This chapter describes how to configure Ethernet over Multiprotocol Label Switching (EoMPLS) on the ML-Series card.

This chapter includes the following major sections:

- Understanding EoMPLS
- Configuring EoMPLS
- EoMPLS Configuration Example
- Monitoring and Verifying EoMPLS

Contents

Understanding EoMPLS

EoMPLS provides a tunneling mechanism for Ethernet traffic through an MPLS-enabled Layer 3 core. It encapsulates Ethernet protocol data units (PDUs) inside MPLS packets and using label stacking forwards them across the MPLS network. EoMPLS is an Internet Engineering Task Force (IETF) standard-track protocol based on the Martini draft, specifically the draft-martini-l2circuit-encap-mpls-01 and draft-martini-l2circuit-transport-mpls-05 sections.

EoMPLS allows service providers to offer customers a virtual Ethernet line service or VLAN service using the service provider's existing MPLS backbone. It also simplifies service provider provisioning, since the provider edge customer-leading edge (PE-CLE) equipment only needs to provide Layer 2 connectivity to the connected customer edge (CE) equipment.

Figure 19-1 shows an example of EoMPLS implemented on a service provider network. In the example, the ML-Series card acts as PE-CLE equipment connecting to the Cisco GSR 12000 Series through an RPR access ring. Point-to-point service is provided to CE equipment in different sites that connect through ML-Series cards to the ML-Series card RPR access ring.

Figure 19-1: EoMPLS Service Provider Network
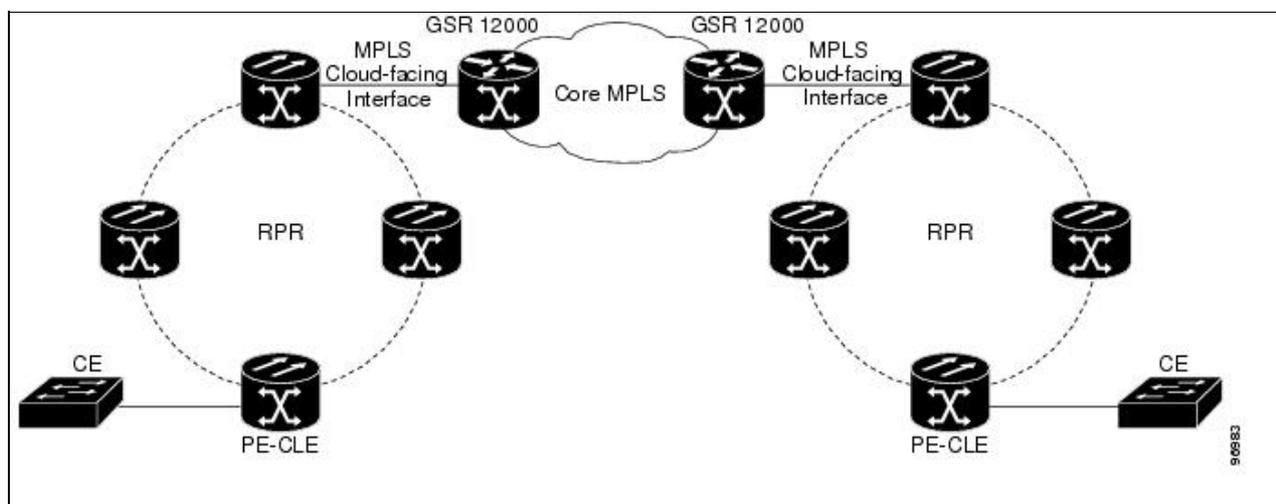
Implementing EoMPLS on a service provider network requires ML-Series card interfaces to play three major roles. The ML-Series card interface roles must be configured on both sides of the EoMPLS point-to-point service crossing the MPLS core.

- ML-Series card interfaces connect the provider's network directly to the customer edge equipment and are known as the PE-CLE interfaces. This PE-CLE interface on the ML-Series card is FastEthernet or GigabitEthernet and is configured to be an endpoint on the EoMPLS point-to-point session.
- An ML-Series card interface bridges the PE-CLE interface and the RPR network of ML-Series cards. This RPR/SPR interface contains POS ports and is configured for MPLS IP.
- An ML-Series card interface connects to a core MPLS interface. This interface is GigabitEthernet or FastEthernet and connects to the port of a Cisco GSR 12000 Series or similar device that is on the MPLS network. This MPLS cloud-facing interface bridges the SPR interface and the MPLS cloud.

Implementing EoMPLS across a service provider's network requires setting up directed Label Distribution Protocol (LDP) sessions (LSPs) between the ingress and egress PE-CLE routers to exchange information for a virtual circuit (VC). Each VC consists of two LSPs, one in each direction, since an LSP is a directed path to

carry Layer 2 frames in one direction only.

EoMPLS uses a two-level label stack to transport Layer 2 frames, where the bottom/inner label is the VC label and the top/outer label is the tunnel label. The VC label is provided to the ingress PE-CLE by the egress PE-CLE of a particular LSP to direct traffic to a particular egress interface on the egress PE-CLE. A VC label is assigned by the egress PE-CLE during the VC setup and represents the binding between the egress interface and a unique and configurative VC ID. During a VC setup, the ingress and egress PE-CLE exchange VC label bindings for the specified VC ID.

An EoMPLS VC on the ML-Series card can transport an Ethernet port or an IEEE 802.1Q VLAN over MPLS. A VC type 5 tunnels an Ethernet port and a VC type 4 transports a VLAN over MPLS. In a VC type 5 session, the user can expect any traffic that is received on an ML-Series card PE-CLE port with an mpls l2transport route command to be tunneled to the remote egress interface on the far-end ML-Series card PE-CLE port. With a VC type 4, a user can expect the tunnel to act as physical extension to that VLAN. The EoMPLS session commands are entered on a VLAN subinterface on the PE-CLE, and only VLAN-tagged traffic received on that port will be tunneled to the remote PE-CLE.

EoMPLS Support

EoMPLS on the ML-Series card has the following characteristics:

- EoMPLS is only supported on FastEthernet and GigabitEthernet interfaces or subinterfaces.
- MPLS tag switching is only supported on SPR interfaces.
- Class of service (CoS) values are mapped to the experimental (EXP) bits in the MPLS label, either statically or by using the IEEE 802.1p bits (default).
- The ingress PE-CLE ML-Series card sets the time-to-live field to 2 and the tunnel label to a value of 255.
- Ingress PE-CLE ML-Series cards set the S bit of the VC label to 1 to indicate that the VC label is at the bottom of the stack.
- Since EoMPLS traffic is carried over the RPR, whatever load balancing is applicable for the traffic ingressing RPR is also applicable for the EoMPLS traffic.
- EoMPLS is supported over RPR under GFP-F framing and HDLC framing.
- The Ethernet over MPLS feature is part of the Cisco Any Transport over MPLS (AToM) product set.
- The ML-Series card hosting the EoMPLS endpoint ports must be running the MPLS microcode image to support EoMPLS. For more information on multiple microcode images, see the Multiple Microcode Images. Other ML-Series cards in the RPR are not restricted to the MPLS microcode image.

EoMPLS Restrictions

EoMPLS on the ML-Series card has the following restrictions:

- Packet-based load balancing is not supported. Instead, circuit-ID based load balancing is used.
- Zero hop or hairpin VCs are not supported. A single ML-Series card cannot be both the source and destination for a VC.
- MPLS control word for sequencing of data transmission is not supported. Packets must be received and transmitted without control word.
- Sequence checking or resequencing of EoMPLS traffic is not supported. Both depend on the control word to function.
- Maximum transmission unit (MTU) fragmentation is not supported.
- Explicit-null label for back-to-back LDP sessions is not supported.

Figure 19-1: EoMPLS Service Provider Network   3

Caution! Since MTU fragmentation is not supported across the MPLS backbone, the network operator must make sure the MTU of all intermediate links between endpoints is sufficient to carry the largest Layer 2 PDU.

EoMPLS Quality of Service

The EXP is a 3-bit field and part of the MPLS header. It was created by the IETF on an experimental basis, but later became part of the standard MPLS header. The EXP bits in the MPLS header carry the packet priority. Each label switch router along the path honors the packet priority by queuing the packet into the proper queue and servicing the packet accordingly.

By default, the ML-Series card does not map the IEEE 802.1P bits in the VLAN tag header to the MPLS EXP bits. The MPLS EXP bits are set to a value of 0.

There is no straight copy between Layer 2 CoS and MPLS EXP, but the user can use the set mpls experimental action to set the MPLS EXP bit values based on a match to 802.1p bits. This mapping occurs at the entry point, the ingress of the network.

Quality of service (QoS) for EoMPLS traffic on ML-Series cards uses strict priority and/or weighted round robin scheduling in the egress interface of both imposition and disposition router. This requires selection of the service class queue that determines the type of scheduling. In the imposition router, the priority bits EXP or RPR CoS that are marked based on policing are used to select the service class queue and in the disposition router, the dot1p CoS bits (which are copied from EXP bits of the labels) are used to do the same. In addition to scheduling in the egress interface, the output policy action can also include remarking of EXP and RPR CoS bits.

EoMPLS on the ML-Series card uses the Cisco Modular Quality of Service Command-Line Interface (MQC), just like the standard QoS on the ML-Series card. But the full range of MQC commands are not available. Table 19-1 lists the applicable MQC statements and actions for the ML-Series card interfaces.

Table 19-1: Applicable EoMPLS QoS Statements and Actions

Interface	Applicable MQC Match Statements	Applicable MQC Actions
Imposition Ingress	match cos match ip precedence match ip dscp match vlan	**police cir** *cir-burst* [*pir-bust* **pir** *pir* conform [*set-mpls-exp*| exceed [set-mpls-exp][**violate** *set-mpls-exp*]
Imposition Egress	match mpls exp	**bandwidth** {*bandwidth-kbps*	**percent** *percent*} and **priority** *kbps* and [set-mpls-exp]
Disposition Ingress	Not applicable	Not applicable

Disposition Egress	match mpls exp	**bandwidth** {*bandwidth-kbps* | **percent** *percent*} and **priority** *kbps* and **set-cos** *cos-value*

Configuring EoMPLS

The ML-Series peer cards on both endpoints of the EoMPLS point-to-point service must be configured. Perform the following configuration tasks to enable EoMPLS:

- VC Type 4 Configuration on PE-CLE Port (Either VC type 4 or VC type 5 is required.)
- VC Type 5 Configuration on PE-CLE Port (Either VC type 4 or VC type 5 is required.)
- EoMPLS Configuration on PE-CLE SPR Interface (Required)
- Bridge Group Configuration on MPLS Cloud-facing Port (Required)
- Setting the Priority of Packets with the EXP

EoMPLS Configuration Guidelines

These are the guidelines for configuring EoMPLS:

- Loopback addresses are used to specify the peer ML-Series card's IP address.
- LDP configuration is required. The default Tag Distribution Protocol (TDP) will not work.
- EoMPLS uses LDP targeted session between the ML-Series cards to create the EoMPLS VCs.
- The MPLS backbone must use an Interior Gateway Protocol (IGP) routing protocol, for example, Intermediate System-to-Intermediate System (IS-IS) Protocol or Open Shortest Path First (OSPF).
- Tag switching of IP packets must be enabled on the SPR interface for the PE-CLE ML-Series card.

VC Type 4 Configuration on PE-CLE Port

The customer-facing FastEthernet or GigabitEthernet port must be provisioned with EoMPLS and a VC type 4 or type 5. Interface GigE 0.1 on card A and card C plays the VC type 4 role in Figure 19-2. For more information on the role of a VC type 4, see the Understanding EoMPLS.

To provision a VC type 4, which transport IEEE 802.1Q VLAN packets between two PE-CLE ML-Series cards, perform the following procedure on the customer facing port, beginning in global configuration mode:

Step	Command	Purpose
1	Router(config)# **mpls label protocol ldp**	Specifies LDP as the label distribution protocol. LDP must be specified. The ML-Series card does not operate EoMPLS with the default TDP as the label distribution protocol.
2	Router(config)# interface loopback0	Enters loopback interface configuration mode.
3		

Table 19-1: Applicable EoMPLS QoS Statements and Actions 5

	`Router(config-if)# ip address ip-address` **`255.255.255.255`**	Assigns an IP address to the loopback interface. This loopback IP addresses is used to identify the peer in the EoMPLS point-to-point session. No subnet mask is needed.
4	`Router(config)# interface {GigabitEthernet	FastEthernet} interface-number.sub-interface- number`	Specifies the Ethernet subinterface for the imposition interface. Make sure the subinterface on the adjoining CE equipment is on the same VLAN as this subinterface.
5	`Router(config-subif)# no ip address`	Disables the IP address if an IP address is assigned.
6	`Router(config-subif)# encapsulation dot1Q vlan-id`	Enables the subinterface to accept 802.1q VLAN packets. Make sure the VLAN ID is the same as the VLAN ID on the adjoining CE equipment.
7	`Router(config-subif)#` **`mpls l2transport route`** *`destination vc-id`* or `xconnect destination vc-id encapsulation mpls`	By entering the mpls l2transport route or the xconnect interface configuration command on a dot1Q VLAN sub-interface for VLAN-based EoMPLS, you can configure an EoMPLS tunnel to forward traffic based on the customer VLAN. **mpls l2transport route** specifies the VC to use to transport the VLAN packets. Initiates a remote LDP session with the peer point-to-point endpoint interface. • destination specifies the loopback IP address for the remote ML-Series at the other end of the VC (PE-CLE). • vc-id is a value you supply. It must be unique for each VC. The VC ID is used to connect the endpoints of the VC. Specify the same VC ID on both ends of the VC. xconnect binds the 802.1q VLAN circuit to a pseudo wire for xconnect service. The encapsulation mpls pseudo wire class parameter specifies MPLS for the tunneling method. **Note:** The xconnect command is a newer version of the mpls l2transport route interface configuration command.

VC Type 4 Configuration on PE-CLE Port   6

		Note: Use the no mpls l2transport route destination vc-id or no xconnect destination vc-id encapsulation mpls interface command to delete the EoMPLS tunnel.
8	`Router(config-subif)# end`	Return to privileged EXEC mode.
9	`Router# show mpls l2transport vc`	Verify the configuration.
10	`Router# copy running-config startup-config`	(Optional) Save your entries in the configuration file

VC Type 5 Configuration on PE-CLE Port

The customer-facing FastEthernet or GigabitEthernet port must be provisioned with EoMPLS and a VC type 4 or type 5. Interface GigE 1 on card A and card C plays the VC type 5 role in Figure 19-2. For more information on the role of a VC type 5, see the Understanding EoMPLS.

To provision a VC type 5, which transports the configured port's packets between two PE-CLE ML-Series cards, perform the following procedure on the customer facing port, beginning in global configuration mode:

Step	Command	Purpose
1	`Router(config)# mpls label protocol ldp`	Specifies LDP as the label distribution protocol. LDP must be specified. The ML-Series card does not operate EoMPLS with the default TDP as the label distribution protocol.
2	`Router(config)# interface loopback0`	Enters loopback interface configuration mode.
3	`Router(config-if)# ip address ip-address` **255.255.255.255**	Assigns an IP address to the loopback interface. This loopback IP addresses is used to identify the peer in the EoMPLS point-to-point session. No subnet mask is needed.
4	`Router(config)# interface {GigabitEthernet	FastEthernet} interface-number`	Specifies the Ethernet interface for the imposition interface.
5	`Router(config-if)# no ip address`	Disables the IP address if an IP address is assigned.

6	`Router(config-subif)#` **mpls l2transport route** *destination vc-id*
	
	or `xconnect destination vc-id encapsulation mpls`
		By entering the mpls l2transport route or the xconnect interface configuration command on a VLAN for VLAN-based EoMPLS, you can configure an EoMPLS tunnel to forward traffic based on the customer VLAN.
		
		mpls l2transport route specifies the VC to use to transport the VLAN packets. Initiates a remote LDP session with the peer point-to-point endpoint interface.
		
		    • destination specifies the loopback IP address for the remote ML-Series at the other end of the VC (PE-CLE).
		    • vc-id is a value you supply. It must be unique

		for each VC. The VC ID is used to connect the endpoints of the VC. Specify the same VC ID on both ends of the VC. xconnect binds the 802.1q VLAN circuit to a pseudo wire for xconnect service. The encapsulation mpls pseudo wire class parameter specifies MPLS for the tunneling method. **Note:** The xconnect command is a newer version of the mpls l2transport route interface configuration command. **Note:** Use the no mpls l2transport route destination vc-id or no xconnect destination vc-id encapsulation mpls interface command to delete the EoMPLS tunnel.
7	`Router(config-subif)# end`	Return to privileged EXEC mode.
8	`Router# show mpls l2transport vc`	Verify the configuration.
9	`Router# copy running-config startup-config`	(Optional) Save your entries in the configuration file

EoMPLS Configuration on PE-CLE SPR Interface

To enable the RPR to act as an access ring for the MPLS cloud, you must provision the SPR interface on the same ML-Series card that hosts the EoMPLS PE-CLE FastEthernet or GigabitEthernet interfaces. Interface SPR 1 on card A and card C plays this role in <u>Figure 19-2</u>.

To provision the SPR interface for MPLS, perform the following procedure, beginning in global configuration mode:

Step	Command	Purpose
1	`Router(config)# mpls label protocol ldp`	Specifies LDP as the label distribution protocol. LDP must be specified. The ML-Series card does not operate EoMPLS with the default TDP as the label distribution protocol.
2	`Router(config)# interface spr 1`	Enters RPR interface configuration mode.
3	`Router(config-if)# ip address ip-address mask`	Assigns an IP address to the RPR interface for MPLS.
4	`Router(config-if)# mpls ip`	Implements tag switching on the SPR interface.
5	`Router(config-if)# end`	Exits interface configuration mode.
6	`Router# `**`copy running-config startup-config`**	Saves the running configuration file to the startup configuration file.

Bridge Group Configuration on MPLS Cloud-facing Port

A FastEthernet or GigabitEthernet port from an ML-Series card in the RPR must connect to the interface of a router that is part of the MPLS cloud. A bridge group must be created that contains this FastEthernet or GigabitEthernet port and the SPR subinterface. Interface GigE 0 on card B and card D plays this role in <u>Figure 19-2</u>.

To provision the MPLS cloud-facing port for EoMPLS, perform the following procedure, beginning in global configuration mode:

Step	Command	Purpose
1	Router(config)# bridge *bridge-group-number* protocol {rstp | ieee}	(Optional) Assigns a bridge group number and defines the appropriate spanning-tree type: either IEEE 802.1D Spanning Tree Protocol or IEEE 802.1W Rapid Spanning Tree.
2	Router(config)# interface {GigabitEthernet | FastEthernet} interface-number	Enters interface configuration mode to configure the MPLS cloud-facing FastEthernet or GigabitEthernet interface of the ML-Series card.
3	Router(config-if)# bridge-group *bridge-group-number*	Assigns a network interface to a bridge group.
4	Router(config-if)# no shutdown	Changes the shutdown state to up and enables the interface.
5	Router(config)# interface spr 1.subinterface-number	Enters SPR subinterface configuration mode for the ML-Series card.
6	Router(config-if)# bridge-group *bridge-group-number*	Assigns the network interface to a bridge group.
7	Router(config-if)# end	Returns to privileged EXEC mode.
8	Router# copy running-config startup-config	(Optional) Saves your entries in the configuration file.

Setting the Priority of Packets with the EXP

Ethernet over MPLS provides QoS using the three EXP bits in a label to determine the priority of packets. To support QoS between ML-Series card point-to-point endpoints, set the experimental bits in both the VC and tunnel labels.

Perform the following steps to set the experimental bits:

Step	Command	Purpose
1	Router(config)# **class-map** *class-name*	Specifies the user-defined name of the traffic class.
2	Router(config-cmap)# **match any**	Specifies that all packets will be matched.
3	Router(config-cmap)#end	Returns to global configuration mode.
4	Router(config)# **policy-map** *policy-name*	Specifies the name of the traffic policy to configure.
5	Router(config-pmap)# **class** *class-name*	Specifies the name of a predefined traffic class, which was configured with the class-map command, used to classify traffic to the traffic policy.
6	Router (config-pmap-c)# **set mpls experimental imposition** *value*	Designates the value to which the MPLS bits are set if the packets match the specified policy map.
7	Router(config)# interface GigabitEthernet interface-number or interface FastEthernet interface-number	Enters interface configuration mode.
8		Attaches a traffic policy to an interface.

```
Router(config-if)# service-policy
input policy-name
```

EoMPLS Configuration Example

Figure 19-2 illustrates the sample network that the configuration commands reference. Examples 19-1, 19-2, 19-3, and 19-4 list relevant portions of the configuration files for enabling EoMPLS on ML-Series cards in a sample network.

Figure 19-2: EoMPLS Configuration Example
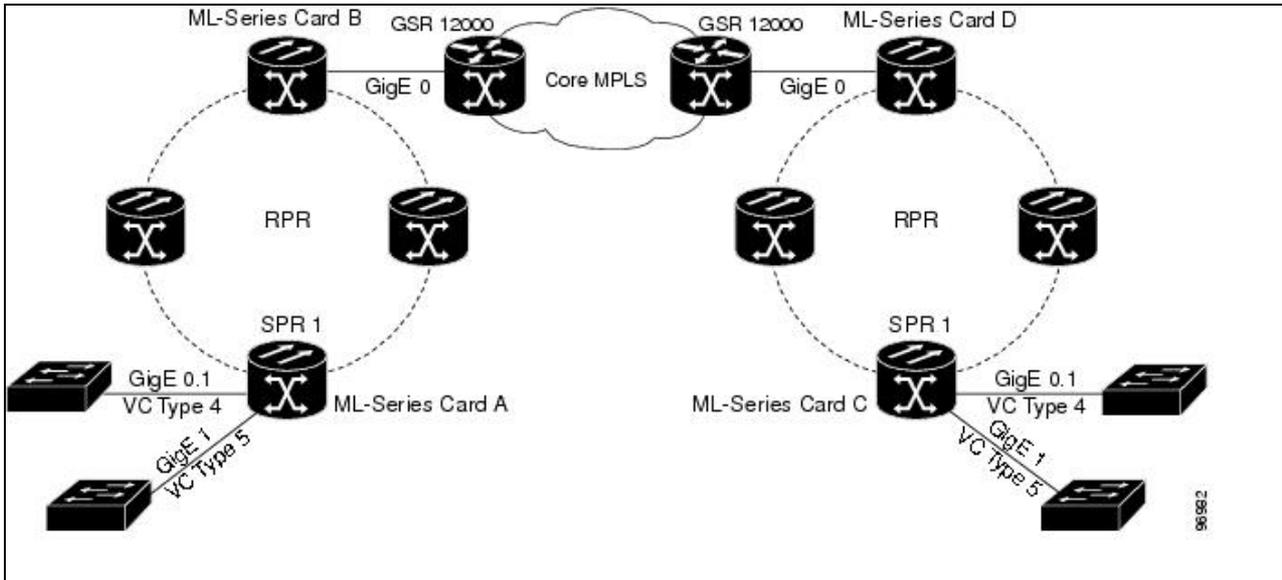
Example 19-1: ML-Series Card A Configuration

```
microcode mpls
ip subnet-zero
no ip domain-lookup
!
mpls label protocol ldp
!
interface Loopback0

 ip address 10.10.10.10 255.255.255.255
!
interface SPR1
 ip address 100.100.100.100 255.255.255.0
 no keepalive
spr station-id 1
 mpls ip
 hold-queue 150 in
!
interface GigabitEthernet0
 no ip address
!
interface GigabitEthernet0.1
 encapsulation dot1Q 10
 mpls l2transport route 3.3.3.3 1
!
interface GigabitEthernet1
 no ip address
 mpls l2transport route 4.4.4.4 2
!
```

```
interface POS0
 no ip address
 spr-intf-id 1
 crc 32
!
interface POS1
 no ip address
 spr-intf-id 1
 crc 32
router ospf 1
 log-adjacency-changes
 network 1.1.1.0 0.0.0.255 area 0
 network 10.10.10.0 0.0.0.255 area 0
!
ip classless
no ip http server
```

Example 19-2: ML-Series Card B Configuration

```
bridge 10 protocol ieee
!
!
interface SPR1
no ip address
no keepalive
 bridge-group 10
 hold-queue 150 in
!
interface GigabitEthernet0
no ip address
bridge-group 10
```

Example 19-3: ML-Series Card C Configuration

```
microcode mpls
ip subnet-zero
no ip domain-lookup
!
mpls label protocol ldp
!
interface Loopback0

 ip address 20.20.20.20 255.255.255.255
!
interface SPR1
 ip address 100.100.100.100 255.255.255.0
 no keepalive
 spr station-id 4
 mpls ip
 hold-queue 150 in
!
interface GigabitEthernet0
 no ip address
!
interface GigabitEthernet0.1
 encapsulation dot1Q 10
 mpls l2transport route 1.1.1.1 1
!
interface GigabitEthernet1
 no ip address
 mpls l2transport route 2.2.2.2 2
!
interface POS0
```

Example 19-1: ML-Series Card A Configuration   11

```
 no ip address
 spr-intf-id 1
 crc 32
!
interface POS1
 no ip address
 spr-intf-id 1
 crc 32
!
router ospf 1
 log-adjacency-changes
 network 1.1.1.0 0.0.0.255 area 0
 network 10.10.10.0 0.0.0.255 area 0
!
ip classless
no ip http server
```

Example 19-4: ML-Series Card D Configuration

```
bridge 20 protocol ieee
!
!
interface SPR1
no ip address
no keepalive
 bridge-group 20
 hold-queue 150 in
!
interface GigabitEthernet0
no ip address
bridge-group 20
```

Monitoring and Verifying EoMPLS

Table 19-2 shows the privileged EXEC commands for monitoring and verifying EoMPLS.

Table 19-2: Commands for Monitoring and Maintaining Tunneling

Command	Purpose
`show mpls l2transport vc`	Provides information about all EoMPLS tunnels.
`show mpls l2transport vc detail`	Provides detailed information about the EoMPLS tunnel.
`show mpls l2transport vc` vc-id	Provides information about a specific EoMPLS tunnel.

Understanding MPLS-TE

MPLS traffic is normally routed to the least cost path as calculated by OSPF or another IGP routing protocol. This routing gives little or no consideration to varying bandwidth demands or link loads. MPLS traffic engineering (MPLS-TE) overcomes this by mapping traffic flows to paths that take bandwidth demands into account. These paths are known as MPLS-TE tunnels, and they may deviate from the normal IGP calculated routes.

MPLS-TE (RFC 2702) allow service providers to create traffic engineered tunnels to reserve bandwidth for specific types of traffic and to provide point-to-point services for end customers. The ML-Series card supports a maximum of 24 MPLS-TE tunnels. MPLS-TE tunnels can carry a VC type 5, which tunnels an Ethernet port, or a VC type 4, which tunnels an 802.1Q VLAN.

Example 19-3: ML-Series Card C Configuration 12

For the ML-Series card to use MPLS-TE, you need to configure three main components. First, you must implement an IGP routing protocol that conveys and distributes information about the link resources throughout the MPLS network. For this purpose, the ML-Series card supports OSPF and OSPF-TE extensions (RFC 2328 and RFC 2370). MPLS-TE extensions for other routing protocols, such as IS-IS, are not supported on the ML-Series card.

Second, you need to configure a signalling protocol to reserve needed resources and establish LSPs across the MPLS network. MPLS-TE tunnels use Resource Reservation Protocol (RSVP) messages (RFC 2205 and RFC 3209) to accomplish this. The ML-Series card supports RSVP and the RSVP extensions for LSP tunnels on both POS interfaces and RPR (SPR) interfaces.

For the third component, you need to set up an MPLS-TE tunnel on the appropriate ML-Series card interface. This requires creating an MPLS tunnel interface with an IP address, destination, encapsulation, bandwidth, and explicit or dynamic path.

RSVP on the ML-Series Card

The ML-Series card uses RSVP to establish MPLS-TE tunnels and the associated tunnel labels. Targeted LDP is still used to establish the VC Labels. Also, RSVP is only used to guarantee the bandwidth on the intermediate nodes on the tunnel. On the ML-Series card, which will be the end-point of the MPLS-TE tunnel, RSVP is used only for bandwidth allocation.

You configure bandwidth guarantees on the ML-Series card ports using the Cisco Modular Quality of Service Command-Line Interface (MQC), just like the standard QoS on the ML-Series card. For more information, see the EoMPLS Quality of Service.

The ML-Series card does not use RSVP messages to carry the information for EoMPLS VCs. LDP sessions are still used to exchange VC information. Also RSVP does not guarantee bandwidth. It only allocates bandwidth.

The ML-Series card supports RSVP summary refresh and RSVP refresh reduction (RFC 2961). Refresh reduction is a set of extensions that reduce the messaging load imposed by RSVP. This helps RSVP scale to support larger numbers of flows. The global configuration command ip rsvp signalling refresh reduction enables this feature.

Ethernet FCS Preservation

You can configure the ML-Series card to encapsulate and preserve the customer's Ethernet FCS. The ML-Series card will carry the Ethernet FCS end-to-end and unmodified across EoMPLS or EoMPLS-TE tunnels. This end-to-end preservation of the original Ethernet FCS is useful for troubleshooting.

Ethernet FCS preservation is off by default on the ML-Series card. Configure Ethernet FCS preservation at the interface or sub-interface configuration level with the [no] fcs-preservation-on command. To operate correctly, both ends of the EoMPLS tunnel need to be configured for FCS preservation.

Configuring MPLS-TE

Perform the following tasks on the MPLS network before you enable MPLS-TE on the ML-Series card :

- Turn on MPLS tunnels
- Turn on OSPF

To configure MPLS-TE on the ML-Series card, perform the tasks described in the following sections:

- Configuring an ML-Series Card for Tunnels Support
- Configuring an Interface to Support RSVP-Based Tunnel Signalling and IGP Flooding
- Configuring OSPF and Refresh Reduction for MPLS-TE
- Configuring an MPLS-TE Tunnel

Note: The ML-Series card does not support MPLS-TE with IS-IS.

Note: Cisco Express Forwarding (CEF) is on by default on the ML-Series card.

Configuring an ML-Series Card for Tunnels Support

To configure an ML-Series card to support tunnels, use the following commands in global configuration mode:

Step	Command	Purpose
1.	`Router(config)# ` **`mpls traffic-eng tunnels`**	Enables the MPLS-TE tunnel feature on a device.

Configuring an Interface to Support RSVP-Based Tunnel Signalling and IGP Flooding

To configure an interface to support RSVP-based tunnel signalling and IGP flooding, use the following commands in interface configuration mode:

Note: You must enable the tunnel feature on interfaces or sub-interfaces that you want to support MPLS-TE.

Note: A VC type 4 requires one POS interface to be configured for MPLS-TE tunnel and the other POS interface configured for the 802.1Q tunnel.

Step	Command	Purpose
1	`Router(config-if)# ` **`mpls traffic-eng tunnels`**	Enables MPLS-TE tunnels on an RPR (SPR) interface or on a POS interface.
2	`Router(config-if)# ` **`ip rsvp bandwidth`** *`bandwidth`*	Enables RSVP for IP on an interface and specifies the amount of bandwidth that will be reserved. For a description of the **ip rsvp** interface command syntax, see the *Cisco IOS Quality of Service Solutions Command Reference*.

Configuring OSPF and Refresh Reduction for MPLS-TE

For a description of the OSPF commands (excluding the OSPF traffic engineering commands), see the *Cisco IOS IP Command Reference, Volume 2 of 3: Routing Protocols.*

To configure OSPF and Refresh Reduction for MPLS-TE, use the following commands beginning in global configuration mode.

Step	Command	Purpose
1	`Router(config)# ` **`router ospf`** *`process-id`*	Configures an OSPF routing process for IP and places the router in configuration mode.

|		
		The process-id argument is an internally used identification parameter for an OSPF routing process. It is locally assigned and can be any positive integer. Assign a unique value for each OSPF routing process.
2	Router(config-router)# **mpls traffic-eng area** *area-id*	Turns on MPLS-TE for a specified OSPF area.
3	Router(config-router)# **mpls traffic-eng router-id loopback0**	Specifies that the traffic engineering router identifier for the node is the IP address associated with interface loopback0.
4	Router(config)# ip rsvp signalling refresh reduction	Reduces the messaging load imposed by RSVP

Configuring an MPLS-TE Tunnel

To configure an MPLS-TE tunnel, use the following commands, beginning in global configuration mode:

Step	Command	Purpose
1	Router(config)# **interface tunnel**	Configures an interface type and enters interface configuration mode.
2	Router(config)# **ip unnumbered loopback0**	Gives the tunnel interface an IP address. An MPLS-TE tunnel interface should be unnumbered because it represents a unidirectional link.
3	Router(config-if)# **tunnel destination** *A.B.C.D*	Specifies the destination for a tunnel.
4	Router(config-if)# **tunnel mode mpls traffic-eng**	Sets the tunnel encapsulation mode to MPLS-TE.
5	Router(config-if)# tunnel mpls traffic-eng autoroute announce	Specifies IGP should use the tunnel (if the tunnel is up) in its enhanced shortest path first (SPF) calculation.
6	Router(config-if)# **tunnel mpls traffic-eng bandwidth** *bandwidth*	Configures the bandwidth for the MPLS-TE tunnel.
7	Router(config-if)# **tunnel mpls traffic-eng path-option** *number* {dynamic | explicit}{name *path-name* | *path-number*} [lockdown]	Configures the tunnel to use a named IP explicit path or a dynamic path.

MPLS-TE Configuration Example

Figure 19-3 illustrates the sample network that the configuration commands reference. Example 19-5 lists relevant portions of the configuration files for enabling MPLS-TE on ML-Series card A in the sample network. ML-Series card A is configured with an explicit path.

Figure 19-3: MPLS-TE Configuration Example
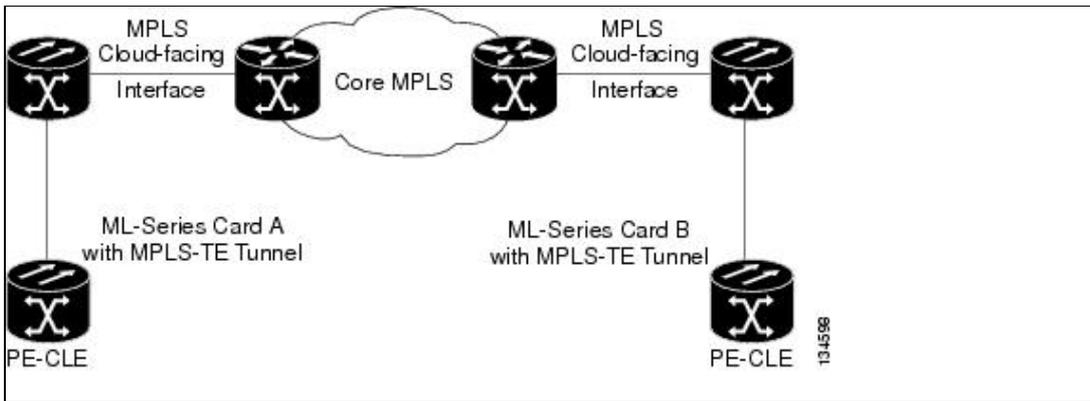
Example 19-5: ML-Series Card A Configuration

```
microcode mpls
ip subnet-zero
no ip domain-lookup
!
mpls label protocol ldp
mpls traffic-eng tunnels
no mpls traffic-eng auto-bw timers frequency 0
!
!
!
interface Loopback0
 ip address 222.222.222.222 255.255.255.255
!
interface Tunnel0
 ip unnumbered Loopback0
 tunnel destination 212.212.212.212
 tunnel mode mpls traffic-eng
 tunnel mpls traffic-eng autoroute announce
 tunnel mpls traffic-eng path-option 1 explicit identifier 1
!
interface Tunnel1
 ip unnumbered Loopback0
 tunnel destination 212.212.212.212
 tunnel mode mpls traffic-eng
 tunnel mpls traffic-eng autoroute announce
 tunnel mpls traffic-eng path-option 2 explicit identifier 2
!
interface GigabitEthernet0
 no ip address
 shutdown
!
interface GigabitEthernet1
 no ip address
!
interface GigabitEthernet1.1
 encapsulation dot1Q 10
fcs-preservation-on
 mpls l2transport route 212.212.212.212 222
!
interface GigabitEthernet1.2
 encapsulation dot1Q 20
 mpls l2transport route 212.212.212.212 223
!
interface GigabitEthernet1.3
 encapsulation dot1Q 30
 mpls l2transport route 212.212.212.212 224
!
```

Figure 19-3: MPLS-TE Configuration Example   16

```
interface POS0
 ip address 170.170.170.172 255.255.255.0
 mpls traffic-eng tunnels
 tag-switching ip
 ip rsvp bandwidth 10000
!
interface POS1
 ip address 2.1.1.22 255.255.255.0
 mpls traffic-eng tunnels
 tag-switching ip
 ip rsvp bandwidth 10000
!
router ospf 1
 mpls traffic-eng router-id Loopback0
 mpls traffic-eng area 0
 log-adjacency-changes
 network 2.1.1.22 0.0.0.0 area 0
 network 170.170.170.172 0.0.0.0 area 0
 network 222.222.222.222 0.0.0.0 area 0
!
ip classless
no ip http server
!
!
ip explicit-path identifier 1 enable
 next-address 2.1.1.1
 next-address 192.168.3.2
 next-address 192.168.3.1
 next-address 2.2.1.1
 next-address 2.2.1.2
 next-address 212.212.212.212
!
ip explicit-path identifier 2 enable
 next-address 170.170.170.171
 next-address 192.168.3.2
 next-address 192.168.3.1
 next-address 2.2.1.1
 next-address 2.2.1.2
 next-address 212.212.212.212
!
!
!
!
control-plane
!
!
line con 0
 exec-timeout 0 0
line vty 0 4
 exec-timeout 0 0
 password xxx
 no login
```

Monitoring and Verifying MPLS-TE and IP RSVP

Table 19-3 shows the privileged EXEC commands supported to monitor and verify the state of MPLS-TE tunnels on the ML-Series cards.

Example 19-5: ML-Series Card A Configuration   17

Table 19-3: Commands for Monitoring and Verifying MPLS-TE

Command	Purpose
`show mpls traffic-eng autoroute`	Displays tunnels announced to the Interior Gateway Protocol (IGP), including interface, destination, and bandwidth
`show mpls traffic-eng link-management admission-control`	Displays which tunnels were admitted locally and their parameters (such as, priority, bandwidth, incoming and outgoing interface, and state).
`show mpls traffic-eng link-management advertisements`	Displays local link information that MPLS traffic engineering link management is currently flooding into the global traffic engineering topology.
`show mpls traffic-eng link-management bandwidth-allocation`	Displays current local link information.
`show mpls traffic-eng link-management igp-neighbors`	Displays IGP neighbors.
`show mpls traffic-eng link-management interfaces`	Displays interface resource and configuration information.
`show mpls traffic-eng link-management summary`	Displays a summary of link management information including link counts.
`show mpls traffic-eng topology`	Displays the MPLS-TE global topology as currently known at this node.
`show mpls traffic-eng tunnel`	Displays information about MPLS-TE tunnels, including LSP Tunnels Process and RSVP process.
`show mpls traffic-eng tunnel summary`	Displays condensed information about MPLS-TE tunnels.

Table 19-4 shows the privileged EXEC commands supported to monitor and verify the state of IP RSVP on the ML-Series cards.

Table 19-4: Commands for Monitoring and Verifying IP RSVP

Command	Purpose
`show ip rsvp interface [interface-type interface-number]`	Displays Resource Reservation Protocol (RSVP)-related information.
`show ip rsvp installed [interface-type interface-number]`	Displays RSVP-related installed filters and corresponding bandwidth information.
`show ip rsvp neighbor [interface-type interface-number]`	Displays current RSVP neighbors.
`show ip rsvp sender [interface-type interface-number]`	Displays RSVP path-related sender information currently in the database.
`show ip rsvp request [interface-type interface-number]`	Displays RSVP-related request information being requested upstream
`show ip rsvp reservation [interface-type interface-number]`	Displays RSVP-related receiver information currently in the database

Table 19-3: Commands for Monitoring and Verifying MPLS-TE   18

RPRW Alarm

For information on the ONS 15454 RPRW alarm, refer to the Cisco ONS 15454 Troubleshooting Guide, Release 5.0.