred-path interface tunnel-ip value fallback disable

AToM IP Interworking: Examples

This section includes configuration examples for all supported AC modes in AToM IP Interworking.

Ethernet

interface GigabitEthernet0/0/0/2
  l2transport
  interface GigabitEthernet0/0/0/3.1 l2transport
dot1q vlan 1
interface GigabitEthernet0/0/0/3.2 l2transport
dot1q vlan 2 2

Frame Relay

interface POS0/2/0/1
mtu 1500
encapsulation frame-relay
frame-relay intf-type dce
interface POS0/2/0/1.20 l2transport
pvc 20
!

**ATM AAL5**

interface ATM0/3/0/1.200 l2transport
pvc 20/200
encapsulation aal5mux ipv4
!
interface ATM0/3/0/1.300 l2transport
pvc 30/300
encapsulation aal5snap
!
interface ATM0/3/0/1.300 l2transport
pvc 30/400
encapsulation aal5nlpid

**PPP**

interface POS0/0/0/0
encapsulation ppp
ppp ipcp proxy-address 1.2.3.4
l2transport
!
!
interface POS0/0/0/1
ppp ipcp proxy-address 1.2.3.14
encapsulation ppp
l2transport
!
!
12vpn
xconnect group foo
  p2p bar
    interface POS0/0/0/0
    interface POS0/0/0/1
    interworking ipv4
  !
  !
12vpn
xconnect group foo
  p2p bar
    interface POS0/0/0/0
    neighbor 10.1.1.1 pw-id 666
    interworking ipv4

**cHDLC**

interface pos 0/1/0/1
l2transport

interface pos 0/1/0/2
l2transport

12vpn
xconnect group foo
  p2p bar
    interface POS 0/1/0/1
    interface POS 0/1/0/2
    interworking ipv4
  !
  !
12vpn
xconnect group foo
  p2p bar
    interface POS 0/1/0/1
Bridged Interworking: Example

interface POS0/2/0/1
  mtu 1504
  encapsulation frame-relay
  load-interval 30
  frame-relay intf-type dce
  frame-relay lmi disable
  neighbor 10.1.1.1 pw-id 666
  interworking ipv4

ATM AAL5 to Ethernet Bridged Interworking: Example

ATM side:
controller T3 0/4/3/1
  mode atm
  interface ATM0/4/3/1.1 l2transport
  pvc 50/50
  encapsulation aal5snap
  mtu 1500
  l2vpn
  pw-class mpls_class
  encapsulation mpls
  protocol ldp
  xconnect group pe1_to_pe2
  p2p xc2
  interface ATM0/4/3/1.1
  neighbor 5.5.5.5 pw-id 2
  pw-class mpls_class
  interworking ethernet

Ethernet side:
  l2vpn
  pw-class mpls_class
  encapsulation mpls
  protocol ldp
  interface GigabitEthernet0/3/0/0.1 l2transport  dot1q vlan 1 end
  xconnect group pe1_to_pe2
  p2p xc2
  interface GigabitEthernet0/3/0/0.1
  neighbor 2.2.2.2 pw-id 2
  pw-class mpls_class
  interworking ethernet
AToM Cross Connect Configuration: Example

This section includes configuration examples for all supported AToM Cross Connects.

```
l2vpn
pseudowire-class ipiw
    encapsulation mpls
!
xconnect group port
    p2p port1
        interface GigabitEthernet0/0/0/2
        neighbor 11.11.11.11 pw-id 300 pw-class ipiw
!
!
xconnect group vlan
    p2p vlan1
        interface GigabitEthernet0/0/0/3.1
        neighbor 11.11.11.11 pw-id 400 pw-class ipiw
!
!
xconnect group frame-relay
    p2p frame1
        interface POS0/2/0/1.20
        neighbor 11.11.11.11 pw-id 600 pw-class ipiw
!
!
xconnect group atm
    p2p atm1
        interface ATM0/3/0/1.200
        neighbor 11.11.11.11 pw-id 700 pw-class ipiw
    p2p atm2
        interface ATM0/3/0/1.300
        neighbor 11.11.11.11 pw-id 800 pw-class ipiw
```

Configuring L2VPN over GRE Tunnels: Example

The following example shows how to configure L2VPN over GRE tunnels:

```
interface tunnel-ip101
    ipv4 address 150.10.1.204 255.255.255.0
    ipv6 address 150:10:1::204/64
    tunnel mode gre ipv4
    tunnel source Loopback1
    tunnel destination 100.1.1.202

router ospf 1
    router-id 100.0.1.204
    cost 1
    router-id Loopback0
    area 1
    interface Loopback0
    !
    interface tunnel-ip101

mpls ldp
    router-id 100.0.1.204
    interface tunnel-ip101

l2vpn
    xconnect group pe2
    p2p 2001
        interface GigabitEthernet0/2/0/0.2001
        neighbor 100.0.1.202 pw-id 2001
```
Configuring Circuit Emulation Over Packet Switched Network: Example

This example shows you how to configure Circuit Emulation Over Packet Switched Network:

**Adding CEM Attachment Circuit to PW**

```
12vpn
 xconnect group gr1
 p2p p1
   interface CEM 0/0/0/0:10
   neighbor 3.3.3.3 pw-id 11
 !
!
!
```

**Associating Pseudowire Class**

```
12vpn
 pw-class class-cem
   encapsulation mpls
   protocol ldp
 !
 !
 xconnect group gr1
 p2p p1
   interface CEM0/0/0/0:20
   neighbor 1.2.3.4 pw-id 11
   pw-class class-cem
 !
```

**Enabling Pseudowire Status**

```
12vpn
 pw-status
 commit
```

**Disabling Pseudowire Status**

```
12vpn
 pw-status disable
 commit
```

**Configuring Backup Pseudowire**

```
12vpn
 pw-status
 pw-class class-cem
   encapsulation mpls
   protocol ldp
 !
 !
 xconnect group gr1
 p2p p1
   interface CEM0/0/0/0:20
   neighbor 1.2.3.4 pw-id 11
   pw-class class-cem
   backup neighbor 9.9.9.9 pw-id 1221
   pw-class class-cem
 !
```

Cisco IOS XR Virtual Private Network Configuration Guide for the Cisco XR 12000 Series Router, Release 5.2.x
Configuring L2VPN Nonstop Routing: Example

This example shows how to configure L2VPN Nonstop Routing.

```
config
l2vpn
nsr
logging nsr
```

Enabling Pseudowire Grouping: Example

This example shows how to enable pseudowire grouping.

```
config
l2vpn
pw-grouping
```
Enabling Pseudowire Grouping: Example