



Any Transport over MPLS

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This module describes how to configure Any Transport over MPLS (AToM) transports data link layer (Layer 2) packets over a Multiprotocol Label Switching (MPLS) backbone. AToM enables service providers to connect customer sites with existing Layer 2 networks by using a single, integrated, packet-based network infrastructure—a Cisco MPLS network. Instead of using separate networks with network management environments, service providers can deliver Layer 2 connections over an MPLS backbone. AToM provides a common framework to encapsulate and transport supported Layer 2 traffic types over an MPLS network core.

AToM supports the following like-to-like transport types:

- ATM Adaptation Layer Type-5 (AAL5) over MPLS
- ATM Cell Relay over MPLS
- Ethernet over MPLS (VLAN and port modes)
- Frame Relay over MPLS
- PPP over MPLS
- High-Level Data Link Control (HDLC) over MPLS

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see 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 for Any Transport over MPLS”](#) section on page 62.

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



Americas Headquarters:

Cisco Systems, Inc., 170 West Tasman Drive, San Jose, CA 95134-1706 USA

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Prerequisites for Any Transport over MPLS

- IP routing must be configured in the core so that the provider edge (PE) routers can reach each other via IP.
- MPLS must be configured in the core so that a label-switched path (LSP) exists between the PE routers.
- Cisco Express Forwarding must be enabled before you configure any Layer 2 circuits.
- A loopback interface must be configured for originating and terminating Layer 2 traffic. Ensure that the PE routers can access the other router's loopback interface. Note that the loopback interface is not needed in all cases. For example, tunnel selection does not need a loopback interface when AToM is directly mapped to a traffic engineering (TE) tunnel.
- Before converting an interface with L2TPv3 xconnect to AToM xconnect, remove the L2TPv3 configuration from the interface and then configure AToM.
- Before configuring Ethernet over MLS in VLAN mode, you must configure Ethernet over MPLS on the subinterfaces.

Restrictions for Any Transport over MPLS

- [General Restrictions, page 3](#)
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General Restrictions

- Address format—Configure the Label Distribution Protocol (LDP) router ID on all PE routers to be a loopback address with a /32 mask. Otherwise, some configurations might not function properly.
- Layer 2 virtual private networks (L2VPN) features (AToM and Layer 2 Tunnel Protocol Version 3 (L2TPv3) are not supported on an ATM interface.
- Some features may not work if AToM is configured and L2TPv3 configuration is not removed properly.

ATM AAL5 over MPLS Restrictions

- AAL5 over MPLS is supported only in SDU mode.

ATM Cell Relay over MPLS Restrictions

- If you have TE tunnels running between the PE routers, you must enable LDP on the tunnel interfaces.
- The F4 end-to-end OAM cells are transparently transported along with the ATM cells. When a permanent virtual path (PVP) or permanent virtual circuit (PVC) is down on one PE router, the label associated with that PVP or PVC is withdrawn. Subsequently, the peer PE router detects the label withdrawal and sends an F4 AIS/RDI signal to its corresponding CE router. The PVP or PVC on the peer PE router remains in the up state.
- VC class configuration mode is not supported in port mode.
- The AToM control word is supported. However, if a peer PE does not support the control word, it is disabled.

For configuring ATM cell relay over MPLS in VP mode, the following restrictions apply:

- If a VPI is configured for VP cell relay, you cannot configure a PVC using the same VPI.
- VP trunking (mapping multiple VPs to one emulated VC label) is not supported. Each VP is mapped to one emulated VC.
- VP mode and VC mode drop idle cells.

Ethernet over MPLS (EoMPLS) Restrictions

- The subinterfaces between the CE and PE routers that are running Ethernet over MPLS must be in the same subnet.
- The subinterface on the adjoining CE router must be on the same VLAN as the PE router.
- Ethernet over MPLS supports VLAN packets that conform to the IEEE 802.1Q standard. The 802.1Q specification establishes a standard method for inserting VLAN membership information into Ethernet frames. The Inter-Switch Link (ISL) protocol is not supported between the PE and CE routers.
- The AToM control word is supported. However, if the peer PE does not support a control word, the control word is disabled.
- Ethernet packets with hardware-level cyclic redundancy check (CRC) errors, framing errors, and runt packets are discarded on input.

Per-Subinterface MTU for Ethernet over MPLS Restrictions

- The following features do not support MTU values in xconnect subinterface configuration mode:
 - Layer 2 Tunnel Protocol Version 3 (L2TPv3)
 - Virtual Private LAN services (VPLS)
 - L2VPN Pseudowire Switching
- The MTU value can be configured in xconnect subinterface configuration mode only on the following interfaces and subinterfaces:
 - Fast Ethernet
 - Gigabit Ethernet
- The router uses an MTU validation process for remote VCs established through LDP, which compares the MTU value configured in xconnect subinterface configuration mode to the MTU value of the remote customer interface. If an MTU value has not been configured in xconnect subinterface configuration mode, then the validation process compares the MTU value of the local customer interface to the MTU value of the remote xconnect, either explicitly configured or inherited from the underlying interface or subinterface.
- When you configure the MTU value in xconnect subinterface configuration mode, the specified MTU value is not enforced by the dataplane. The dataplane enforces the MTU values of the interface (port mode) or subinterface (VLAN mode).
- Ensure that the interface MTU is larger than the MTU value configured in xconnect subinterface configuration mode. If the MTU value of the customer-facing subinterface is larger than the MTU value of the core-facing interface, traffic may not be able to travel across the pseudowire.

Frame Relay over MPLS Restrictions

Frame Relay traffic shaping is not supported with AToM switched VCs.

HDLC over MPLS Restrictions

- Asynchronous interfaces are not supported.
- You must configure HDLC over MPLS on router interfaces only. You cannot configure HDLC over MPLS on subinterfaces.

PPP over MPLS Restrictions

- Zero hops on one router is not supported. However, you can have back-to-back PE routers.
- Asynchronous interfaces are not supported. The connections between the CE and PE routers on both ends of the backbone must have similar link layer characteristics. The connections between the CE and PE routers must both be synchronous.
- Multilink PPP (MLP) is not supported.
- You must configure PPP on router interfaces only. You cannot configure PPP on subinterfaces.

Tunnel Selection Restrictions

- The selected path should be an LSP destined to the peer PE router.

- The selected tunnel must be an MPLS TE tunnel.
- If you select a tunnel, the tunnel tailend must be on the remote PE router.
- If you specify an IP address, that address must be the IP address of the loopback interface on the remote PE router. The address must have a /32 mask. There must be an LSP destined to that selected address. The LSP need not be a TE tunnel.

Experimental Bits with AToM Restrictions

- You must statically set the experimental (EXP) bits in both the VC label and the LSP tunnel label, because the LSP tunnel label might be removed at the penultimate router.
- For EXP bits and ATM AAL5 over MPLS and for EXP bits and Frame Relay over MPLS, if you do not assign values to the experimental bits, the priority bits in the header's "tag control information" field are set to zero.
- For EXP bits and ATM Cell Relay over MPLS in VC mode, if you do not assign values to the experimental bits, the priority bits in the header's "tag control information" field are set to zero.
- For EXP bits and HDLC over MPLS and PPP over MPLS, if you do not assign values to the experimental bits, zeros are written into the experimental bit fields.

Remote Ethernet Port Shutdown Restrictions

This feature is not symmetrical if the remote PE router is running an older version image or is on another platform that does not support the EoMPLS remote Ethernet port shutdown feature and the local PE is running an image which supports this feature.

Information About Any Transport over MPLS

To configure AToM, you must understand the following concepts:

- [How AToM Transports Layer 2 Packets, page 5](#)
- [Benefits of AToM, page 6](#)
- [MPLS Traffic Engineering Fast Reroute, page 7](#)
- [Maximum Transmission Unit Guidelines for Estimating Packet Size, page 7](#)
- [Per-Subinterface MTU for Ethernet over MPLS, page 9](#)
- [Frame Relay over MPLS and DTE, DCE, and NNI Connections, page 9](#)
- [QoS Features Supported with AToM, page 11](#)
- [OAM Cell Emulation for ATM AAL5 over MPLS, page 13](#)
- [Any Transport over MPLS \(AToM\): Remote Ethernet Port Shutdown, page 14](#)
- [AToM Load Balancing with Single PW, page 15](#)

How AToM Transports Layer 2 Packets

AToM encapsulates Layer 2 frames at the ingress PE and sends them to a corresponding PE 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 the connection, called a pseudowire, between the routers. You specify the following information on each PE router:

- The type of Layer 2 data that will be transported across the pseudowire, such as Ethernet, Frame Relay, or ATM
- 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

The following example shows the basic configuration steps on a PE router that enable the transport of Layer 2 packets. Each transport type has slightly different steps.

Step 1 defines the interface or subinterface on the PE router:

```
Router# interface interface-type interface-number
```

Step 2 specifies the encapsulation type for the interface, such as dot1q:

```
Router(config-if)# encapsulation encapsulation-type
```

Step 3 does the following:

- Makes a connection to the peer PE router by specifying the LDP router ID of the peer PE router.
- Specifies a 32-bit unique identifier, called the VC ID, which is shared between the two PE routers. The combination of the peer router ID and the VC ID must be unique on the router. Two circuits cannot use the same combination of peer router ID and VC ID.
- Specifies the tunneling method used to encapsulate data in the pseudowire. AToM uses MPLS as the tunneling method.

```
Router(config-if)# xconnect peer-router-id vcid encapsulation mpls
```

As an alternative, you can set up a pseudowire class to specify the tunneling method and other characteristics. For more information, see the [“Configuring the Pseudowire Class”](#) section on page 16.

Benefits of AToM

The following list explains some of the benefits of enabling Layer 2 packets to be sent in the MPLS network:

- The AToM product set accommodates many types of Layer 2 packets, including Ethernet and Frame Relay, across multiple Cisco router platforms. This enables the service provider to transport all types of traffic over the backbone and accommodate all types of customers.
- AToM adheres to the standards developed for transporting Layer 2 packets over MPLS. This benefits the service provider that wants to incorporate industry-standard methodologies in the network. Other Layer 2 solutions are proprietary, which can limit the service provider’s ability to expand the network and can force the service provider to use only one vendor’s equipment.
- Upgrading to AToM is transparent to the customer. Because the service provider network is separate from the customer network, the service provider can upgrade to AToM without disruption of service to the customer. The customers assume that they are using a traditional Layer 2 backbone.

MPLS Traffic Engineering Fast Reroute

AToM can use MPLS traffic engineering (TE) tunnels with fast reroute (FRR) support. AToM VCs can be rerouted around a failed link or node at the same time as MPLS and IP prefixes.

Enabling fast reroute on AToM does not require any special commands; you can use standard fast reroute commands. At the ingress PE, an AToM tunnel is protected by fast reroute when it is routed to an FRR-protected TE tunnel. Both link and node protection are supported for AToM VCs at the ingress PE.

In the following example, the primary link is disabled, which causes the backup tunnel (Tunnel 1) to become the primary path. The output in boldface font shows the status of the tunnel:

```
Router# execute-on slot 3 debug mpls l2transport fast-reroute

===== Line Card (Slot 3) =====
AToM fast reroute debugging is on
SLOT 3:Sep 16 17:58:56.346: AToM SMGR: Processing TFIB FRR event for 10.4.0.1
SLOT 3:Sep 16 17:58:56.346: AToM SMGR: Finished processing TFIB FRR event for 10.4.0.1
SLOT 3:Sep 16 17:58:56.346: AToM SMGR: Processing TFIB FRR event for Tunnel41
SLOT 3:Sep 16 17:58:56.346: AToM SMGR: Finished processing TFIB FRR event for Tunnel41
Sep 16 17:58:58.342: %LINK-3-UPDOWN: Interface POS0/0/0, changed state to down
Sep 16 17:58:58.342: %OSPF-5-ADJCHG: Process 1, Nbr 10.0.0.1 on POS0/0 from FULL to DOWN,
Neighbor Down: Interface down or detached
Sep 16 17:58:59.342: %LINEPROTO-5-UPDOWN: Line protocol on Interface POS0/0/0, changed
state to down
```

Maximum Transmission Unit Guidelines for Estimating Packet Size

The following calculation helps you determine the size of the packets traveling through the core network. You set the maximum transmission unit (MTU) on the core-facing interfaces of the P and PE routers to accommodate packets of this size. The MTU should be greater than or equal to the total bytes of the items in the following equation:

$$\text{Core MTU} \geq (\text{Edge MTU} + \text{Transport header} + \text{AToM header} + (\text{MPLS label stack} * \text{MPLS label size}))$$

The following sections describe the variables used in the equation.

Edge MTU

The edge MTU is the MTU for the customer-facing interfaces.

Transport Header

The Transport header depends on the transport type. [Table 1](#) lists the specific sizes of the headers.

Table 1 Header Size of Packets

Transport Type	Packet Size
AAL5	0–32 bytes
Ethernet VLAN	18 bytes
Ethernet Port	14 bytes
Frame Relay DLCI	2 bytes for Cisco encapsulation, 8 bytes for Internet Engineering Task Force (IETF) encapsulation

Table 1 Header Size of Packets (continued)

Transport Type	Packet Size
HDLC	4 bytes
PPP	4 bytes

AToM Header

The AToM header is 4 bytes (control word). The control word is optional for Ethernet, PPP, HDLC, and cell relay transport types. The control word is required for Frame Relay and ATM AAL5 transport types.

MPLS Label Stack

The MPLS label stack size depends on the configuration of the core MPLS network:

- AToM uses one MPLS label to identify the AToM VCs (VC label). Therefore, the minimum MPLS label stack is one for directly connected AToM PEs, which are PE routers that do not have a P router between them.
- If LDP is used in the MPLS network, the label stack size is two (the LDP label and the VC label).
- If a TE tunnel instead of LDP is used between PE routers in the MPLS network, the label stack size is two (the TE label and the VC label).
- If a TE tunnel and LDP are used in the MPLS network (for example, a TE tunnel between P routers or between P and PE routers, with LDP on the tunnel), the label stack is three (TE label, LDP label, VC label).
- If you use MPLS fast reroute in the MPLS network, you add a label to the stack. The maximum MPLS label stack in this case is four (FRR label, TE label, LDP label, VC label).
- If AToM is used by the customer carrier in an MPLS VPN Carrier Supporting Carrier environment, you add a label to the stack. The maximum MPLS label stack in the provider carrier network is five (FRR label, TE label, LDP label, VPN label, VC label).
- If an AToM tunnel spans different service providers that exchange MPLS labels using IPv4 Border Gateway Protocol (BGP) (RFC 3107), you add a label to the stack. The maximum MPLS label stack is five (FRR label, TE label, Border Gateway Protocol (BGP) label, LDP label, VC label).

Other circumstances can increase the MPLS label stack size. Therefore, analyze the complete data path between the AToM tunnel endpoints and determine the maximum MPLS label stack size for your network. Then multiply the label stack size by the size of the MPLS label.

Estimating Packet Size: Example

The estimated packet size in the following example is 1526 bytes, based on the following assumptions:

- The edge MTU is 1500 bytes.
- The transport type is Ethernet VLAN, which designates 18 bytes for the transport header.
- The AToM header is 0, because the control word is not used.
- The MPLS label stack is 2, because LDP is used. The MPLS label is 4 bytes.

$$\begin{array}{r} \text{Edge MTU} + \text{Transport header} + \text{AToM header} + (\text{MPLS label stack} * \text{MPLS label}) = \text{Core MTU} \\ 1500 \quad + 18 \quad \quad \quad + 0 \quad \quad + (2 \quad \quad \quad * 4 \quad \quad \quad) = 1526 \end{array}$$

You must configure the P and PE routers in the core to accept packets of 1526 bytes.

Per-Subinterface MTU for Ethernet over MPLS

Cisco IOS XE software includes the ability to specify MTU values in xconnect subinterface configuration mode. When you use xconnect subinterface configuration mode to set the MTU value, you establish a pseudowire connection for situations where the interfaces have different MTU values that cannot be changed.

If you specify an MTU value in xconnect subinterface configuration mode that is outside the range of supported MTU values (64 bytes to the maximum number of bytes supported by the interface), the command might be rejected. If you specify an MTU value that is out of range in xconnect subinterface configuration mode, the router enters the command in subinterface configuration mode.

For example, if you specify an MTU of 1501 in xconnect subinterface configuration mode, and that value is out of range, the router enters the command in subinterface configuration mode, where it is accepted:

```
Router# configure terminal
Router(config)# interface gigabitethernet0/0/2.1
Router(config-subif)# xconnect 10.10.10.1 100 encapsulation mpls
Router(config-subif-xconn)# mtu ?
<64 - 1500> MTU size in bytes
Router(config-subif-xconn)# mtu 1501 <<=====
Router(config-subif)# mtu ?
<64 - 17940> MTU size in bytes
```

If the MTU value is not accepted in either xconnect subinterface configuration mode or subinterface configuration mode, then the command is rejected.

Frame Relay over MPLS and DTE, DCE, and NNI Connections

You can configure an interface as a DTE device or a DCE switch, or as a switch connected to a switch with network-to-network interface (NNI) connections. Use the following command in interface configuration mode:

```
frame-relay intf-type [dce | dte | nni]
```

The keywords are explained in [Table 2](#).

Table 2 *frame-relay intf-type Command Keywords*

Keyword	Description
dce	Enables the router or access server to function as a switch connected to a router.
dte	Enables the router or access server to function as a DTE device. DTE is the default.
nni	Enables the router or access server to function as a switch connected to a switch.

Local Management Interface and Frame Relay over MPLS

Local Management Interface (LMI) is a protocol that communicates status information about PVCs. When a PVC is added, deleted, or changed, the LMI notifies the endpoint of the status change. LMI also provides a polling mechanism that verifies that a link is up.

How LMI Works

To determine the PVC status, LMI checks that a PVC is available from the reporting device to the Frame Relay end-user device. If a PVC is available, LMI reports that the status is “Active,” which means that all interfaces, line protocols, and core segments are operational between the reporting device and the Frame Relay end-user device. If any of those components is not available, the LMI reports a status of “Inactive.”



Note

Only the DCE and NNI interface types can report LMI status.

Figure 1 is a sample topology that helps illustrate how LMI works.

Figure 1 **Sample Topology**



In Figure 1, note the following:

- CE1 and PE1 and PE2 and CE2 are Frame Relay LMI peers.
- CE1 and CE2 can be Frame Relay switches or end-user devices.
- Each Frame Relay PVC comprises multiple segments.
- The DLCI value is local to each segment and is changed as traffic is switched from segment to segment. Two Frame Relay PVC segments exist in Figure 1; one is between PE1 and CE1 and the other is between PE2 and CE2.

The LMI protocol behavior depends on whether you have DLCI-to-DLCI or port-to-port connections.

DLCI-to-DLCI Connections

If you have DLCI-to-DLCI connections, LMI runs locally on the Frame Relay ports between the PE and CE devices:

- CE1 sends an active status to PE1 if the PVC for CE1 is available. If CE1 is a switch, LMI checks that the PVC is available from CE1 to the user device attached to CE1.
- PE1 sends an active status to CE1 if the following conditions are met:
 - A PVC for PE1 is available.
 - PE1 received an MPLS label from the remote PE router.
 - An MPLS tunnel label exists between PE1 and the remote PE.

For DTE or DCE configurations, the following LMI behavior exists: The Frame Relay device accessing the network (DTE) does not report PVC status. Only the network device (DCE) or NNI can report status. Therefore, if a problem exists on the DTE side, the DCE is not aware of the problem.

Port-to-Port Connections

If you have port-to-port connections, the PE routers do not participate in the LMI status-checking procedures. LMI operates between the CE routers only. The CE routers must be configured as DCE-DTE or NNI-NNI.

QoS Features Supported with AToM

The following tables list the QoS features supported by AToM:

- [Table 3, QoS Features Supported with Ethernet over MPLS](#)
- [Table 4, QoS Features Supported with Frame Relay over MPLS](#)
- [Table 5, QoS Features Supported with ATM Cell Relay and AAL5 over MPLS](#)

Table 3 QoS Features Supported with Ethernet over MPLS

QoS Feature	Ethernet over MPLS
Service policy	Can be applied to: <ul style="list-style-type: none"> • Interface (input and output) • Subinterface (input and output)
Classification	Supports the following commands: <ul style="list-style-type: none"> • match cos (on interfaces and subinterfaces) • match mpls experimental (on interfaces and subinterfaces) • match qos-group (on interfaces) (output policy)
Marking	Supports the following commands: <ul style="list-style-type: none"> • set cos (output policy) • set discard-class (input policy) • set mpls experimental (input policy) (on interfaces and subinterfaces) • set qos-group (input policy)
Policing	Supports the following: <ul style="list-style-type: none"> • Color-aware policing • Multiple-action policing • Single-rate policing • Two-rate policing
Queueing and shaping	Supports the following: <ul style="list-style-type: none"> • Byte-based WRED • Low Latency Queueing (LLQ) • Weighted Random Early Detection (WRED)

Table 4 QoS Features Supported with Frame Relay over MPLS

QoS Feature	Frame Relay over MPLS
Service policy	Can be applied to: <ul style="list-style-type: none"> • Interface (input and output) • PVC (input and output)
Classification	Supports the following commands: <ul style="list-style-type: none"> • match fr-de (on interfaces and VCs) • match fr-dlci (on interfaces) • match qos-group
Marking	Supports the following commands: <ul style="list-style-type: none"> • frame-relay congestion management (output) • set discard-class • set fr-de (output policy) • set fr-fecn-becn (output) • set mpls experimental • set qos-group • threshold ecn (output)
Policing	Supports the following: <ul style="list-style-type: none"> • Color-aware policing • Multiple-action policing • Single-rate policing • Two-rate policing
Queueing and shaping	Supports the following: <ul style="list-style-type: none"> • Byte-based WRED • Class-based weighted fair queueing (CBWFQ) • LLQ • random-detect discard-class-based command • Traffic shaping • WRED

Table 5 QoS Features Supported with ATM Cell Relay and AAL5 over MPLS

QoS Feature	ATM Cell Relay and AAL5 over MPLS
Service policy	Can be applied to: <ul style="list-style-type: none"> • Interface (input and output) • PVC (input and output) • Subinterface (input and output)
Classification	Supports the following commands: <ul style="list-style-type: none"> • match mpls experimental (on VCs) • match qos-group (output)
Marking	Supports the following commands: <ul style="list-style-type: none"> • random-detect discard-class-based (input) • set clp (output) (on interfaces, subinterfaces, and VCs) • set discard-class (input) • set mpls experimental (input) (on interfaces, subinterfaces, and VCs) • set qos-group (input)
Policing	Supports the following: <ul style="list-style-type: none"> • Color-aware policing • Multiple-action policing • Single-rate policing • Two-rate policing
Queueing and shaping	Supports the following: <ul style="list-style-type: none"> • Byte-based WRED • CBWFQ • Class-based shaping support on ATM PVCs • LLQ • random-detect discard-class-based command • WRED

OAM Cell Emulation for ATM AAL5 over MPLS

If a PE router does not support the transport of Operation, Administration, and Maintenance (OAM) cells across a label switched path (LSP), you can use OAM cell emulation to locally terminate or loop back the OAM cells. You configure OAM cell emulation on both PE routers, which emulates a VC by forming two unidirectional LSPs. You use Cisco software commands on both PE routers to enable OAM cell emulation.

After you enable OAM cell emulation on a router, you can configure and manage the ATM VC in the same manner as you would a terminated VC. A VC that has been configured with OAM cell emulation can send loopback cells at configured intervals toward the local CE router. The endpoint can be either of the following:

- End-to-end loopback, which sends OAM cells to the local CE router.
- Segment loopback, which responds to OAM cells to a device along the path between the PE and CE routers.

The OAM cells include the following cells:

- Alarm indication signal (AIS)
- Remote defect indication (RDI)

These cells identify and report defects along a VC. When a physical link or interface failure occurs, intermediate nodes insert OAM AIS cells into all the downstream devices affected by the failure. When a router receives an AIS cell, it marks the ATM VC down and sends an RDI cell to let the remote end know about the failure.

OAM Cell Emulation for ATM AAL5 over MPLS in VC Class Configuration Mode

You can configure OAM cell emulation as part of a VC class and then apply the VC class to an interface, a subinterface, or a VC. When you configure OAM cell emulation in VC class configuration mode and then apply the VC class to an interface, the settings in the VC class apply to all the VCs on the interface, unless you specify a different OAM cell emulation value at a lower level, such as the subinterface or VC level. For example, you can create a VC class that specifies OAM cell emulation and sets the rate of AIS cells to every 30 seconds. You can apply the VC class to an interface. Then, for one PVC, you can enable OAM cell emulation and set the rate of AIS cells to every 15 seconds. All the PVCs on the interface use the cell rate of 30 seconds, except for the one PVC that was set to 15 seconds.

Any Transport over MPLS (AToM): Remote Ethernet Port Shutdown

This Cisco IOS XE feature allows a service provider edge (PE) router on the local end of an Ethernet over MPLS (EoMPLS) pseudowire to detect a remote link failure and cause the shutdown of the Ethernet port on the local customer edge (CE) router. Because the Ethernet port on the local CE router is shut down, the router does not lose data by continuously sending traffic to the failed remote link. This is beneficial if the link is configured as a static IP route.

Figure 2 illustrates a condition in an EoMPLS WAN, with a down Layer 2 tunnel link between a CE router (Customer Edge 1) and the PE router (Provider Edge 1). A CE router on the far side of the Layer 2 tunnel (Customer Edge 2), continues to forward traffic to Customer Edge 1 through the L2 tunnel.

Figure 2 Remote Link Outage in EoMPLS WAN



Previous to this feature, the Provider Edge 2 router could not detect a failed remote link. Traffic forwarded from Customer Edge 2 to Customer Edge 1 would be lost until routing or spanning tree protocols detected the down remote link. If the link was configured with static routing, the remote link outage would be even more difficult to detect.

With this feature, the Provider Edge 2 router detects the remote link failure and causes a shutdown of the local Customer Edge 2 Ethernet port. When the remote L2 tunnel link is restored, the local interface is automatically restored as well. The possibility of data loss is thus diminished.

With reference to [Figure 2](#), the Remote Ethernet Shutdown sequence is generally described as follows:

1. The remote link between Customer Edge 1 and Provider Edge 1 fails.
2. Provider Edge 2 detects the remote link failure and disables the transmit laser on the line card interface connected to Customer Edge 2.
3. An RX_LOS error alarm is received by Customer Edge 2 causing Customer Edge 2 to bring down the interface.
4. Provider Edge 2 maintains its interface with Customer Edge 2 in an up state.
5. When the remote link and EoMPLS connection is restored, the Provider Edge 2 router enables the transmit laser.
6. The Customer Edge 2 router brings up its downed interface.

This feature is enabled by default for Ethernet over MPLS (EoMPLS). You can also enable this feature by using the **remote link failure notification** command in xconnect configuration mode as shown in the following example:

```
pseudowire-class eompls
  encapsulation mpls
  !
interface GigabitEthernet1/0/0
  xconnect 10.13.13.13 1 pw-class eompls
  remote link failure notification
  !
```

This feature can be disabled using the **no remote link failure notification** command in xconnect configuration mode. Use the **show ip interface brief** privileged EXEC command to display the status of all remote L2 tunnel links. Use the **show interface** privileged EXEC command to show the status of the L2 tunnel on a specific interface.

**Note**

The **no remote link failure notification** command will not give notification to clients for remote attachment circuit status down.

AToM Load Balancing with Single PW

Prior to Cisco IOS XE Release 3.4S, the Cisco ASR 1000 Series Aggregation Services Router did not perform load balancing for packets within the same pseudowire (PW) at the Provide Edge (PE) even if Equal Cost Multiple Paths (ECMPs) were available between PEs in an MPLS cloud. Only one of the routing options from the table would be used, and the other paths would be left unused. The AToM Load Balancing with Single PW feature enables load balancing for packets within the same pseudowire by further classifying packets within the same pseudowire into different flows based on certain fields in the packet received on an attachment circuit. For example, for Ethernet this load balancing is based on the source MAC address in the incoming packets.

In Cisco IOS XE Release 3.4S, this feature is available only for the Ethernet family of attachment circuits (ACs); so the flow-identification logic is based on source MAC address. All packets with the same source MAC address follow one path and are identified as flows.

How to Configure Any Transport over MPLS

This section explains how to perform a basic AToM configuration and includes the following procedures:

- [Configuring the Pseudowire Class, page 16](#) (required)
- [Changing the Encapsulation Type and Removing a Pseudowire, page 17](#) (optional)
- [Configuring ATM AAL5 over MPLS, page 17](#) (optional)
- [Configuring OAM Cell Emulation for ATM AAL5 over MPLS, page 20](#) (optional)
- [Configuring ATM Cell Relay over MPLS, page 24](#) (optional)
- [Configuring Ethernet over MPLS, page 28](#) (optional)
- [Configuring Frame Relay over MPLS, page 34](#) (optional)
- [Configuring HDLC or PPP over MPLS, page 37](#) (optional)
- [Configuring Tunnel Selection, page 38](#) (optional)
- [Setting Experimental Bits with AToM, page 41](#) (optional)
- [Enabling the Control Word, page 42](#) (optional)
- [Configuring MPLS AToM Remote Ethernet Port Shutdown, page 43](#) (optional)
- [Configuring AToM Load Balancing with Single PW, page 45](#) (optional)

Configuring the Pseudowire Class



Note

- In simple configurations, this task is optional. You need not specify a pseudowire class if you specify the tunneling method as part of the **xconnect** command.
- You must specify the **encapsulation mpls** command as part of the pseudowire class or as part of the **xconnect** command for the AToM VCs to work properly. If you omit the **encapsulation mpls** command as part of the **xconnect** command, you receive the following error:

```
% Incomplete command.
```

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **pseudowire-class** *name*
4. **encapsulation mpls**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	pseudowire-class name Example: Router(config)# pseudowire-class atom	Establishes a pseudowire class with a name that you specify and enters pseudowire class configuration mode.
Step 4	encapsulation mpls Example: Router(config-pw)# encapsulation mpls	Specifies the tunneling encapsulation.

Changing the Encapsulation Type and Removing a Pseudowire

Once you specify the **encapsulation mpls** command, you cannot remove it using the **no encapsulation mpls** command. Nor can you change the command's setting using the **encapsulation l2tpv3** command. Those methods result in the following error message:

```
Encapsulation changes are not allowed on an existing pw-class.
```

To remove the **encapsulation mpls** command, you must delete the pseudowire with the **no pseudowire-class** command.

To change the type of encapsulation, remove the pseudowire using the **no pseudowire-class** command and reconfigure the pseudowire to specify the new encapsulation type.

Configuring ATM AAL5 over MPLS

- [Configuring ATM AAL5 over MPLS on PVCs, page 17](#)
- [Configuring ATM AAL5 over MPLS in VC Class Configuration Mode, page 19](#)

Configuring ATM AAL5 over MPLS on PVCs

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface type slot/subslot/port[.subinterface]**
4. **pvc [name] vpi/vci l2transport**

5. **encapsulation aal5**
6. **xconnect peer-router-id vcid encapsulation mpls**
7. **end**
8. **show mpls l2transport vc**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	interface type slot/subslot/port[.subinterface] Example: Router(config)# interface atm1/0/0	Specifies the interface type and enters interface configuration mode.
Step 4	pvc [name] vpi/vci l2transport Example: Router(config-if)# pvc 1/200 l2transport	Creates or assigns a name to an ATM PVC and enters L2transport PVC configuration mode. <ul style="list-style-type: none"> The l2transport keyword indicates that the PVC is a switched PVC instead of a terminated PVC.
Step 5	encapsulation aal5 Example: Router(config-if-atm-l2trans-pvc)# encapsulation aal5	Specifies ATM AAL5 encapsulation for the PVC. Make sure you specify the same encapsulation type on the PE and customer edge (CE) routers.
Step 6	xconnect peer-router-id vcid encapsulation mpls Example: Router(config-if-atm-l2trans-pvc)# xconnect 10.13.13.13 100 encapsulation mpls	Binds the attachment circuit to a pseudowire VC.
Step 7	end Example: Router(config-if-atm-l2trans-pvc)# end	Exits to privileged EXEC mode.
Step 8	show mpls l2transport vc Example: Router# show mpls l2transport vc	Displays output that shows ATM AAL5 over MPLS is configured on a PVC.

Examples

The following is sample output from the **show mpls l2transport vc** command that shows that ATM AAL5 over MPLS is configured on a PVC:

```
Router# show mpls l2transport vc

Local intf   Local circuit   Dest address   VC ID   Status
-----
ATM1/0      ATM AAL5 1/100 10.4.4.4      100     UP
```

Configuring ATM AAL5 over MPLS in VC Class Configuration Mode

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vc-class atm** *vc-class-name*
4. **encapsulation** *layer-type*
5. **exit**
6. **interface** *type slot/subslot/port[.subinterface]*
7. **class-int** *vc-class-name*
8. **pvc** [*name*] *vpi/vci l2transport*
9. **xconnect** *peer-router-id vcid encapsulation mpls*
10. **end**
11. **show atm class-links**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	vc-class atm <i>vc-class-name</i> Example: Router(config)# vc-class atm aal5class	Creates a VC class and enters VC class configuration mode.
Step 4	encapsulation <i>layer-type</i> Example: Router(config-vc-class)# encapsulation aal5	Configures the AAL and encapsulation type.

Step 5	exit Example: Router(config-vc-class)# exit	Exits VC class configuration mode.
Step 6	interface <i>type slot/subslot/port[.subinterface]</i> Example: Router(config)# interface atm1/0/0	Specifies the interface type enters interface configuration mode.
Step 7	class-int <i>vc-class-name</i> Example: Router(config-if)# class-int aal5class	Applies a VC class to the ATM main interface or subinterface. Note You can also apply a VC class to a PVC.
Step 8	pvc [<i>name</i>] <i>vpi/vci</i> l2transport Example: Router(config-if)# pvc 1/200 l2transport	Creates or assigns a name to an ATM PVC and enters L2transport PVC configuration mode. • The l2transport keyword indicates that the PVC is a switched PVC instead of a terminated PVC.
Step 9	xconnect <i>peer-router-id vcid</i> encapsulation mpls Example: Router(config-if-atm-l2trans-pvc)# xconnect 10.13.13.13 100 encapsulation mpls	Binds the attachment circuit to a pseudowire VC.
Step 10	end Example: Router(config-if-atm-l2trans-pvc)# end	Exits to privileged EXEC mode.
Step 11	show atm class-links Example: Router# show atm class-links	Displays the type of encapsulation and that the VC class was applied to an interface.

Examples

In the following example, the command output from the **show atm class-links** command verifies that ATM AAL5 over MPLS is configured as part of a VC class. The command output shows the type of encapsulation and that the VC class was applied to an interface.

```
Router# show atm class-links 1/100
```

```
Displaying vc-class inheritance for ATM1/0/0.0, vc 1/100:
no broadcast - Not configured - using default
encapsulation aal5 - VC-class configured on main interface
```

Configuring OAM Cell Emulation for ATM AAL5 over MPLS

- [Configuring OAM Cell Emulation for ATM AAL5 over MPLS on PVCs, page 21](#)
- [Configuring OAM Cell Emulation for ATM AAL5 over MPLS in VC Class Configuration Mode, page 22](#)
- [Configuring OAM Cell Emulation for ATM AAL5 over MPLS on PVCs, page 21](#)

Configuring OAM Cell Emulation for ATM AAL5 over MPLS on PVCs

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type slot/subslot/port[.subinterface]*
4. **pvc** [*name*] *vpi/vci l2transport*
5. **encapsulation aal5**
6. **xconnect** *peer-router-id vcid encapsulation mpls*
7. **oam-ac emulation-enable** [*ais-rate*]
8. **oam-pvc manage** [*frequency*]
9. **end**
10. **show atm pvc**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	interface <i>type slot/subslot/port[.subinterface]</i> Example: Router(config)# interface atm1/0/0	Specifies the interface type enters interface configuration mode.
Step 4	pvc [<i>name</i>] <i>vpi/vci l2transport</i> Example: Router(config-if)# pvc 1/200 l2transport	Creates or assigns a name to an ATM PVC and enters L2transport PVC configuration mode. <ul style="list-style-type: none"> • The l2transport keyword indicates that the PVC is a switched PVC instead of a terminated PVC.
Step 5	encapsulation aal5 Example: Router(config-if-atm-l2trans-pvc)# encapsulation aal5	Specifies ATM AAL5 encapsulation for the PVC. <ul style="list-style-type: none"> • Specify the same encapsulation type on the PE and CE routers.
Step 6	xconnect <i>peer-router-id vcid encapsulation mpls</i> Example: Router(config-if-atm-l2trans-pvc)# xconnect 10.13.13.13 100 encapsulation mpls	Binds the attachment circuit to a pseudowire VC.

Step 7	<pre>oam-ac emulation-enable [ais-rate]</pre> <p>Example: Router(config-if-atm-l2trans-pvc)# oam-ac emulation-enable 30 </p>	<p>Enables OAM cell emulation for AAL5 over MPLS. The <i>ais-rate</i> argument lets you specify the rate at which AIS cells are sent. The default is one cell every second. The range is 0 to 60 seconds.</p>
Step 8	<pre>oam-pvc manage [frequency]</pre> <p>Example: Router(config-if-atm-l2trans-pvc)# oam-pvc manage </p>	<p>Enables the PVC to generate end-to-end OAM loopback cells that verify connectivity on the virtual circuit.</p> <p>The optional <i>frequency</i> argument is the interval between transmission of loopback cells and ranges from 0 to 600 seconds. The default value is 10 seconds.</p>
Step 9	<pre>end</pre> <p>Example: Router(config-if-atm-l2trans-pvc)# end </p>	<p>Exits to privileged EXEC mode.</p>
Step 10	<pre>show atm pvc</pre> <p>Example: Router# show atm pvc </p>	<p>Displays output that shows OAM cell emulation is enabled on the ATM PVC.</p>

Examples

The following output from the **show atm pvc** command shows that OAM cell emulation is enabled on the ATM PVC:

```
Router# show atm pvc 5/500

ATM4/1/0.200: VCD: 6, VPI: 5, VCI: 500
UBR, PeakRate: 1
AAL5-LLC/SNAP, etype:0x0, Flags: 0x34000C20, VCmode: 0x0
OAM Cell Emulation: enabled, F5 End2end AIS Xmit frequency: 1 second(s)
OAM frequency: 0 second(s), OAM retry frequency: 1 second(s)
OAM up retry count: 3, OAM down retry count: 5
OAM Loopback status: OAM Disabled
OAM VC state: Not ManagedVerified
ILMI VC state: Not Managed
InPkts: 564, OutPkts: 560, InBytes: 19792, OutBytes: 19680
InPRoc: 0, OutPRoc: 0
InFast: 4, OutFast: 0, InAS: 560, OutAS: 560
InPktDrops: 0, OutPktDrops: 0
CrcErrors: 0, SarTimeOuts: 0, OverSizedSDUs: 0
Out CLP=1 Pkts: 0
OAM cells received: 26
F5 InEndloop: 0, F5 InSegloop: 0, F5 InAIS: 0, F5 InRDI: 26
OAM cells sent: 77
F5 OutEndloop: 0, F5 OutSegloop: 0, F5 OutAIS: 77, F5 OutRDI: 0
OAM cell drops: 0
Status: UP
```

Configuring OAM Cell Emulation for ATM AAL5 over MPLS in VC Class Configuration Mode

SUMMARY STEPS

1. enable

2. **configure terminal**
3. **vc-class atm** *name*
4. **encapsulation** *layer-type*
5. **oam-ac emulation-enable** [*ais-rate*]
6. **oam-pvc manage** [*frequency*]
7. **exit**
8. **interface** *type slot/subslot/port[.subinterface]*
9. **class-int** *vc-class-name*
10. **pvc** [*name*] *vpi/vci l2transport*
11. **xconnect** *peer-router-id vcid encapsulation mpls*

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	vc-class atm <i>name</i> Example: Router(config)# vc-class atm oamclass	Creates a VC class and enters VC class configuration mode.
Step 4	encapsulation <i>layer-type</i> Example: Router(config-vc-class)# encapsulation aal5	Configures the AAL and encapsulation type.
Step 5	oam-ac emulation-enable [<i>ais-rate</i>] Example: Router(config-vc-class)# oam-ac emulation-enable 30	Enables OAM cell emulation for AAL5 over MPLS and specifies the rate at which AIS cells are sent.
Step 6	oam-pvc manage [<i>frequency</i>] Example: Router(config-vc-class)# oam-pvc manage	Enables the PVC to generate end-to-end OAM loopback cells that verify connectivity on the virtual circuit.
Step 7	exit Example: Router(config-vc-class)# exit	Exits VC class configuration mode.

Step 8	<pre>interface <i>type slot/subslot/port[.subinterface]</i></pre> <p>Example: Router(config)# interface atm1/0/0</p>	Specifies the interface type and enters interface configuration mode.
Step 9	<pre>class-int <i>vc-class-name</i></pre> <p>Example: Router(config-if)# class-int oamclass</p>	Applies a VC class to the ATM main interface or subinterface. Note You can also apply a VC class to a PVC.
Step 10	<pre>pvc [<i>name</i>] <i>vpi/vci l2transport</i></pre> <p>Example: Router(config-if)# pvc 1/200 l2transport</p>	Creates or assigns a name to an ATM PVC and enters L2transport PVC configuration mode. <ul style="list-style-type: none">The l2transport keyword indicates that the PVC is a switched PVC instead of a terminated PVC.
Step 11	<pre>xconnect <i>peer-router-id vcid encapsulation mpls</i></pre> <p>Example: Router(config-if-atm-l2trans-pvc)# xconnect 10.13.13.13 100 encapsulation mpls</p>	Binds the attachment circuit to a pseudowire VC.

Configuring ATM Cell Relay over MPLS

- [Configuring ATM Cell Relay over MPLS in VC Mode, page 24](#)
- [Configuring ATM Cell Relay over MPLS in VC Mode Using VC Class Configuration Mode, page 26](#)
- [Configuring ATM Cell Relay over MPLS in PVP Mode, page 27](#)

Configuring ATM Cell Relay over MPLS in VC Mode

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface atm** *slot/subslot/port[.subinterface]*
4. **pvc** *vpi/vci l2transport*
5. **encapsulation aal0**
6. **xconnect** *peer-router-id vcid encapsulation mpls*
7. **end**
8. **show atm vc**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none">Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	interface atm slot/subslot/port[.subinterface] Example: Router(config)# interface atm1/0/0	Specifies an ATM interface and enters interface configuration mode.
Step 4	pvc vpi/vci l2transport Example: Router(config-if)# pvc 0/100 l2transport	Assigns a virtual path identifier (VPI) and virtual circuit identifier (VCI) and enters L2transport VC configuration mode.
Step 5	encapsulation aal0 Example: Router(config-if-atm-l2trans-pvc)# encapsulation aal0	For ATM cell relay, specifies raw cell encapsulation for the interface. <ul style="list-style-type: none">Make sure you specify the same encapsulation type on the PE and CE routers.
Step 6	xconnect peer-router-id vcid encapsulation mpls Example: Router(config-if-atm-l2trans-pvc)# xconnect 10.13.13.13 100 encapsulation mpls	Binds the attachment circuit to a pseudowire VC.
Step 7	end Example: Router(config-if-atm-l2trans-pvc)# end	Exits to privileged EXEC mode.
Step 8	show atm vc Example: Router# show atm vc	Verifies that OAM cell emulation is enabled on the ATM VC.

Example

The following sample output from the **show atm vc** command shows that the interface is configured for VC mode cell relay:

```
Router# show atm vc 7

ATM3/0: VCD: 7, VPI: 23, VCI: 100
UBR, PeakRate: 149760
AAL0-Cell Relay, etype:0x10, Flags: 0x10000C2D, VCmode: 0x0
OAM Cell Emulation: not configured
```

```
InBytes: 0, OutBytes: 0
Status: UP
```

Configuring ATM Cell Relay over MPLS in VC Mode Using VC Class Configuration Mode

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vc-class atm name**
4. **encapsulation layer-type**
5. **exit**
6. **interface type slot/subslot/port[.subinterface]**
7. **class-int vc-class-name**
8. **pvc [name] vpi/vci l2transport**
9. **xconnect peer-router-id vcid encapsulation mpls**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none">• Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	vc-class atm name Example: Router(config)# vc-class atm cellrelay	Creates a VC class and enters VC class configuration mode.
Step 4	encapsulation layer-type Example: Router(config-vc-class)# encapsulation aal0	Configures the AAL and encapsulation type.
Step 5	exit Example: Router(config-vc-class)# exit	Exits VC class configuration mode.
Step 6	interface type slot/subslot/port[.subinterface] Example: Router(config)# interface atm1/0/0	Specifies the interface type and enters interface configuration mode.

Step 7	class-int <i>vc-class-name</i> Example: Router(config-if)# class-int cellrelay	Applies a VC class to the ATM main interface or subinterface. Note You can also apply a VC class to a PVC.
Step 8	pvc [<i>name</i>] <i>vpi/vci</i> l2transport Example: Router(config-if)# pvc 1/200 l2transport	Creates or assigns a name to an ATM PVC and enters L2transport PVC configuration mode.
Step 9	xconnect <i>peer-router-id</i> <i>vcid</i> encapsulation mpls Example: Router(config-if-atm-l2trans-pvc)# xconnect 10.13.13.13 100 encapsulation mpls	Binds the attachment circuit to a pseudowire VC.

Configuring ATM Cell Relay over MPLS in PVP Mode

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface atm** *slot/subslot/port* [*.subinterface*]
4. **atm pvp** *vpi* **l2transport**
5. **xconnect** *peer-router-id* *vcid* **encapsulation mpls**
6. **end**
7. **show atm vp**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	interface atm <i>slot/subslot/port</i> [<i>.subinterface</i>] Example: Router(config)# interface atm1/0/0	Defines the interface and enters interface configuration mode.

	Command or Action	Purpose
Step 4	<pre>atm pvp vpi l2transport</pre> <p>Example: Router(config-if)# atm pvp 1 l2transport</p>	<p>Specifies that the PVP is dedicated to transporting ATM cells and enters L2transport PVP configuration mode.</p> <ul style="list-style-type: none"> The l2transport keyword indicates that the PVP is for cell relay. This mode is for Layer 2 transport only; it is not for regular PVPs.
Step 5	<pre>xconnect peer-router-id vcid encapsulation mpls</pre> <p>Example: Router(config-if-atm-l2trans-pvp)# xconnect 10.0.0.1 123 encapsulation mpls</p>	<p>Binds the attachment circuit to a pseudowire VC. The syntax for this command is the same as for all other Layer 2 transports.</p>
Step 6	<pre>end</pre> <p>Example: Router(config-if-atm-l2trans-pvp)# end</p>	<p>Exits to privileged EXEC mode.</p>
Step 7	<pre>show atm vp</pre> <p>Example: Router# show atm vp</p>	<p>Displays output that shows OAM cell emulation is enabled on the ATM VP.</p>

Examples

The following output from the **show atm vp** command shows that the interface is configured for VP mode cell relay:

```
Router# show atm vp 1
```

```
ATM5/0 VPI: 1, Cell Relay, PeakRate: 149760, CesRate: 0, DataVCs: 1, CesVCs: 0, Status:
ACTIVE
```

VCD	VCI	Type	InPkts	OutPkts	AAL/Encap	Status
6	3	PVC	0	0	F4 OAM	ACTIVE
7	4	PVC	0	0	F4 OAM	ACTIVE

```
TotalInPkts: 0, TotalOutPkts: 0, TotalInFast: 0, TotalOutFast: 0,
TotalBroadcasts: 0 TotalInPktDrops: 0, TotalOutPktDrops: 0
```

Configuring Ethernet over MPLS

- [Configuring Ethernet over MPLS in VLAN Mode to Connect Two VLAN Networks That Are in Different Locations.](#), page 29
- [Configuring Ethernet over MPLS in Port Mode](#), page 29
- [Configuring Ethernet over MPLS with VLAN ID Rewrite](#), page 31
- [Configuring per-Subinterface MTU for Ethernet over MPLS](#), page 33

Configuring Ethernet over MPLS in VLAN Mode to Connect Two VLAN Networks That Are in Different Locations.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface gigabitethernet slot/subslot/port[.subinterface]**
4. **encapsulation dot1q vlan-id**
5. **xconnect peer-router-id vcid encapsulation mpls**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	interface gigabitethernet slot/subslot/port[.subinterface] Example: Router(config)# interface gigabitethernet4/0/0.1	Specifies the Gigabit Ethernet subinterface and enters subinterface configuration mode. <ul style="list-style-type: none"> • Make sure the subinterface on the adjoining CE router is on the same VLAN as this PE router.
Step 4	encapsulation dot1q vlan-id Example: Router(config-subif)# encapsulation dot1q 100	Enables the subinterface to accept 802.1Q VLAN packets.
Step 5	xconnect peer-router-id vcid encapsulation mpls Example: Router(config-subif)# xconnect 10.0.0.1 123 encapsulation mpls	Binds the attachment circuit to a pseudowire VC.

Configuring Ethernet over MPLS in Port Mode

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface gigabitethernet slot/subslot/port[.subinterface]**
4. **xconnect peer-router-id vcid encapsulation mpls**

5. **end**
6. **show mpls l2transport vc**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	interface gigabitethernet <i>slot/subslot/port[.subinterface]</i> Example: Router(config)# interface gigabitethernet4/0/0	Specifies the Gigabit Ethernet interface and enters interface configuration mode. <ul style="list-style-type: none"> Make sure the interface on the adjoining CE router is on the same VLAN as this PE router.
Step 4	xconnect peer-router-id vcid encapsulation mpls Example: Router(config-if)# xconnect 10.0.0.1 123 encapsulation mpls	Binds the attachment circuit to a pseudowire VC.
Step 5	end Example: Router(config-if)# end	Exits to privileged EXEC mode.
Step 6	show mpls l2transport vc Example: Router# show mpls l2transport vc	Displays information about Ethernet over MPLS port mode.

Examples

The sample output in the following example shows two VCs for Ethernet over MPLS:

- VC 2 is in Ethernet VLAN mode.
- VC 8 is in Ethernet port mode.

Router# **show mpls l2transport vc**

Local intf	Local circuit	Dest address	VC ID	Status
Gi4/0/0.1	Eth VLAN 2	10.1.1.1	2	UP
Gi8/0/1	Ethernet	10.1.1.1	8	UP

The sample output from the **show mpls l2transport vc detail** command displays the same information in a different format:

```
Router# show mpls l2transport vc detail
```

```
Local interface: Gi4/0/0.1 up, line protocol up, Eth VLAN 2 up
Destination address: 10.1.1.1, VC ID: 2, VC status: up
.
.
Local interface: Gi8/0/1 up, line protocol up, Ethernet up
Destination address: 10.1.1.1, VC ID: 8, VC status: up
```

Configuring Ethernet over MPLS with VLAN ID Rewrite

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface gigabitethernet** *slot/subslot/port*[*.subinterface*]
4. **encapsulation dot1q** *vlan-id*
5. **xconnect** *peer-router-id* *vcid* **encapsulation mpls**
6. **remote circuit id** *remote-vlan-id*
7. **end**
8. **show controllers compls forwarding-table**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	interface gigabitethernet <i>slot/subslot/port</i> [<i>.subinterface</i>] Example: Router(config)# interface gigabitethernet4/0/0.1	Specifies the Gigabit Ethernet subinterface and enters subinterface configuration mode.
Step 4	encapsulation dot1q <i>vlan-id</i> Example: Router(config-subif)# encapsulation dot1q 100	Enables the subinterface to accept 802.1Q VLAN packets.

Step 5	xconnect <i>peer-router-id vcid encapsulation mpls</i>	Binds the attachment circuit to a pseudowire VC and enters xconnect configuration mode.
	Example: Router(config-subif)# xconnect 10.0.0.1 123 encapsulation mpls	
Step 6	remote circuit id <i>remote-vlan-id</i>	(Optional) Enables you to use VLAN interfaces with different VLAN IDs at both ends of the tunnel.
	Example: Router(config-subif-xconn)# remote circuit id 101	
Step 7	end	Exits to privileged EXEC mode.
	Example: Router(config-subif-xconn)# end	
Step 8	show controllers eompls forwarding-table	Displays information about VLAN ID rewrite.
	Example: Router# show controllers eompls forwarding-table	

Examples

The following sample output from the **show controllers eompls forwarding-table** command shows VLAN ID rewrite configured on a router with an engine 2 3-port Gigabit Ethernet line card. In this example, the output in boldface font shows the VLAN ID rewrite information.

On PE1

```
Router# execute slot 0 show controllers eompls forwarding-table 0 2

Port # 0, VLAN-ID # 2, Table-index 2
EoMPLS configured: 1
tag_rew_ptr          = D001BB58
Leaf entry?         = 1
FCR index           = 20
    **tagrew_psa_addr = 0006ED60
    **tagrew_vir_addr = 7006ED60
    **tagrew_phy_addr = F006ED60
[0-7] loq 8800 mtu 4458 oq 4000 ai 3 oi 04019110 (encaps size 4)
cw-size 4 vlanid-rew 3
gather A30 (bufhdr size 32 EoMPLS (Control Word) Imposition profile 81)
2 tag: 18 18
counters 1182, 10 reported 1182, 10.
Local OutputQ (Unicast): Slot:2 Port:0 RED queue:0 COS queue:0
Output Q (Unicast):      Port:0      RED queue:0 COS queue:0
```

On PE2

```
Router# execute slot 0 show controllers eompls forwarding-table 0 3

Port # 0, VLAN-ID # 3, Table-index 3
EoMPLS configured: 1
tag_rew_ptr          = D0027B90
Leaf entry?         = 1
FCR index           = 20
    **tagrew_psa_addr = 0009EE40
    **tagrew_vir_addr = 7009EE40
```

```

**tagrew_phy_addr      = F009EE40
[0-7] loq 9400 mtu 4458 oq 4000 ai 8 oi 84000002 (encaps size 4)
cw-size 4 vlanid-rew 2
gather A30 (bufhdr size 32 EoMPLS (Control Word) Imposition profile 81)
2 tag: 17 18
counters 1182, 10 reported 1182, 10.
Local OutputQ (Unicast):   Slot:5  Port:0  RED queue:0  COS queue:0
Output Q (Unicast):       Port:0      RED queue:0  COS queue:0

```

Configuring per-Subinterface MTU for Ethernet over MPLS

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface gigabitethernet *slot/subslot/port*[*.subinterface*]**
4. **mtu *mtu-value***
5. **interface gigabitethernet *slot/subslot/port*[*.subinterface*]**
6. **encapsulation dot1q *vlan-id***
7. **xconnect *peer-router-id vcid encapsulation mpls***
8. **mtu *mtu-value***
9. **end**
10. **show mpls l2transport binding**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	interface gigabitethernet <i>slot/subslot/port</i>[<i>.subinterface</i>] Example: Router(config)# interface gigabitethernet4/0/0	Specifies the Gigabit Ethernet interface and enters interface configuration mode.
Step 4	mtu <i>mtu-value</i> Example: Router(config-if)# mtu 2000	Specifies the MTU value for the interface. The MTU value specified at the interface level can be inherited by a subinterface.

	Command or Action	Purpose
Step 5	<pre>interface gigabitethernet slot/subslot/port[.subinterface]</pre> <p>Example: Router(config-if)# interface gigabitethernet4/0/0.1</p>	<p>Specifies the Gigabit Ethernet subinterface and enters subinterface configuration mode.</p> <p>Make sure the subinterface on the adjoining CE router is on the same VLAN as this PE router.</p>
Step 6	<pre>encapsulation dot1q vlan-id</pre> <p>Example: Router(config-subif)# encapsulation dot1q 100</p>	<p>Enables the subinterface to accept 802.1Q VLAN packets.</p> <p>The subinterfaces between the CE and PE routers that are running Ethernet over MPLS must be in the same subnet. All other subinterfaces and backbone routers need not be.</p>
Step 7	<pre>xconnect peer-router-id vcid encapsulation mpls</pre> <p>Example: Router(config-subif)# xconnect 10.0.0.1 123 encapsulation mpls</p>	<p>Binds the attachment circuit to a pseudowire VC.</p> <p>The syntax for this command is the same as for all other Layer 2 transports. Enters xconnect subinterface configuration mode.</p>
Step 8	<pre>mtu mtu-value</pre> <p>Example: Router(config-if-xconn)# mtu 1400</p>	<p>Specifies the MTU for the VC.</p>
Step 9	<pre>end</pre> <p>Example: Router(config-if-xconn)# end</p>	<p>Exits to privileged EXEC mode.</p>
Step 10	<pre>show mpls l2transport binding</pre> <p>Example: Router# show mpls l2transport binding</p>	<p>Displays the MTU values assigned to the local and remote interfaces.</p>

Configuring Frame Relay over MPLS

- [Configuring Frame Relay over MPLS with DLCI-to-DLCI Connections, page 34](#)
- [Configuring Frame Relay over MPLS with Port-to-Port Connections, page 36](#)

Configuring Frame Relay over MPLS with DLCI-to-DLCI Connections

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **frame-relay switching**
4. **interface serial slot/subslot/port[.subinterface]**
5. **encapsulation frame-relay [cisco | ietf]**
6. **frame-relay intf-type dce**

7. **exit**
8. **connect** *connection-name interface dlcil2transport*
9. **xconnect** *peer-router-id vcid encapsulation mpls*

DETAILED STEPS

	Command or Action	Purpose
Step 1	<p>enable</p> <p>Example: Router> enable</p>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	<p>configure terminal</p> <p>Example: Router# configure terminal</p>	<p>Enters global configuration mode.</p>
Step 3	<p>frame-relay switching</p> <p>Example: Router(config)# frame-relay switching</p>	<p>Enables PVC switching on a Frame Relay device.</p>
Step 4	<p>interface serial <i>slot/subslot/port[.subinterface]</i></p> <p>Example: Router(config)# interface serial3/1/0</p>	<p>Specifies a serial interface and enters interface configuration mode.</p>
Step 5	<p>encapsulation frame-relay [cisco ietf]</p> <p>Example: Router(config-if)# encapsulation frame-relay ietf</p>	<p>Specifies Frame Relay encapsulation for the interface. You can specify different types of encapsulations. You can set one interface to Cisco encapsulation and the other interface to IETF encapsulation.</p>
Step 6	<p>frame-relay intf-type dce</p> <p>Example: Router(config-if)# frame-relay intf-type dce</p>	<p>Specifies that the interface is a DCE switch. You can also specify the interface to support Network-to-Network Interface (NNI) and DTE connections.</p>
Step 7	<p>exit</p> <p>Example: Router(config-if)# exit</p>	<p>Exits from interface configuration mode.</p>

	Command or Action	Purpose
Step 8	<p>connect <i>connection-name interface dlci</i> l2transport</p> <p>Example: Router(config)# connect fr1 serial5/0 1000 l2transport</p>	<p>Defines connections between Frame Relay PVCs and enters connect configuration mode. Using the l2transport keyword specifies that the PVC will not be a locally switched PVC, but will be tunneled over the backbone network.</p> <p>The <i>connection-name</i> argument is a text string that you provide.</p> <p>The <i>interface</i> argument is the interface on which a PVC connection will be defined.</p> <p>The <i>dlci</i> argument is the DLCI number of the PVC that will be connected.</p>
Step 9	<p>xconnect <i>peer-router-id vcid</i> encapsulation mpls</p> <p>Example: Router(config-fr-pw-switching)# xconnect 10.0.0.1 123 encapsulation mpls</p>	<p>Creates the VC to transport the Layer 2 packets. In a DLCI-to-DLCI connection type, Frame Relay over MPLS uses the xconnect command in connect configuration mode.</p>

Configuring Frame Relay over MPLS with Port-to-Port Connections

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface serial** *slot/subslot/port[.subinterface]*
4. **encapsulation hdlc**
5. **xconnect** *peer-router-id vcid encapsulation mpls*

DETAILED STEPS

	Command or Action	Purpose
Step 1	<p>enable</p> <p>Example: Router> enable</p>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	<p>configure terminal</p> <p>Example: Router# configure terminal</p>	<p>Enters global configuration mode.</p>
Step 3	<p>interface serial <i>slot/subslot/port[.subinterface]</i></p> <p>Example: Router(config)# interface serial5/0/0</p>	<p>Specifies a serial interface and enters interface configuration mode.</p>

	Command or Action	Purpose
Step 4	encapsulation <i>hdlc</i> Example: Router(config-if)# encapsulation hdlc	Specifies that Frame Relay PDUs will be encapsulated in HDLC packets.
Step 5	xconnect <i>peer-router-id vcid</i> encapsulation <i>mpls</i> Example: Router(config-if)# xconnect 10.0.0.1 123 encapsulation mpls	Creates the VC to transport the Layer 2 packets.

Configuring HDLC or PPP over MPLS

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface serial** *slot/subslot/port[.subinterface]*
4. **encapsulation** *encapsulation-type*
5. **xconnect** *peer-router-id vcid encapsulation mpls*

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	interface serial <i>slot/subslot/port[.subinterface]</i> Example: Router(config)# interface serial5/0/0	Specifies a serial interface and enters interface configuration mode.

	Command or Action	Purpose
Step 4	<pre>encapsulation ppp or encapsulation hdlc</pre> <p>Example: Router(config-if)# encapsulation ppp or</p> <p>Example: Router(config-if)# encapsulation hdlc </p>	Specifies HDLC or PPP encapsulation and enters connect configuration mode.
Step 5	<pre>xconnect peer-router-id vcid encapsulation mpls</pre> <p>Example: Router(config-fr-pw-switching)# xconnect 10.0.0.1 123 encapsulation mpls </p>	Creates the VC to transport the Layer 2 packets.

Configuring Tunnel Selection

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **pseudowire-class** *name*
4. **encapsulation mpls**
5. **preferred-path** {**interface tunnel** *tunnel-number* | **peer** {*ip-address* | *host-name*}}
[**disable-fallback**]
6. **exit**
7. **interface** *type slot/subslot/port[.subinterface]*
8. **encapsulation** *encapsulation-type*
9. **xconnect** *peer-router-id vcid pw-class name*

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	pseudowire-class name Example: Router(config)# pseudowire-class ts1	Establishes a pseudowire class with a name that you specify and enters pseudowire configuration mode.
Step 4	encapsulation mpls Example: Router(config-pw)# encapsulation mpls	Specifies the tunneling encapsulation. For AToM, the encapsulation type is mpls.
Step 5	preferred-path {interface tunnel tunnel-number peer {ip-address host-name}} [disable-fallback] Example: Router(config-pw)# preferred path peer 10.18.18.18	Specifies the MPLS traffic engineering tunnel or IP address or hostname to be used as the preferred path.
Step 6	exit Example: Router(config-pw)# exit	Exits from pseudowire configuration mode and enables the Tunnel Selection feature.
Step 7	interface type slot/subslot/port[.subinterface] Example: Router(config)# interface atm1/1/0	Specifies an interface type and enters interface configuration mode.
Step 8	encapsulation encapsulation-type Example: Router(config-if)# encapsulation aal5	Specifies the encapsulation for the interface.
Step 9	xconnect peer-router-id vcid pw-class name Example: Router(config-if)# xconnect 10.0.0.1 123 pw-class ts1	Binds the attachment circuit to a pseudowire VC.

Examples

In the following sample output from the **show mpls l2transport vc** command includes the following information about the VCs:

- VC 101 has been assigned a preferred path called Tunnel1. The default path is disabled, because the preferred path specified that the default path should not be used if the preferred path fails.
- VC 150 has been assigned an IP address of a loopback address on PE2. The default path can be used if the preferred path fails.

Command output that is in boldface font shows the preferred path information.

```
Router# show mpls l2transport vc detail

Local interface: Gi0/0/0.1 up, line protocol up, Eth VLAN 222 up
Destination address: 10.16.16.16, VC ID: 101, VC status: up
  Preferred path: Tunnel1, active
  Default path: disabled
  Tunnel label: 3, next hop point2point
  Output interface: Tu1, imposed label stack {17 16}
  Create time: 00:27:31, last status change time: 00:27:31
  Signaling protocol: LDP, peer 10.16.16.16:0 up
  MPLS VC labels: local 25, remote 16
  Group ID: local 0, remote 6
  MTU: local 1500, remote 1500
  Remote interface description:
  Sequencing: receive disabled, send disabled
  VC statistics:
    packet totals: receive 10, send 10
    byte totals:   receive 1260, send 1300
    packet drops:  receive 0, send 0

Local interface: ATM1/0/0 up, line protocol up, ATM AAL5 0/50 up
Destination address: 10.16.16.16, VC ID: 150, VC status: up
  Preferred path: 10.18.18.18, active
  Default path: ready
  Tunnel label: 3, next hop point2point
  Output interface: Tu2, imposed label stack {18 24}
  Create time: 00:15:08, last status change time: 00:07:37
  Signaling protocol: LDP, peer 10.16.16.16:0 up
  MPLS VC labels: local 26, remote 24
  Group ID: local 2, remote 0
  MTU: local 4470, remote 4470
  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, send 0
```

Troubleshooting Tips

You can use the **debug mpls l2transport vc event** command to troubleshoot tunnel selection. For example, if the tunnel interface that is used for the preferred path is shut down, the default path is enabled.

Examples

```
Router# debug mpls l2transport vc event

AToM SMGR [10.2.2.2, 101]: Processing imposition update, vc_handle 62091860, update_action
3, remote_vc_label 16
AToM SMGR [10.2.2.2, 101]: selected route no parent rewrite: tunnel not up
```

AToM SMGR [10.2.2.2, 101]: Imposition Programmed, Output Interface: Fe3/2/1

Setting Experimental Bits with AToM

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **class-map** *class-name*
4. **match any**
5. **policy-map** *policy-name*
6. **class** *class-name*
7. **set mpls experimental** *value*
8. **exit**
9. **exit**
10. **interface** *type slot/subslot/port[.subinterface]*
11. **service-policy input** *policy-name*
12. **end**
13. **show policy-map interface** *interface-name* [**vc** [*vpi/*] *vci*] [**dlci** *dlci*] [**input** | **output**]

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	class-map <i>class-name</i> Example: Router(config)# class-map class1	Specifies the user-defined name of the traffic class and enters class map configuration mode.
Step 4	match any Example: Router(config-cmap)# match any	Specifies that all packets will be matched. Use only the any keyword. Other keywords might cause unexpected results.
Step 5	policy-map <i>policy-name</i> Example: Router(config-cmap)# policy-map policy1	Specifies the name of the traffic policy to configure and enters policy-map configuration mode.

	Command or Action	Purpose
Step 6	class <i>class-name</i> Example: Router(config-pmap)# class class1	Specifies the name of a predefined traffic class, which was configured with the class-map command, used to classify traffic to the traffic policy and enters policy-map class configuration mode.
Step 7	set mpls experimental <i>value</i> Example: Router(config-pmap-c)# set mpls experimental 7	Designates the value to which the MPLS bits are set if the packets match the specified policy map.
Step 8	exit Example: Router(config-pmap-c)# exit	Exits policy-map class configuration mode.
Step 9	exit Example: Router(config-pmap)# exit	Exits policy-map configuration mode.
Step 10	interface <i>type</i> <i>slot/subslot/port[.subinterface]</i> Example: Router(config)# interface atm1/0/0	Specifies the interface type and enters interface configuration mode.
Step 11	service-policy input <i>policy-name</i> Example: Router(config-if)# service-policy input policy1	Attaches a traffic policy to an interface.
Step 12	end Example: Router(config-if)# end	Exits to privileged EXEC mode.
Step 13	show policy-map interface <i>interface-name</i> [<i>vc [vpi/] vci]</i> [<i>dlci dlci</i>] [input output] Example: Router# show policy-map interface serial3/0/0	Displays the traffic policy attached to an interface.

Enabling the Control Word

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **pseudowire-class cw_enable**

4. **encapsulation mpls**
5. **control-word**
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	pseudowire-class cw_enable Example: Router(config)# pseudowire-class cw_enable	Enters pseudowire class configuration mode.
Step 4	encapsulation mpls Example: Router(config-pw-class)# encapsulation mpls	Specifies the tunneling encapsulation. <ul style="list-style-type: none"> • For AToM, the encapsulation type is mpls.
Step 5	control-word Example: Router(config-pw-class)# control-word	Enables the control word.
Step 6	end Example: Router(config-pw-class)# end	Exits to privileged EXEC mode.

Configuring MPLS AToM Remote Ethernet Port Shutdown



Note

The Any Transport over MPLS (AToM): Remote Ethernet Port Shutdown feature is automatically enabled by default when an image with the feature supported is loaded on the router.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **pseudowire-class [pw-class-name]**

4. **encapsulation mpls**
5. **exit**
6. **interface** *type slot/subslot/port[.subinterface]*
7. **xconnect** *peer-ip-address vc-id pw-class pw-class-name*
8. **no remote link failure notification**
9. **remote link failure notification**
10. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	pseudowire-class [<i>pw-class-name</i>] Example: Router(config)# pseudowire-class eompls	Specifies the name of a Layer 2 pseudowire class and enters pseudowire class configuration mode.
Step 4	encapsulation mpls Example: Router(config-pw)# encapsulation mpls	Specifies that MPLS is used as the data encapsulation method for tunneling Layer 2 traffic over the pseudowire.
Step 5	exit Example: Router(config-pw)# exit	Exits to global configuration mode.
Step 6	interface <i>type slot/subslot/port[.subinterface]</i> Example: Router (config)# interface GigabitEthernet1/0/0	Configures an interface type and enters interface configuration mode.
Step 7	xconnect <i>peer-ip-address vc-id pw-class pw-class-name</i> Example: Router(config-if)# xconnect 10.1.1.1 1 pw-class eompls	Binds an attachment circuit to a pseudowire, and configures an Any Transport over MPLS (AToM) static pseudowire.

	Command or Action	Purpose
Step 8	no remote link failure notification Example: Router(config-if-xconn)# remote link failure notification	Disables MPLS AToM remote link failure notification and shutdown.
Step 9	remote link failure notification Example: Router(config-if-xconn)# remote link failure notification	Enables MPLS AToM remote link failure notification and shutdown.
Step 10	end Example: Router(config-if-xconn)# end	Exits to privileged EXEC mode.

Configuring AToM Load Balancing with Single PW

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **pseudowire-class ecmp-class**
4. **encapsulation mpls**
5. **load-balance flow**
6. **xconnect url pw-class ecmp-class**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	pseudowire-class ecmp-class Example: Router(config)# pseudowire-class ecmp-class	Establishes a pseudowire class with a name that you specify, and enters pseudowire class configuration mode.

	Command or Action	Purpose
Step 4	encapsulation mpls Example: Router(config-pw-class)# encapsulation mpls	Specifies the tunneling encapsulation. <ul style="list-style-type: none">For AToM, the encapsulation type is mpls.
Step 5	load-balance flow Example: Router(config-pw-class)# load-balance flow	Enables the AToM Load Balancing with Single PW feature so that load balancing is done on a per-flow basis.
Step 6	xconnect url pw-class ecmp-class Example: Router(config-pw-class)# xconnect 10.0.0.1 pw-class ecmp-class	Binds the attachment circuit to a pseudowire virtual circuit, and enters xconnect configuration mode. <ul style="list-style-type: none">The syntax for this command is the same as for all other Layer 2 transports.

Configuration Examples for Any Transport over MPLS

- [Example: ATM over MPLS, page 46](#)
- [Example: Configuring ATM AAL5 over MPLS in VC Class Configuration Mode, page 47](#)
- [Example: Ethernet over MPLS with MPLS Traffic Engineering Fast Reroute, page 47](#)
- [Example: Configuring OAM Cell Emulation, page 50](#)
- [Example: Configuring ATM Cell Relay over MPLS, page 51](#)
- [Example: Configuring per-Subinterface MTU for Ethernet over MPLS, page 52](#)
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Example: ATM over MPLS

[Example 1](#) shows the configuration of ATM over MPLS on two PE routers.

Example 1 ATM over MPLS Configuration Example

PE1	PE2
<pre> mpls label protocol ldp mpls ldp router-id Loopback0 force ! interface Loopback0 ip address 10.16.12.12 255.255.255.255 ! interface ATM4/0/0 pvc 0/100 l2transport encapsulation aal0 xconnect 10.13.13.13 100 encapsulation mpls ! interface ATM4/0/0.300 point-to-point no ip directed-broadcast no atm enable-ilmi-trap pvc 0/300 l2transport encapsulation aal0 xconnect 10.13.13.13 300 encapsulation mpls </pre>	<pre> mpls label protocol ldp mpls ldp router-id Loopback0 force ! interface Loopback0 ip address 10.13.13.13 255.255.255.255 ! interface ATM4/0/0 pvc 0/100 l2transport encapsulation aal0 xconnect 10.16.12.12 100 encapsulation mpls ! interface ATM4/0/0.300 point-to-point no ip directed-broadcast no atm enable-ilmi-trap pvc 0/300 l2transport encapsulation aal0 xconnect 10.16.12.12 300 encapsulation mpls </pre>

Example: Configuring ATM AAL5 over MPLS in VC Class Configuration Mode

The following example configures ATM AAL5 over MPLS in VC class configuration mode. The VC class is then applied to an interface.

```

enable
configure terminal
vc-class atm aal5class
 encapsulation aal5
interface atm1/0/0
 class-int aal5class
 pvc 1/200 l2transport
 xconnect 10.13.13.13 100 encapsulation mpls

```

The following example configures ATM AAL5 over MPLS in VC class configuration mode. The VC class is then applied to a PVC.

```

enable
configure terminal
vc-class atm aal5class
 encapsulation aal5
interface atm1/0/0
 pvc 1/200 l2transport
 class-vc aal5class
 xconnect 10.13.13.13 100 encapsulation mpls

```

Example: Ethernet over MPLS with MPLS Traffic Engineering Fast Reroute

The following configuration example and [Figure 3](#) show the configuration of Ethernet over MPLS with fast reroute on AToM PE routers.

Routers PE1 and PE2 have the following characteristics:

- A TE tunnel called Tunnel41 is configured between PE1 and PE2, using an explicit path through a link called L1. AToM VCs are configured to travel through the FRR-protected tunnel Tunnel41.
- The link L1 is protected by FRR, the backup tunnel is Tunnel1.

- PE2 is configured to forward the AToM traffic back to PE1 through the L2 link.

Figure 3 **Fast Reroute Configuration**



PE1 Configuration

```

mpls label protocol ldp
mpls traffic-eng tunnels
mpls ldp router-id Loopback1 force
!
pseudowire-class T41
  encapsulation mpls
  preferred-path interface Tunnel41 disable-fallback
!
pseudowire-class IP1
  encapsulation mpls
  preferred-path peer 10.4.0.1 disable-fallback
!
interface Loopback1
  ip address 10.0.0.27 255.255.255.255
!
interface Tunnel1
  ip unnumbered Loopback1
  tunnel destination 10.0.0.1
  tunnel mode mpls traffic-eng
  tunnel mpls traffic-eng priority 1 1
  tunnel mpls traffic-eng bandwidth 10000
  tunnel mpls traffic-eng path-option 1 explicit name FRR
!
interface Tunnel41
  ip unnumbered Loopback1
  tunnel destination 10.0.0.4
  tunnel mode mpls traffic-eng
  tunnel mpls traffic-eng priority 1 1
  tunnel mpls traffic-eng bandwidth 1000
  tunnel mpls traffic-eng path-option 1 explicit name name-1
  tunnel mpls traffic-eng fast-reroute
!
interface POS0/0/0
  description pelname POS8/0/0
  ip address 10.1.0.2 255.255.255.252
  mpls traffic-eng tunnels
  mpls traffic-eng backup-path Tunnel1
  crc 16
  clock source internal
  pos ais-shut
  pos report lrldi
  ip rsvp bandwidth 155000 155000
!
interface POS0/3/0
  description pelname POS10/1/0
  ip address 10.1.0.14 255.255.255.252
  mpls traffic-eng tunnels
  crc 16
  clock source internal

```

```

ip rsvp bandwidth 155000 155000
!
interface gigabitethernet3/0/0.1
 encapsulation dot1Q 203
 xconnect 10.0.0.4 2 pw-class IP1
!
interface gigabitethernet3/0/0.2
 encapsulation dot1Q 204
 xconnect 10.0.0.4 4 pw-class T41
!
router ospf 1
 network 10.0.0.0 0.255.255.255 area 0
 mpls traffic-eng router-id Loopback1
 mpls traffic-eng area 0
!
ip classless
ip route 10.4.0.1 255.255.255.255 Tunnel41
!
ip explicit-path name xxxx-1 enable
 next-address 10.4.1.2
 next-address 10.1.0.10

```

P Configuration

```

ip cef
mpls traffic-eng tunnels
!
interface Loopback1
 ip address 10.0.0.1 255.255.255.255
!
interface FastEthernet1/0/0
 ip address 10.4.1.2 255.255.255.0
 mpls traffic-eng tunnels
 ip rsvp bandwidth 10000 10000
!
interface POS8/0/0
 description xxxx POS0/0
 ip address 10.1.0.1 255.255.255.252
 mpls traffic-eng tunnels
 pos ais-shut
 pos report lrldi
 ip rsvp bandwidth 155000 155000
!
interface POS10/1/0
 description xxxx POS0/3
 ip address 10.1.0.13 255.255.255.252
 mpls traffic-eng tunnels
 ip rsvp bandwidth 155000 155000
!
router ospf 1
 network 10.0.0.0 0.255.255.255 area 0
 mpls traffic-eng router-id Loopback1
 mpls traffic-eng area 0

```

PE2 Configuration

```

ip cef
mpls label protocol ldp
mpls traffic-eng tunnels
mpls ldp router-id Loopback1 force
!
interface Loopback1
 ip address 10.0.0.4 255.255.255.255
!

```

```

interface loopback 2
ip address 10.4.0.1 255.255.255.255
!
interface Tunnel27
ip unnumbered Loopback1
tunnel destination 10.0.0.27
tunnel mode mpls traffic-eng
tunnel mpls traffic-eng autoroute announce
tunnel mpls traffic-eng priority 1 1
tunnel mpls traffic-eng bandwidth 1000
tunnel mpls traffic-eng path-option 1 explicit name xxxx-1
!
interface FastEthernet0/0/0.2
encapsulation dot1Q 203
xconnect 10.0.0.27 2 encapsulation mpls
!
interface FastEthernet0/0/0.3
encapsulation dot1Q 204
xconnect 10.0.0.27 4 encapsulation mpls
!
interface FastEthernet1/1/0
ip address 10.4.1.1 255.255.255.0
mpls traffic-eng tunnels
ip rsvp bandwidth 10000 10000
!
router ospf 1
network 10.0.0.0 0.255.255.255 area 0
mpls traffic-eng router-id Loopback1
mpls traffic-eng area 0
!
ip explicit-path name xxxx-1 enable
next-address 10.4.1.2
next-address 10.1.0.10

```

Example: Configuring OAM Cell Emulation

The following example shows how to enable OAM cell emulation on an ATM PVC:

```

interface ATM 1/0/0
pvc 1/200 l2transport
encapsulation aal5
xconnect 10.13.13.13 100 encapsulation mpls
oam-ac emulation-enable
oam-pvc manage

```

The following example shows how to set the rate at which an AIS cell is sent every 30 seconds:

```

interface ATM 1/0/0
pvc 1/200 l2transport
encapsulation aal5
xconnect 10.13.13.13 100 encapsulation mpls
oam-ac emulation-enable 30
oam-pvc manage

```

The following example shows how to configure OAM cell emulation for ATM AAL5 over MPLS in VC class configuration mode. The VC class is then applied to an interface.

```

enable
configure terminal
vc-class atm oamclass
encapsulation aal5

```

```
oam-ac emulation-enable 30
oam-pvc manage
interface atm1/0/0
class-int oamclass
pvc 1/200 l2transport
xconnect 10.13.13.13 100 encapsulation mpls
```

The following example shows how to configure OAM cell emulation for ATM AAL5 over MPLS in VC class configuration mode. The VC class is then applied to a PVC.

```
enable
configure terminal
vc-class atm oamclass
encapsulation aal5
oam-ac emulation-enable 30
oam-pvc manage
interface atm1/0/0
pvc 1/200 l2transport
class-vc oamclass
xconnect 10.13.13.13 100 encapsulation mpls
```

The following example shows how to configure OAM cell emulation for ATM AAL5 over MPLS in VC class configuration mode. The VC class is then applied to an interface. One PVC is configured with OAM cell emulation at an AIS rate of 10. That PVC uses the AIS rate of 10 instead of 30.

```
enable
configure terminal
vc-class atm oamclass
encapsulation aal5
oam-ac emulation-enable 30
oam-pvc manage
interface atm1/0/0
class-int oamclass
pvc 1/200 l2transport
oam-ac emulation-enable 10
xconnect 10.13.13.13 100 encapsulation mpls
```

Example: Configuring ATM Cell Relay over MPLS

The following example shows how to configure ATM cell relay over MPLS in VC class configuration mode. The VC class is then applied to an interface.

```
enable
configure terminal
vc-class atm cellrelay
encapsulation aal0
interface atm1/0/0
class-int cellrelay
pvc 1/200 l2transport
xconnect 10.13.13.13 100 encapsulation mpls
```

The following example shows how to configure ATM cell relay over MPLS in VC class configuration mode. The VC class is then applied to a PVC.

```
enable
configure terminal
vc-class atm cellrelay
encapsulation aal0
interface atm1/0/0
pvc 1/200 l2transport
class-vc cellrelay
xconnect 10.13.13.13 100 encapsulation mpls
```

The following example shows how to configure a pseudowire class to transport single ATM cells over a virtual path:

```
pseudowire-class vp-cell-relay
encapsulation mpls
interface atm 5/0
atm pvp 1 l2transport
xconnect 10.0.0.1 123 pw-class vp-cell-relay
```

Example: Configuring per-Subinterface MTU for Ethernet over MPLS

Figure 4 shows a configuration that enables matching MTU values between VC endpoints.

As shown in Figure 4, PE1 is configured in xconnect subinterface configuration mode with an MTU value of 1500 bytes in order to establish an end-to-end VC with PE2, which also has an MTU value of 1500 bytes. If PE1 was not set with an MTU value of 1500 bytes, in xconnect subinterface configuration mode, the subinterface would inherit the MTU value of 2000 bytes set on the interface. This would cause a mismatch in MTU values between the VC endpoints, and the VC would not come up.

Figure 4 *Configuring MTU Values in xconnect Subinterface Configuration Mode*



The following examples show the router configurations in Figure 4:

CE1 Configuration

```
interface gigabitethernet0/0/0
mtu 1500
no ip address
!
interface gigabitethernet0/0/0.1
encapsulation dot1Q 100
ip address 10.181.182.1 255.255.255.0
```

PE1 Configuration

```
interface gigabitethernet0/0/0
mtu 2000
no ip address
!
interface gigabitethernet0/0/0.1
encapsulation dot1Q 100
xconnect 10.1.1.152 100 encapsulation mpls
mtu 1500
!
interface gigabitethernet0/0/0.2
encapsulation dot1Q 200
ip address 10.151.100.1 255.255.255.0
mpls ip
```

PE2 Configuration

```

interface gigabitethernet1/0/0
  mtu 2000
  no ip address
!
interface gigabitethernet1/0/0.2
  encapsulation dot1Q 200
  ip address 10.100.152.2 255.255.255.0
  mpls ip
!
interface fastethernet0/0/0
  no ip address
!
interface fastethernet0/0/0.1
  description default MTU of 1500 for FastEthernet
  encapsulation dot1Q 100
  xconnect 10.1.1.151 100 encapsulation mpls

```

CE2 Configuration

```

interface fastethernet0/0/0
  no ip address
interface fastethernet0/0/0.1
  encapsulation dot1Q 100
  ip address 10.181.182.2 255.255.255.0

```

The **show mpls l2transport binding** command, issued from router PE1, shows a matching MTU value of 1500 bytes on both the local and remote routers:

Router# **show mpls l2transport binding**

```

Destination Address: 10.1.1.152, VC ID: 100
  Local Label: 100
    Cbit: 1, VC Type: FastEthernet, GroupID: 0
    MTU: 1500, Interface Desc: n/a
    VCCV: CC Type: CW [1], RA [2]
    CV Type: LSPV [2]
  Remote Label: 202
    Cbit: 1, VC Type: FastEthernet, GroupID: 0
    MTU: 1500, Interface Desc: n/a
    VCCV: CC Type: RA [2]
    CV Type: LSPV [2]

```

Router# **show mpls l2transport vc detail**

```

Local interface: Gi0/0/0.1 up, line protocol up, Eth VLAN 100 up
  Destination address: 10.1.1.152, VC ID: 100, VC status: up
  Output interface: Gi0/0/0.2, imposed label stack {202}
  Preferred path: not configured
  Default path: active
  Next hop: 10.151.152.2
  Create time: 1d11h, last status change time: 1d11h
  Signaling protocol: LDP, peer 10.1.1.152:0 up
  Targeted Hello: 10.1.1.151(LDP ID) -> 10.1.1.152
  MPLS VC labels: local 100, remote 202
  Group ID: local 0, remote 0
  MTU: local 1500, remote 1500
  Remote interface description:
  Sequencing: receive disabled, send disabled
  VC statistics:
    packet totals: receive 41, send 39
    byte totals: receive 4460, send 5346
    packet drops: receive 0, send 0

```

Configuring Tunnel Selection

The following example shows how to set up two preferred paths for PE1. One preferred path specifies an MPLS traffic engineering tunnel. The other preferred path specifies an IP address of a loopback address on PE2. There is a static route configured on PE1 that uses a TE tunnel to reach the IP address on PE2.

PE1 Configuration

```

mpls label protocol ldp
mpls traffic-eng tunnels
tag-switching tdp router-id Loopback0
pseudowire-class pw1
  encapsulation mpls
  preferred-path interface Tunnel1 disable-fallback
!
pseudowire-class pw2
  encapsulation mpls
  preferred-path peer 10.18.18.18
!
interface Loopback0
  ip address 10.2.2.2 255.255.255.255
  no ip directed-broadcast
  no ip mroute-cache
!
interface Tunnel1
  ip unnumbered Loopback0
  no ip directed-broadcast
  tunnel destination 10.16.16.16
  tunnel mode mpls traffic-eng
  tunnel mpls traffic-eng priority 7 7
  tunnel mpls traffic-eng bandwidth 1500
  tunnel mpls traffic-eng path-option 1 explicit name path-tul
!
interface Tunnel2
  ip unnumbered Loopback0
  no ip directed-broadcast
  tunnel destination 10.16.16.16
  tunnel mode mpls traffic-eng
  tunnel mpls traffic-eng priority 7 7
  tunnel mpls traffic-eng bandwidth 1500
  tunnel mpls traffic-eng path-option 1 dynamic
!
interface gigabitethernet0/0/0
  no ip address
  no ip directed-broadcast
  no negotiation auto
!
interface gigabitethernet0/0/0.1
  encapsulation dot1q 222
  no ip directed-broadcast
  xconnect 10.16.16.16 101 pw-class pw1
!
interface ATM1/0/0
  no ip address
  no ip directed-broadcast
  no atm enable-ilmi-trap
  no atm ilmi-keepalive
  pvc 0/50 l2transport
  encapsulation aal5
  xconnect 10.16.16.16 150 pw-class pw2
!

```

```

interface FastEthernet2/0/1
 ip address 10.0.0.1 255.255.255.0
 no ip directed-broadcast
 tag-switching ip
 mpls traffic-eng tunnels
 ip rsvp bandwidth 15000 15000
 !
router ospf 1
 log-adjacency-changes
 network 10.0.0.0 0.0.0.255 area 0
 network 10.2.2.2 0.0.0.0 area 0
 mpls traffic-eng router-id Loopback0
 mpls traffic-eng area 0
 !
ip route 10.18.18.18 255.255.255.255 Tunnel2
 !
ip explicit-path name path-tu1 enable
 next-address 10.0.0.1
 index 3 next-address 10.0.0.1

```

PE2 Configuration

```

mpls label protocol ldp
 mpls traffic-eng tunnels
 mpls ldp router-id Loopback0
interface Loopback0
 ip address 10.16.16.16 255.255.255.255
 no ip directed-broadcast
 no ip mroute-cache
 !
interface Loopback2
 ip address 10.18.18.18 255.255.255.255
 no ip directed-broadcast
 !
interface FastEthernet1/1/0
 ip address 10.0.0.2 255.255.255.0
 no ip directed-broadcast
 mpls traffic-eng tunnels
 mpls ip
 no cdp enable
 ip rsvp bandwidth 15000 15000
 !
interface FastEthernet1/1/1
 no ip address
 no ip directed-broadcast
 no cdp enable
 !
interface FastEthernet1/1/1.1
 encapsulation dot1Q 222
 no ip directed-broadcast
 no cdp enable
 mpls l2transport route 10.2.2.2 101
 !
interface ATM5/0/0
 no ip address
 no ip directed-broadcast
 no atm enable-ilmi-trap
 no atm ilmi-keepalive
 pvc 0/50 l2transport
 encapsulation aal5
 xconnect 10.2.2.2 150 encapsulation mpls
 !
router ospf 1
 log-adjacency-changes

```

```

network 10.0.0.0 0.0.0.255 area 0
network 10.16.16.16 0.0.0.0 area 0
mpls traffic-eng router-id Loopback0
mpls traffic-eng area 0

```

Example: Configuring MTU Values in xconnect Configuration Mode for L2VPN Interworking

The following example shows an L2VPN Interworking example. The PE1 router has a serial interface configured with an MTU value of 1492 bytes. The PE2 router uses xconnect configuration mode to set a matching MTU of 1492 bytes, which allows the two routers to form an interworking VC. If the PE2 router did not set the MTU value in xconnect configuration mode, the interface would be set to 1500 bytes by default and the VC would not come up.

PE1 Configuration

```

pseudowire-class atom-ipiw
 encapsulation mpls
 interworking ip
!
interface Loopback0
 ip address 10.1.1.151 255.255.255.255
!
interface Serial2/0/0
 mtu 1492
 no ip address
 encapsulation ppp
 no fair-queue
 serial restart-delay 0
 xconnect 10.1.1.152 123 pw-class atom-ipiw
!
interface Serial4/0/0
 ip address 10.151.100.1 255.255.255.252
 encapsulation ppp
 mpls ip
 serial restart-delay 0
!
router ospf 1
 log-adjacency-changes
 network 10.1.1.151 0.0.0.0 area 0
 network 10.151.100.0 0.0.0.3 area 0
!
mpls ldp router-id Loopback0

```

PE2 Configuration

```

pseudowire-class atom-ipiw
 encapsulation mpls
 interworking ip
!
interface Loopback0
 ip address 10.1.1.152 255.255.255.255
!
interface FastEthernet0/0/0
 no ip address
 xconnect 10.1.1.151 123 pw-class atom-ipiw
 mtu 1492
!
interface Serial4/0/0
 ip address 10.100.152.2 255.255.255.252

```

```

encapsulation ppp
mpls ip
serial restart-delay 0
!
router ospf 1
log-adjacency-changes
network 10.1.1.152 0.0.0.0 area 0
network 10.100.152.0 0.0.0.3 area 0
!
mpls ldp router-id Loopback0

```

The **show mpls l2transport binding** command shows that the MTU value for the local and remote routers is 1492 bytes.

PE1

```
Router# show mpls l2transport binding
```

```

Destination Address: 10.1.1.152, VC ID: 123
  Local Label: 105
    Cbit: 1, VC Type: PPP, GroupID: 0
    MTU: 1492, Interface Desc: n/a
    VCCV: CC Type: CW [1], RA [2]
    CV Type: LSPV [2]
  Remote Label: 205
    Cbit: 1, VC Type: FastEthernet, GroupID: 0
    MTU: 1492, Interface Desc: n/a
    VCCV: CC Type: RA [2]
    CV Type: LSPV [2]

```

```
Router# show mpls l2transport vc detail
```

```

Local interface: Serial2/0/0 up, line protocol up, PPP up
MPLS VC type is PPP, interworking type is IP
Destination address: 10.1.1.152, VC ID: 123, VC status: up
  Output interface: Serial4/0/0, imposed label stack {1003 205}
  Preferred path: not configured
  Default path: active
  Next hop: point2point
Create time: 00:25:29, last status change time: 00:24:54
Signaling protocol: LDP, peer 10.1.1.152:0 up
  Targeted Hello: 10.1.1.151(LDP Id) -> 10.1.1.152
  Status TLV support (local/remote) : enabled/supported
  Label/status state machine : established, LruRru
  Last local dataplane status rcvd: no fault
  Last local SSS circuit status rcvd: no fault
  Last local SSS circuit status sent: no fault
  Last local LDP TLV status sent: no fault
  Last remote LDP TLV status rcvd: no fault
MPLS VC labels: local 105, remote 205
Group ID: local n/a, remote 0
MTU: local 1492, remote 1492
Remote interface description:
Sequencing: receive disabled, send disabled
VC statistics:
  packet totals: receive 30, send 29
  byte totals: receive 2946, send 3364
  packet drops: receive 0, send 0

```

PE2

```
Router# show mpls l2transport binding
```

```
Destination Address: 10.1.1.151, VC ID: 123
```

```

Local Label: 205
  Cbit: 1,      VC Type: FastEthernet,      GroupID: 0
  MTU: 1492,   Interface Desc: n/a
  VCCV: CC Type: RA [2]
  CV Type: LSPV [2]
Remote Label: 105
  Cbit: 1,      VC Type: FastEthernet,      GroupID: 0
  MTU: 1492,   Interface Desc: n/a
  VCCV: CC Type: CW [1], RA [2]
  CV Type: LSPV [2]

```

Router# **show mpls l2transport vc detail**

```

Local interface: Fe0/0/0 up, line protocol up, FastEthernet up
MPLS VC type is FastEthernet, interworking type is IP
Destination address: 10.1.1.151, VC ID: 123, VC status: up
  Output interface: Se4/0/0, imposed label stack {1002 105}
  Preferred path: not configured
  Default path: active
  Next hop: point2point
Create time: 00:25:19, last status change time: 00:25:19
Signaling protocol: LDP, peer 10.1.1.151:0 up
  Targeted Hello: 10.1.1.152(LDP Id) -> 10.1.1.151
  Status TLV support (local/remote)   : enabled/supported
  Label/status state machine          : established, LruRru
  Last local dataplane status rcvd: no fault
  Last local SSS circuit status rcvd: no fault
  Last local SSS circuit status sent: no fault
  Last local LDP TLV status sent: no fault
  Last remote LDP TLV status rcvd: no fault
MPLS VC labels: local 205, remote 105
Group ID: local n/a, remote 0
MTU: local 1492, remote 1492
Remote interface description:
Sequencing: receive disabled, send disabled
VC statistics:
  packet totals: receive 29, send 30
  byte totals:   receive 2900, send 3426
  packet drops:  receive 0, send 0

```

Examples: Configuring Any Transport over MPLS (AToM): Remote Ethernet Port Shutdown

The following example shows how to enable remote Ethernet port shutdown:

```

configure terminal
!
pseudowire-class eompls
  encapsulation mpls
!
interface GigabitEthernet1/0/0
  xconnect 10.1.1.1 1 pw-class eompls
  remote link failure notification

```

The following example shows how to disable remote Ethernet port shutdown:

```

configure terminal
!
pseudowire-class eompls
  encapsulation mpls
!

```

```
interface GigabitEthernet1/0/0
  xconnect 10.1.1.1 1 pw-class eompls
  no remote link failure notification
```

The related **show** command output reports operational status for all remote L2 Tunnels by interface.

```
Router# show interface G1/0/0
```

```
GigabitEthernet1/0/0 is L2 Tunnel remote down, line protocol is up
Hardware is GigMac 4 Port GigabitEthernet, address is 0003.ff4e.12a8 (bia 0003.ff4e.12a8)
  Internet address is 10.9.9.2/16
  MTU 1500 bytes, BW 1000000 Kbit, DLY 10 usec, rely 255/255, load 1/255
```

```
Router# show ip interface brief
```

```
Interface          IP-Address      OK? Method Status Protocol
GigabitEthernet2/0/0 unassigned     YES NVRAM  L2 Tunnel remote down up
GigabitEthernet2/1/0 unassigned     YES NVRAM  administratively down down
```

Additional References

Related Documents

Related Topic	Document Title
Cisco ATM commands	Cisco Interface and Hardware Component Command Reference
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Cisco MPLS commands	Cisco IOS Multiprotocol Label Switching Command Reference

Standards

Standard	Title
draft-martini-l2circuit-trans-mpls-08.txt	<i>Transport of Layer 2 Frames Over MPLS</i>
draft-martini-l2circuit-encap-mpls-04.txt	<i>Encapsulation Methods for Transport of Layer 2 Frames Over MPLS</i>

MIBs

MIB	MIBs Link
<p>ATM AAL5 over MPLS and ATM Cell Relay over MPLS:</p> <ul style="list-style-type: none"> • MPLS LDP MIB (MPLS-LDP-MIB.my) • ATM MIB (ATM-MIB.my) • CISCO AAL5 MIB (CISCO-AAL5-MIB.my) • Cisco Enterprise ATM Extension MIB (CISCO-ATM-EXT-MIB.my) • Supplemental ATM Management Objects (CISCO-IETF-ATM2-PVCTRAP-MIB.my) • Interfaces MIB (IF-MIB.my) <p>Ethernet over MPLS</p> <ul style="list-style-type: none"> • CISCO-ETHERLIKE-CAPABILITIES.my • Ethernet MIB (ETHERLIKE-MIB.my) • Interfaces MIB (IF-MIB.my) • MPLS LDP MIB (MPLS-LDP-MIB.my) <p>Frame Relay over MPLS</p> <ul style="list-style-type: none"> • Cisco Frame Relay MIB (CISCO-FRAME-RELAY-MIB.my) • Interfaces MIB (IF-MIB.my) • MPLS LDP MIB (MPLS-LDP-MIB.my) <p>HDLC and PPP over MPLS</p> <ul style="list-style-type: none"> • MPLS LDP MIB (MPLS-LDP-MIB.my) • Interface MIB (IF-MIB.my) 	<p>To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL:</p> <p>http://www.cisco.com/go/mibs</p>

RFCs

RFC	Title
RFC 3032	<i>MPLS Label Stack Encoding</i>
RFC 3036	<i>LDP Specification</i>

Technical Assistance

Description	Link
<p>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.</p>	<p>http://www.cisco.com/cisco/web/support/index.html</p>

Feature Information for Any Transport over MPLS

Table 6 lists the features in this module and provides links to specific configuration information.

Use Cisco Feature Navigator to find information about platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to <http://www.cisco.com/go/cfn>. An account on Cisco.com is not required.


Note

Table 6 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.

Table 6 Feature Information for Any Transport over MPLS

Feature Name	Releases	Feature Information
Any Transport over MPLS (AToM): ATM AAL5 over MPLS (AAL5oMPLS)	Cisco IOS XE Release 3.2S	In Cisco IOS XE Release 3.2S, this feature was introduced on the Cisco ASR 1000 Series Aggregation Services Routers. The following sections provides information about this feature: <ul style="list-style-type: none"> • Configuring ATM AAL5 over MPLS, page 17 This feature introduced no new or modified commands.
Any Transport over MPLS (AToM): ATM OAM Emulation	Cisco IOS XE Release 3.2S	In Cisco IOS XE Release 3.2S, this feature was introduced on the Cisco ASR 1000 Series Aggregation Services Routers. The following section provides information about this feature: <ul style="list-style-type: none"> • Configuring OAM Cell Emulation for ATM AAL5 over MPLS, page 20 This feature introduced no new or modified commands.
Any Transport over MPLS (AToM): Ethernet over MPLS (EoMPLS)	Cisco IOS XE Release 2.4	This feature allows you to transport Layer 2 Ethernet VLAN packets from various sources over an MPLS backbone. Ethernet over MPLS 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 Layer 2 VLAN packets by configuring the PE routers at the both ends of the MPLS backbone. In Cisco IOS XE Release 2.4, this feature was introduced on the Cisco ASR 1000 Series Routers. The following sections provide information about this feature: <ul style="list-style-type: none"> • Information About Any Transport over MPLS, page 5 • How to Configure Any Transport over MPLS, page 15

Table 6 Feature Information for Any Transport over MPLS (continued)

Feature Name	Releases	Feature Information
Any Transport over MPLS (AToM): Ethernet over MPLS: Port Mode (EoMPLS)	Cisco IOS XE Release 2.4	<p>Ethernet over MPLS (EoMPLS) is the transport of Ethernet frames across an MPLS core. It transports all frames received on a particular Ethernet or virtual LAN (VLAN) segment, regardless of the destination Media Access Control (MAC) information. It does not perform MAC learning or MAC look up for forwarding packets from the Ethernet interface. Port mode allows a frame coming into an interface to be packed into an MPLS packet and transported over the MPLS backbone to an egress interface.</p> <p>In Cisco IOS XE Release 2.4, this feature was introduced on the Cisco ASR 1000 Series Routers.</p> <p>The following sections provide information about this feature:</p> <ul style="list-style-type: none"> • Information About Any Transport over MPLS, page 5 • How to Configure Any Transport over MPLS, page 15
Any Transport over MPLS–Ethernet over MPLS Enhancements: Fast Reroute	Cisco IOS XE Release 2.4	<p>AToM can use MPLS traffic engineering (TE) tunnels with fast reroute (FRR) support. This feature enhances FRR functionality for Ethernet over MPLS (EoMPLS).</p> <p>In Cisco IOS XE Release 2.4, this feature was introduced on the Cisco ASR 1000 Series Routers.</p> <p>The following sections provide information about this feature:</p> <ul style="list-style-type: none"> • Information About Any Transport over MPLS, page 5 • MPLS Traffic Engineering Fast Reroute, page 7
Any Transport over MPLS (AToM): Frame Relay over MPLS (FRoMPLS)	Cisco IOS XE Release 3.2.1S	<p>In Cisco IOS XE Release 3.2.1S, this feature was introduced on the Cisco ASR 1000 Series Aggregation Services Routers.</p> <p>The following section provides information about this feature:</p> <ul style="list-style-type: none"> • Configuring Frame Relay over MPLS, page 34 <p>This feature introduced no new or modified commands.</p>
Any Transport over MPLS (AToM): HDLC over MPLS (HDLCoMPLS)	Cisco IOS XE Release 3.2S	<p>In Cisco IOS XE Release 3.2S, this feature was introduced on the Cisco ASR 1000 Series Aggregation Services Routers.</p> <p>The following section provides information about this feature:</p> <ul style="list-style-type: none"> • Configuring HDLC or PPP over MPLS, page 37 <p>This feature introduced no new or modified commands.</p>
Any Transport over MPLS (AToM): Layer 2 Quality of Service (QoS)	Cisco IOS XE Release 2.3	<p>This feature provides support for quality of service (QoS) features such as traffic policing, traffic shaping, packet marking, and mapping of the packets.</p> <p>In Cisco IOS XE Release 2.3, this feature was introduced on the Cisco ASR 1000 Series Routers.</p> <p>The following section provides information about this feature:</p> <ul style="list-style-type: none"> • QoS Features Supported with AToM, page 11

Table 6 Feature Information for Any Transport over MPLS (continued)

Feature Name	Releases	Feature Information
Any Transport over MPLS (AToM): PPP over MPLS (PPPoMPLS)	Cisco IOS XE Release 3.2S	<p>In Cisco IOS XE Release 3.2S, this feature was introduced on the Cisco ASR 1000 Series Aggregation Services Routers.</p> <p>The following section provides information about this feature:</p> <ul style="list-style-type: none"> • Configuring HDLC or PPP over MPLS, page 37 <p>This feature introduced no new or modified commands.</p>
Any Transport over MPLS (AToM): Remote Ethernet Port Shutdown	Cisco IOS XE Release 2.4	<p>This feature allows a service provider edge (PE) router on the local end of an Ethernet over MPLS (EoMPLS) pseudowire to detect a remote link failure and cause the shutdown of the Ethernet port on the local customer edge (CE) router. Because the Ethernet port on the local CE router is shut down, the router does not lose data by continuously sending traffic to the failed remote link. This is beneficial if the link is configured as a static IP route.</p> <p>In Cisco IOS XE Release 2.4, this feature was introduced on the Cisco ASR 1000 Series Routers.</p> <p>The following sections provide information about this feature:</p> <ul style="list-style-type: none"> • Any Transport over MPLS (AToM): Remote Ethernet Port Shutdown, page 14 • Configuring MPLS AToM Remote Ethernet Port Shutdown, page 43
ATM VC Class Support	Cisco IOS XE Release 2.3	<p>The ATM VC Class Support feature allows you to specify AAL5 and AAL0 encapsulations as part of a VC class.</p> <p>In Cisco IOS XE Release 2.3, this feature was introduced on the Cisco ASR 1000 Series Routers.</p> <p>The following sections provide information about this feature:</p> <ul style="list-style-type: none"> • Information About Any Transport over MPLS, page 5 • How to Configure Any Transport over MPLS, page 15
AToM Tunnel Selection	Cisco IOS XE Release 2.3	<p>The AToM Tunnel Selection feature allows you to specify the path that traffic uses. You can specify either an MPLS TE tunnel or destination IP address or domain name server (DNS) name.</p> <p>You also have the option of specifying whether the VCs should use the default path (the path LDP uses for signaling) if the preferred path is unreachable. This option is enabled by default; you must explicitly disable it.</p> <p>In Cisco IOS XE Release 2.3, this feature was introduced on the Cisco ASR 1000 Series Aggregation Services Routers.</p> <p>The following sections provide information about this feature:</p> <ul style="list-style-type: none"> • Information About Any Transport over MPLS, page 5 • How to Configure Any Transport over MPLS, page 15

Table 6 Feature Information for Any Transport over MPLS (continued)

Feature Name	Releases	Feature Information
AToM: ATM Cell Relay over MPLS: VP Mode	Cisco IOS XE Release 2.3	<p>The AToM: ATM Cell Relay over MPLS: VP Mode feature allows you to insert one ATM cell in each MPLS packet in VP mode.</p> <p>In Cisco IOS XE Release 2.3, this feature was introduced on the Cisco ASR 1000 Series Routers.</p> <p>The following sections provide information about this feature:</p> <ul style="list-style-type: none"> • Information About Any Transport over MPLS, page 5 • How to Configure Any Transport over MPLS, page 15
AToM: Single Cell Relay–VC Mode	Cisco IOS XE Release 2.3	<p>The AToM Single Cell Relay–VC Mode feature allows you to insert one ATM cell in each MPLS packet in VC mode.</p> <p>In Cisco IOS XE Release 2.3, this feature was introduced on the Cisco ASR 1000 Series Routers.</p> <p>The following sections provide information about this feature:</p> <ul style="list-style-type: none"> • Information About Any Transport over MPLS, page 5 • How to Configure Any Transport over MPLS, page 15
MPLS MTU Command for GRE Tunnels	Cisco IOS XE Release 2.6	<p>This feature allows you to set the MPLS MTU size in GRE tunnels to the maximum size besides the current default size.</p> <p>The following command was modified for this release: mpls mtu.</p>
MPLS L2VPN Clear Xconnect Command	Cisco IOS XE Release 3.1S	<p>These features enable you to:</p> <ul style="list-style-type: none"> • Reset a VC associated with an interface, a peer address, or on all the configured xconnect circuit attachments • Set the control word on dynamic pseudowires. • Enable ATM cell packing for static pseudowires. <p>The following commands were introduced or modified by these features: cell-packing, clear xconnect, control-word, encapsulation (Any Transport over MPLS), oam-ac emulation-enable.</p>
Per-Subinterface MTU for Ethernet over MPLS (EoMPLS)	Cisco IOS XE Release 2.4	<p>This feature provides you with the ability to specify maximum transmission unit (MTU) values in xconnect subinterface configuration mode. When you use xconnect subinterface configuration mode to set the MTU value, you establish a pseudowire connection for situations where the interfaces have different MTU values that cannot be changed.</p> <p>In Cisco IOS XE Release 2.4, this feature was introduced on the Cisco ASR 1000 Series Aggregation Services Routers.</p> <p>The following section provides information about this feature:</p> <ul style="list-style-type: none"> • Configuring per-Subinterface MTU for Ethernet over MPLS, page 33 <p>No commands were new or modified for this release.</p>

Table 6 Feature Information for Any Transport over MPLS (continued)

Feature Name	Releases	Feature Information
VLAN ID Rewrite	Cisco IOS XE Release 2.4	<p>The VLAN ID rewrite feature enables you to use VLAN interfaces with different VLAN IDs at both ends of the tunnel.</p> <p>In Cisco IOS XE Release 2.4, this feature was introduced on the Cisco ASR 1000 Series Routers.</p> <p>The following sections provide information about this feature:</p> <ul style="list-style-type: none"> • Information About Any Transport over MPLS, page 5 • Configuring Ethernet over MPLS with VLAN ID Rewrite, page 31
AToM Load Balancing with Single PW	Cisco IOS XE Release 3.4S	<p>The AToM Load Balancing with Single PW feature enables load balancing for packets within the same pseudowire by further classifying packets within the same pseudowire into different flows based on some field in the packet received on attachment circuit.</p> <p>In Cisco IOS XE Release 3.4S, this feature was introduced on the Cisco ASR 1000 Series Aggregation Services Routers.</p> <p>The following sections provide information about this feature:</p> <ul style="list-style-type: none"> • AToM Load Balancing with Single PW, page 15 • Configuring AToM Load Balancing with Single PW, page 45

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