



Configuring Ethernet-over-MPLS and Pseudowire Redundancy

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Configuring Ethernet-over-MPLS

This section provides information about how to configure Ethernet over Multiprotocol Label Switching (EoMPLS).

Prerequisites for Ethernet-over-MPLS

Before you configure EoMPLS, ensure that the network is configured as follows:

- Configure IP routing in the core so that the provider edge (PE) devices can reach each other through IP.
- Configure MPLS in the core so that a label switched path (LSP) exists between the PE devices.
- Configure the **no switchport**, **no keepalive**, and **no ip address** commands before configuring Xconnect on the attachment circuit.
- For load-balancing, configuring the **port-channel load-balance** command is mandatory.
- Subinterfaces must be supported to enable EoMPLS VLAN mode.
- The **mpls ldp graceful-restart** command must be configured to enable the device to protect LDP bindings and MPLS forwarding state during a disruption in service. We recommend you to configure this command (even if you do not want to preserve the forwarding state) to avoid device failure during SSO in a high availability setup with scale configurations.

Restrictions for Ethernet-over-MPLS

The following sections list the restrictions for EoMPLS port mode and EoMPLS VLAN mode.

Restrictions for Ethernet-over-MPLS Port Mode

- Ethernet Flow Point is not supported.
- Quality of Service (QoS): Customer differentiated services code point (DSCP) re-marking is not supported with virtual private wire service (VPWS) and EoMPLS.
- Virtual Circuit Connectivity Verification (VCCV) ping with explicit null is not supported.
- Layer 2 Protocol Tunneling CLI is not supported.
- Flow-Aware Transport (FAT) Pseudowire Redundancy is supported only in Protocol-CLI mode. Supported load-balancing parameters are Source IP, Source MAC address, Destination IP, and Destination MAC address.
- MPLS QoS is supported only in pipe and uniform mode. Default mode is pipe mode.
- Both legacy Xconnect and Protocol-CLI (interface pseudowire configuration) modes are supported.
- Xconnect mode cannot be configured on SVI.
- Xconnect and MACSec cannot be configured on the same interface.
- MACSec should be configured on CE devices and Xconnect should be configured on PE devices.
- A MACSec session should be available between CE devices.
- By default, EoMPLS PW tunnels all the protocols such as Cisco Discovery Protocol and Spanning Tree Protocol (STP). EoMPLS PW cannot perform selective protocol tunneling as part of L2 Protocol Tunneling CLI.
- Link Aggregation Control Protocol (LACP) and Port Aggregation Protocol (PAgP) packets are not forwarded over Ethernet-over-MPLS Pseudowire, as these are processed by the local PE.

Restrictions for Ethernet-over-MPLS VLAN Mode

- Virtual circuit will not work if the same interworking type is not configured on PE devices.
- Untagged traffic is not supported as incoming traffic.
- Xconnect mode cannot be enabled on Layer 2 subinterfaces because multiplexer user-network interface (MUX UNI) is not supported.
- Xconnect mode cannot be configured on subinterfaces if it is enabled on the main interface for port-to-port transport.
- FAT can be configured on Protocol CLI mode only.
- MACsec is not supported on EoMPLS VLAN mode.
- QoS: Customer DSCP Remarking is not supported with VPWS and EoMPLS.
- MPLS QoS is supported in pipe and uniform mode. Default mode is pipe mode.
- In VLAN mode EoMPLS, Cisco Discovery Protocol packets from the CE will be processed by the PE, but will not be carried over the EoMPLS virtual circuit, whereas in port mode, Cisco Discovery Protocol packets from the CE will be carried over the virtual circuit.
- Only Ethernet and VLAN interworking types are supported.

- L2 Protocol Tunneling CLI is not supported.
- Link Aggregation Control Protocol (LACP) and Port Aggregation Protocol (PAgP) packets are not forwarded over Ethernet-over-MPLS Pseudowire, as these are processed by the local PE.

Information About Ethernet-over-MPLS

EoMPLS is one of the Any Transport over MPLS (AToM) transport types. EoMPLS works by encapsulating Ethernet protocol data units (PDUs) in MPLS packets and forwarding them across the MPLS network. Each PDU is transported as a single packet.

The following modes are supported:

- Port mode: Allows all traffic on a port to share a single virtual circuit across an MPLS network. Port mode uses virtual circuit type 5.
- VLAN mode: Transports Ethernet traffic from a source 802.1Q VLAN to a destination 802.1Q VLAN through a single virtual circuit over an MPLS network. VLAN mode uses virtual circuit type 5 as the default (does not transport dot1q tag); however, uses virtual circuit type 4 (transports dot1 tag) if the remote PE does not support virtual circuit type 5 for subinterface-based (VLAN-based) EoMPLS.

Interworking between EoMPLS port mode and EoMPLS VLAN mode: If EoMPLS port mode is configured on a local PE and EoMPLS VLAN mode on a remote PE, then the customer edge (CE) Layer 2 switchport interface must be configured as an *access* on the port mode side and the Spanning Tree Protocol must be disabled on the VLAN mode side of the CE device.

The maximum transmission unit (MTU) of all the intermediate links between PEs must be able to carry the largest Layer 2 packet received on ingress PE.

How to Configure Ethernet-over-MPLS

EoMPLS can be configured in the port mode or VLAN mode.

Configuring Ethernet-over-MPLS Port Mode

EoMPLS port mode can be configured using either the Xconnect mode or protocol CLI method.

Xconnect Mode

To configure EoMPLS port mode in Xconnect mode, perform the following task:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *interface-id*
4. **no switchport**
5. **no ip address**
6. **no keepalive**
7. **xconnect** *peer-device-id* *vc-id* **encapsulation mpls**
8. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	interface <i>interface-id</i> Example: Device(config)# interface TenGigabitEthernet1/0/36	Defines the interface to be configured as a trunk, and enters interface configuration mode.
Step 4	no switchport Example: Device(config-if)# no switchport	Enters Layer 3 mode for physical ports only.
Step 5	no ip address Example: Device(config-if)# no ip address	Ensures that no IP address is assigned to the physical port.
Step 6	no keepalive Example: Device(config-if)# no keepalive	Ensures that the device does not send keepalive messages.
Step 7	xconnect <i>peer-device-id</i> <i>vc-id</i> encapsulation mpls Example: Device(config-if)# xconnect 10.1.1.1 962 encapsulation mpls	Binds the attachment circuit to a pseudowire virtual circuit (VC). The syntax for this command is the same as for all other Layer 2 transports.

	Command or Action	Purpose
Step 8	end Example: Device(config-if) # end	Exits interface configuration mode and returns to privileged EXEC mode.

Protocol CLI Method

To configure EoMPLS port mode in protocol CLI mode, perform the following task:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **port-channel load-balance dst-ip**
4. **interface** *interface-id*
5. **no switchport**
6. **no ip address**
7. **no keepalive**
8. **exit**
9. **interface pseudowire** *number*
10. **encapsulation mpls**
11. **neighbor** *peer-ip-addr vc-id*
12. **l2vpn xconnect context** *context-name*
13. **member** *interface-id*
14. **member pseudowire** *number*
15. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	port-channel load-balance dst-ip Example:	Sets the load distribution method to the destination IP address.

	Command or Action	Purpose
	Device(config)# port-channel load-balance dst-ip	
Step 4	interface <i>interface-id</i> Example: Device(config)# interface TenGigabitEthernet1/0/21	Defines the interface to be configured as a trunk, and enters interface configuration mode.
Step 5	no switchport Example: Device(config-if)# no switchport	Enters Layer 3 mode for physical ports only.
Step 6	no ip address Example: Device(config-if)# no ip address	Ensures that no IP address is assigned to the physical port.
Step 7	no keepalive Example: Device(config-if)# no keepalive	Ensures that the device does not send keepalive messages.
Step 8	exit Example: Device(config-if)# exit	Exits interface configuration mode and returns to global configuration mode.
Step 9	interface pseudowire <i>number</i> Example: Device(config)# interface pseudowire 17	Establishes a pseudowire interface with a value that you specify and enters pseudowire configuration mode.
Step 10	encapsulation mpls Example: Device(config-if)# encapsulation mpls	Specifies the tunneling encapsulation.

	Command or Action	Purpose
Step 11	neighbor <i>peer-ip-addr</i> <i>vc-id</i> Example: Device(config-if) # neighbor 10.10.0.10 17	Specifies the peer IP address and virtual circuit (VC) ID value of a Layer 2 VPN (L2VPN) pseudowire.
Step 12	l2vpn xconnect context <i>context-name</i> Example: Device(config-if) # l2vpn xconnect context vpws17	Creates an L2VPN cross connect context and enters Xconnect context configuration mode.
Step 13	member <i>interface-id</i> Example: Device(config-if-xconn) # member TenGigabitEthernet1/0/21	Specifies interface that forms an L2VPN cross connect.
Step 14	member pseudowire <i>number</i> Example: Device(config-if-xconn) # member pseudowire 17	Specifies the pseudowire interface that forms an L2VPN cross connect.
Step 15	end Example: Device(config-if-xconn) # end	Exits Xconnect interface configuration mode and returns to privileged EXEC mode.

Configuring Ethernet-over-MPLS VLAN Mode

EoMPLS VLAN mode can be configured using either the Xconnect mode or protocol-CLI method.

Xconnect Mode

To configure EoMPLS VLAN mode in Xconnect mode, perform the following task:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *interface-id*
4. **no switchport**
5. **no ip address**

6. **no keepalive**
7. **exit**
8. **interface** *interface-id.subinterface*
9. **encapsulation dot1Q** *vlan-id*
10. **xconnect** *peer-ip-addr vc-id encapsulation mpls*
11. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	interface <i>interface-id</i> Example: Device(config)# interface TenGigabitEthernet1/0/36	Defines the interface to be configured as a trunk, and enters interface configuration mode.
Step 4	no switchport Example: Device(config-if)# no switchport	Enters Layer 3 mode, for physical ports only.
Step 5	no ip address Example: Device(config-if)# no ip address	Ensures that there is no IP address assigned to the physical port.
Step 6	no keepalive Example: Device(config-if)# no keepalive	Ensures that the device does not send keepalive messages.

	Command or Action	Purpose
Step 7	exit Example: Device(config-if) # exit	Exits interface configuration mode and returns to global configuration mode.
Step 8	interface <i>interface-id.subinterface</i> Example: Device(config)# interface TenGigabitEthernet1/0/36.1105	Defines the subinterface to be configured, and enters subinterface configuration mode.
Step 9	encapsulation dot1Q <i>vlan-id</i> Example: Device(config-subif) # encapsulation dot1Q 1105	Enables IEEE 802.1Q encapsulation of traffic on the subinterface.
Step 10	xconnect <i>peer-ip-addr vc-id encapsulation mpls</i> Example: Device(config-subif) # xconnect 10.0.0.1 1105 encapsulation mpls	Binds the attachment circuit to a pseudowire VC. The syntax for this command is the same as for all other Layer 2 transports.
Step 11	end Example: Device(config-subif-xconn) # end	Returns to privileged EXEC mode.

Protocol CLI Method

To configure EoMPLS VLAN mode in protocol-CLI mode, perform the following task:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **port-channel load-balance dst-ip**
4. **interface** *interface-id*
5. **no switchport**
6. **no ip address**
7. **no keepalive**
8. **exit**
9. **interface** *interface-id.subinterface*
10. **encapsulation dot1Q** *vlan-id*

11. `exit`
12. `interface pseudowire number`
13. `encapsulation mpls`
14. `neighbor peer-ip-addr vc-id`
15. `l2vpn xconnect context context-name`
16. `member interface-id.subinterface`
17. `member pseudowire number`
18. `end`

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Device> <code>enable</code>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Device# <code>configure terminal</code>	Enters global configuration mode.
Step 3	port-channel load-balance dst-ip Example: Device(config)# <code>port-channel load-balance dst-ip</code>	Sets the load-distribution method to the destination IP address.
Step 4	interface interface-id Example: Device(config)# <code>interface TenGigabitEthernet1/0/36</code>	Defines the interface to be configured as a trunk, and enters interface configuration mode.
Step 5	no switchport Example: Device(config-if)# <code>no switchport</code>	Enters Layer 3 mode, for physical ports only.
Step 6	no ip address Example: Device(config-if)# <code>no ip address</code>	Ensures that there is no IP address assigned to the physical port.

	Command or Action	Purpose
Step 7	no keepalive Example: Device(config-if) # no keepalive	Ensures that the device does not send keepalive messages.
Step 8	exit Example: Device(config-if) # exit	Exits interface configuration mode and returns to global configuration mode.
Step 9	interface interface-id.subinterface Example: Device(config) # interface TenGigabitEthernet1/0/36.1105	Defines the subinterface to be configured, and enters subinterface configuration mode.
Step 10	encapsulation dot1Q vlan-id Example: Device(config-subif) # encapsulation dot1Q 1105	Enables IEEE 802.1Q encapsulation of traffic on the subinterface.
Step 11	exit Example: Device(config-subif) # exit	Exits subinterface configuration mode and returns to interface configuration mode.
Step 12	interface pseudowire number Example: Device(config) # interface pseudowire 17	Establishes a pseudowire interface with a value that you specify and enters pseudowire configuration mode.
Step 13	encapsulation mpls Example: Device(config-if) # encapsulation mpls	Specifies the tunneling encapsulation.
Step 14	neighbor peer-ip-addr vc-id Example: Device(config-if) # neighbor 10.10.0.10 17	Specifies the peer IP address and VC ID value of a L2VPN pseudowire.

	Command or Action	Purpose
Step 15	l2vpn xconnect context <i>context-name</i> Example: Device(config-if) # l2vpn xconnect context vpws17	Creates a L2VPN cross connect context, and enters Xconnect context configuration mode.
Step 16	member <i>interface-id.subinterface</i> Example: Device(config-if-xconn) # member TenGigabitEthernet1/0/36.1105	Specifies the subinterface that forms a L2VPN cross connect.
Step 17	member pseudowire <i>number</i> Example: Device(config-if-xconn) # member pseudowire 17	Specifies pseudowire interface that forms a L2VPN cross connect.
Step 18	end Example: Device(config-if-xconn) # end	Exits Xconnect configuration mode and returns to privileged EXEC mode.

Configuration Examples for Ethernet-over-MPLS

Figure 1: EoMPLS Topology

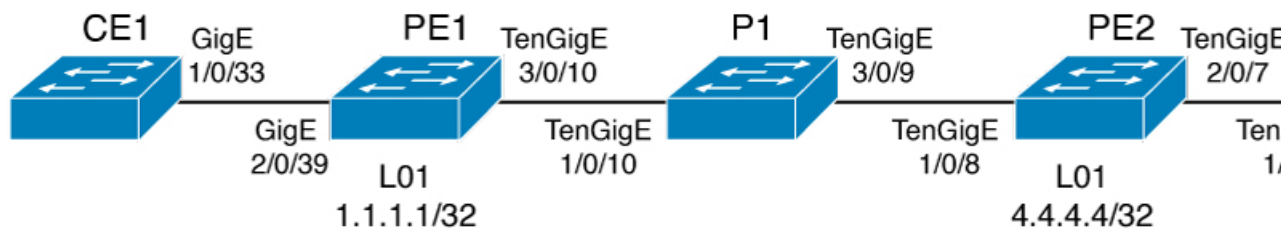


Table 1: EoMPLS Port Mode Configuration

PE Configuration	CE Configuration
<pre> mpls ip mpls label protocol ldp mpls ldp graceful-restart mpls ldp router-id loopback 1 force interface Loopback1 ip address 10.1.1.1 255.255.255.255 ip ospf 100 area 0 router ospf 100 router-id 10.1.1.1 nsf system mtu 9198 port-channel load-balance dst-ip ! interface gigabitethernet 2/0/39 no switchport no ip address no keepalive ! interface pseudowire101 encapsulation mpls neighbor 10.10.10.10 101 load-balance flow ip dst-ip load-balance flow-label both l2vpn xconnect context pw101 member pseudowire101 member gigabitethernet 2/0/39 ! interface tengigabitethernet 3/0/10 switchport trunk allowed vlan 142 switchport mode trunk channel-group 42 mode active ! interface Port-channel42 switchport trunk allowed vlan 142 switchport mode trunk ! interface Vlan142 ip address 10.11.11.11 255.255.255.0 ip ospf 100 area 0 mpls ip mpls label protocol ldp ! </pre>	<pre> interface gigabitethernet 1/0/33 switchport trunk allowed vlan 912 switchport mode trunk spanning-tree portfast trunk ! interface Vlan912 ip address 10.91.2.3 255.255.255.0 ! </pre>

Table 2: EoMPLS VLAN Mode Configuration

PE Configuration	CE Configuration
<pre> interface tengigabitethernet 1/0/36 no switchport no ip address no keepalive exit ! interface tengigabitethernet 1/0/36.1105 encapsulation dot1Q 1105 exit ! interface pseudowire1105 encapsulation mpls neighbor 10.10.0.10 1105 exit ! l2vpn xconnect context vme1105 member tengigabitethernet 1/0/36.1105 member pseudowire1105 end ! </pre>	<pre> interface fortygigabitethernet 1/9 switchport switchport mode trunk switchport trunk allowed vlan 1105 mtu 9216 end ! </pre>

Table 3: Interworking Between EoMPLS Port Mode and EoMPLS VLAN Mode Configuration

PE Configuration: Port Mode	CE Configuration: Port Mode
<pre> interface tengigabitethernet 1/0/37 no switchport no ip address no keepalive exit ! interface pseudowire1105 encapsulation mpls neighbor 10.11.11.11 1105 exit ! l2vpn xconnect context vme1105 member tengigabitethernet 1/0/37 member pseudowire1105 end ! </pre>	<pre> interface fortygigabitethernet1/10 switchport switchport mode access switchport access vlan 1105 end no spanning-tree vlan 1105 ! </pre>

PE Configuration: VLAN Mode	CE Configuration: VLAN Mode
<pre> interface tengigabitethernet 1/0/36 no switchport no ip address no keepalive exit ! interface tengigabitethernet 1/0/36.1105 encapsulation dot1Q 1105 exit ! interface pseudowire1105 encapsulation mpls neighbor 10.10.0.10 1105 exit ! l2vpn xconnect context vme1105 member tengigabitethernet 1/0/36.1105 member pseudowire1105 end ! </pre>	<pre> interface fortygigabitethernet 1/9 switchport switchport mode trunk switchport trunk allowed vlan 1105 mtu 9216 end no spanning-tree vlan 1105 ! </pre>

Another scenario for interworking between EoMPLS port mode and EoMPLS VLAN mode is to configure the following commands on both CE devices:

- **switchport mode trunk**
- **switchport trunk allowed vlan *vlan-id***
- **spanning-tree vlan *vlan-id***

Data traffic will flow through by disabling STP on both CE devices, if the traffic sent is not double VLAN tagged.

The following is a sample output of the **show mpls l2 vc vcid *vc-id* detail** command:

```

Device# show mpls l2 vc vcid 1105 detail
Local interface: TenGigabitEthernet1/0/36.1105 up, line protocol up, Eth VLAN 1105 up
  Interworking type is Ethernet
  Destination address: 10.0.0.1, VC ID: 1105, VC status: up
  Output interface: Po10, imposed label stack {33 10041}
  Preferred path: not configured
  Default path: active
  Next hop: 10.10.0.1
  Create time: 00:04:09, last status change time: 00:02:13
  Last label FSM state change time: 00:02:12
  Signaling protocol: LDP, peer 10.0.0.1:0 up
  Targeted Hello: 10.0.0.10(LDP Id) -> 10.0.0.1, LDP is UP
  Graceful restart: configured and enabled
  Non stop routing: not configured and not enabled
  Status TLV support (local/remote) : enabled/supported
    LDP route watch : enabled
    Label/status state machine : established, LruRru
  Last local dataplane status rcvd: No fault
  Last BFD dataplane status rcvd: Not sent
  Last BFD peer monitor status rcvd: No fault
  Last local AC circuit status rcvd: No fault
  Last local AC circuit status sent: No fault
  Last local PW i/f circ status rcvd: No fault

```

```

Last local LDP TLV      status sent: No fault
Last remote LDP TLV    status rcvd: No fault
Last remote LDP ADJ    status rcvd: No fault
MPLS VC labels: local 124, remote 10041
Group ID: local 336, remote 352
MTU: local 9198, remote 9198
Remote interface description:
MAC Withdraw: sent:1, received:0
Sequencing: receive disabled, send disabled
Control Word: On (configured: autosense)
SSO Descriptor: 10.0.0.1/1105, local label: 124
Dataplane:
SSM segment/switch IDs: 9465983/446574 (used), PWID: 109
VC statistics:
transit packet totals: receive 0, send 0
transit byte totals:  receive 0, send 0
transit packet drops:  receive 0, seq error 0, send 0

```

The following is a sample output of the **show l2vpn atom vc vcid vc-id detail** command:

```

Device# show l2vpn atom vc vcid 1105 detail
pseudowire100109 is up, VC status is up PW type: Ethernet
Create time: 00:04:17, last status change time: 00:02:22
Last label FSM state change time: 00:02:20
Destination address: 10.0.0.1 VC ID: 1105
Output interface: Po10, imposed label stack {33 10041}
Preferred path: not configured
Default path: active
Next hop: 10.10.0.1
Member of xconnect service TenGigabitEthernet1/0/36.1105-1105, group right
Associated member TenGigabitEthernet1/0/36.1105 is up, status is up
Interworking type is Ethernet
Service id: 0x1f000037
Signaling protocol: LDP, peer 10.0.0.1:0 up
Targeted Hello: 10.0.0.10(LDP Id) -> 10.0.0.1, LDP is UP
Graceful restart: configured and enabled
Non stop routing: not configured and not enabled
PWid FEC (128), VC ID: 1105
Status TLV support (local/remote)      : enabled/supported
LDP route watch                        : enabled
Label/status state machine              : established, LruRru
Local dataplane status received         : No fault
BFD dataplane status received           : Not sent
BFD peer monitor status received        : No fault
Status received from access circuit     : No fault
Status sent to access circuit           : No fault
Status received from pseudowire i/f     : No fault
Status sent to network peer             : No fault
Status received from network peer       : No fault
Adjacency status of remote peer         : No fault
Sequencing: receive disabled, send disabled
Bindings
Parameter      Local                               Remote
-----
Label          124                                           10041
Group ID       336                                           352
Interface
MTU            9198                                           9198
Control word on (configured: autosense)  on
PW type        Ethernet                                       Ethernet
VCCV CV type  0x02                                           0x02
                LSPV [2]                                       LSPV [2]
VCCV CC type  0x06                                           0x06
                RA [2], TTL [3]                               RA [2], TTL [3]

```



```

    Status TLV   enabled                               supported
SSO Descriptor: 10.0.0.1/1105, local label: 124
Dataplane:
    SSM segment/switch IDs: 9465983/446574 (used), PWID: 109
Rx Counters
    0 input transit packets, 0 bytes
    0 drops, 0 seq err
    0 MAC withdraw
Tx Counters
    0 output transit packets, 0 bytes
    0 drops
    1 MAC withdraw

```

The following is a sample output of the **show mpls forwarding-table** command:

```

Device# show mpls forwarding-table 10.0.0.1

Local      Outgoing  Prefix          Bytes Label  Outgoing      Next Hop
Label      Label     or Tunnel Id   Switched     interface
2049      33        10.0.0.1/32    38540        Hu2/0/30/2.1  10.0.0.2
          33        10.0.0.1/32    112236       Hu2/0/30/2.2  10.0.0.6
          33        10.0.0.1/32    46188        Hu2/0/30/2.3  10.0.0.8

```

Configuring Pseudowire Redundancy

This section provides information about how to configure pseudowire redundancy.

Prerequisites for Pseudowire Redundancy

- Configure the **no switchport**, **no keepalive**, and **no ip address** before configuring Xconnect mode to connect the attachment circuit.
- For load-balancing, configure the **port-channel load-balance** command.
- Subinterfaces must be supported to enable pseudowire redundancy VLAN mode.

Restrictions for Pseudowire Redundancy

The following sections list the restrictions for pseudowire redundancy port mode and pseudowire redundancy VLAN mode.

Restrictions for Pseudowire Redundancy Port Mode

- Ethernet Flow Point (EFP) and Internet Group Management Protocol (IGMP) Snooping is not supported.
- Flow Label for ECMP load balancing in a core network based on customer's source IP, destination IP, source MAC and destination MAC.
- MPLS QoS is supported in Pipe and Uniform Mode. Default mode is Pipe Mode.
- QoS: Customer DSCP Re-marking is not supported with VPWS and EoMPLS.
- VCCV Ping with explicit null is not supported.

- The **ip unnumbered** command is not supported in MPLS configuration.
- Not more than one backup pseudowire supported.
- PW redundancy group switchover is not supported

Restrictions for Pseudowire Redundancy VLAN Mode

- Virtual circuit will not work if the same interworking type is not configured on PE devices.
- Untagged traffic is not supported as incoming traffic.
- Xconnect mode cannot be enabled on Layer 2 subinterfaces because multiplexer user-network interface (MUX UNI) is not supported.
- Xconnect mode cannot be configured on subinterfaces if it is enabled on the main interface for port-to-port transport.
- Flow Aware Transport (FAT) can be configured on Protocol CLI mode only.
- MACsec is not supported on pseudowire redundancy VLAN mode.
- QoS: Customer DSCP Remarking is not supported with VPWS and pseudowire redundancy.
- MPLS QoS is supported only in pipe and uniform mode. Default mode is pipe mode.
- In VLAN mode pseudowire redundancy, Cisco Discovery Protocol packets from the CE will be processed by the PE, but is not carried over the pseudowire redundancy virtual circuit, whereas in port mode, Cisco Discovery Protocol packets from the CE will be carried over the virtual circuit.
- Only Ethernet and VLAN interworking types are supported.
- L2 Protocol Tunneling CLI is not supported.

Information About Pseudowire Redundancy

The L2VPN pseudowire redundancy feature enables you to configure your network to detect a failure in the network and reroute the Layer 2 service to another endpoint that can continue to provide service. This feature provides the ability to recover from a failure either of the remote provider edge (PE) device or of the link between the PE and customer edge (CE) devices.

The maximum transmission unit (MTU) of all the intermediate links between PEs must be able to carry the largest Layer 2 packet received on ingress PE.

Pseudowire redundancy can be configured using both the Xconnect and the protocol CLI method.

How to Configure Pseudowire Redundancy

Pseudowire redundancy can be configured in the port mode or VLAN mode.

Configuring Pseudowire Redundancy Port Mode

Pseudowire redundancy port-mode can be configured using either the Xconnect mode or protocol-CLI method.

Xconnect Mode

To configure pseudowire redundancy port mode in Xconnect mode, perform the following task:



Note To enable load balance, use the corresponding **load-balance** commands from Xconnect Mode procedure of the 'How to Configure Ethernet-over-MPLS section.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *interface-id*
4. **no switchport**
5. **no ip address**
6. **no keepalive**
7. **xconnect** *peer-device-id* *vc-id* **encapsulation mpls**
8. **backup peer** *peer-router-ip-addr* **vcid** *vc-id* [**priority** *value*]
9. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	interface <i>interface-id</i> Example: Device(config)# interface GigabitEthernet1/0/44	Defines the interface to be configured as a trunk, and enters interface configuration mode.
Step 4	no switchport Example: Device(config-if)# no switchport	Enters Layer 3 mode, for physical ports only.

	Command or Action	Purpose
Step 5	no ip address Example: <pre>Device(config-if)# no ip address</pre>	Ensures that there is no IP address assigned to the physical port.
Step 6	no keepalive Example: <pre>Device(config-if)# no keepalive</pre>	Ensures that the device does not send keepalive messages.
Step 7	xconnect <i>peer-device-id</i> <i>vc-id</i> encapsulation mpls Example: <pre>Device(config-if)# xconnect 10.1.1.1 117 encapsulation mpls</pre>	Binds the attachment circuit to a pseudowire VC. The syntax for this command is the same as for all other Layer 2 transports.
Step 8	backup peer <i>peer-router-ip-addr</i> <i>vcid</i> <i>vc-id</i> [<i>priority value</i>] Example: <pre>Device(config-if)# backup peer 10.11.11.11 118 priority 9</pre>	Specifies a redundant peer for a pseudowire VC.
Step 9	end Example: <pre>Device(config)# end</pre>	Exits interface configuration mode and returns to privileged EXEC mode.

Protocol CLI Method

To configure pseudowire redundancy port mode in protocol CLI mode, perform the following task:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **port-channel load-balance *dst-ip***
4. **interface *interface-id***
5. **no switchport**
6. **no ip address**
7. **no keepalive**

8. **exit**
9. **interface pseudowire** *number-active*
10. **encapsulation mpls**
11. **neighbor** *active-peer-ip-addr vc-id*
12. **exit**
13. **interface pseudowire** *number-standby*
14. **encapsulation mpls**
15. **neighbor** *standby-peer-ip-addr vc-id*
16. **l2vpn xconnect context** *context-name*
17. **member** *interface-id*
18. **member pseudowire** *number-active* **group** *group-name* [**priority** *value*]
19. **member pseudowire** *number-standby* **group** *group-name* [**priority** *value*]
20. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	port-channel load-balance dst-ip Example: Device(config)# port-channel load-balance dst-ip	Sets the load-distribution method to the destination IP address.
Step 4	interface <i>interface-id</i> Example: Device(config)# interface TenGigabitEthernet1/0/36	Defines the interface to be configured as a trunk, and enters interface configuration mode.
Step 5	no switchport Example: Device(config-if)# no switchport	Enters Layer 3 mode, for physical ports only.

	Command or Action	Purpose
Step 6	no ip address Example: Device(config-if) # no ip address	Ensures that there is no IP address assigned to the physical port.
Step 7	no keepalive Example: Device(config-if) # no keepalive	Ensures that the device does not send keepalive messages.
Step 8	exit Example: Device(config-if) # exit	Exits interface configuration mode.
Step 9	interface pseudowire <i>number-active</i> Example: Device(config) # interface pseudowire 17	Establishes an active pseudowire interface with a value that you specify and enters pseudowire configuration mode.
Step 10	encapsulation mpls Example: Device(config-if) # encapsulation mpls	Specifies the tunneling encapsulation.
Step 11	neighbor <i>active-peer-ip-addr vc-id</i> Example: Device(config-if) # neighbor 10.10.0.10 17	Specifies the active peer IP address and VC ID value of a L2VPN pseudowire.
Step 12	exit Example: Device(config-if) # exit	Exits interface configuration mode and returns to global configuration mode.
Step 13	interface pseudowire <i>number-standby</i> Example:	Establishes a standby pseudowire interface with a value that you specify and enters pseudowire configuration mode.

	Command or Action	Purpose
	Device(config)# interface pseudowire 18	
Step 14	encapsulation mpls Example: Device(config-if)# encapsulation mpls	Specifies the tunneling encapsulation.
Step 15	neighbor <i>standby-peer-ip-addr vc-id</i> Example: Device(config-if)# neighbor 10.10.0.11 18	Specifies the standby peer IP address and VC ID value of a L2VPN pseudowire.
Step 16	l2vpn xconnect context <i>context-name</i> Example: Device(config-if)# l2vpn xconnect context vpws17	Creates a L2VPN cross connect context, and attaches the VLAN mode EoMPLS attachment circuit to the active and standby pseudowire interfaces.
Step 17	member <i>interface-id</i> Example: Device(config-if-xconn)# member TenGigabitEthernet1/0/36	Specifies interface that forms a L2VPN cross connect.
Step 18	member pseudowire <i>number-active group group-name</i> [<i>priority value</i>] Example: Device(config-if-xconn)# member pseudowire 17 group pwr10	Specifies active pseudowire interface that forms a L2VPN cross connect.
Step 19	member pseudowire <i>number-standby group group-name</i> [<i>priority value</i>] Example: Device(config-if-xconn)# member pseudowire 18 group pwr10 priority 6	Specifies standby pseudowire interface that forms a L2VPN cross connect.
Step 20	end Example:	Exits Xconnect configuration mode and returns to privileged EXEC mode.

	Command or Action	Purpose
	Device(config-if-xconn)# end	

Configuring Pseudowire Redundancy VLAN Mode

Pseudowire redundancy VLAN mode can be configured using either the Xconnect mode or the protocol CLI method.

Xconnect Mode

To configure pseudowire redundancy VLAN mode in Xconnect mode, perform the following task:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *interface-id*
4. **no switchport**
5. **no ip address**
6. **no keepalive**
7. **exit**
8. **interface** *interface-id.subinterface*
9. **encapsulation dot1Q** *vlan-id*
10. **xconnect** *peer-ip-addr vc-id encapsulation mpls*
11. **backup peer** *peer-ip-addr vc-id [priority value]*
12. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	interface <i>interface-id</i> Example: Device(config)# interface TenGigabitEthernet1/0/36	Defines the interface to be configured as a trunk, and enters interface configuration mode.

	Command or Action	Purpose
Step 4	no switchport Example: Device(config-if)# no switchport	Enters Layer 3 mode for physical ports only.
Step 5	no ip address Example: Device(config-if)# no ip address	Ensures that no IP address is assigned to the physical port.
Step 6	no keepalive Example: Device(config-if)# no keepalive	Ensures that the device does not send keepalive messages.
Step 7	exit Example: Device(config-if)# exit	Exits interface configuration mode and returns to global configuration mode.
Step 8	interface interface-id.subinterface Example: Device(config)# interface TenGigabitEthernet1/0/36.1105	Defines the subinterface to be configured, and enters subinterface configuration mode.
Step 9	encapsulation dot1Q vlan-id Example: Device(config-subif)# encapsulation dot1Q 1105	Enables IEEE 802.1Q encapsulation of traffic on the subinterface.
Step 10	xconnect peer-ip-addr vc-id encapsulation mpls Example: Device(config-subif)# xconnect 10.0.0.1 1105 encapsulation mpls	Binds the attachment circuit to a pseudowire VC. The syntax for this command is the same as for all other Layer 2 transports.

	Command or Action	Purpose
Step 11	backup peer <i>peer-ip-addr vc-id</i> [priority value] Example: <pre>Device(config-subif-xconn) # backup peer 10.10.10.10 1105 priority 8</pre>	Specifies a redundant peer for the pseudowire VC.
Step 12	end Example: <pre>Device(config-subif-xconn) # end</pre>	Exits Xconnect configuration mode and returns to privileged EXEC mode.

Protocol CLI Method

To configure pseudowire redundancy VLAN mode in protocol CLI mode, perform the following task:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **port-channel load-balance dst-ip**
4. **interface** *interface-id*
5. **no switchport**
6. **no ip address**
7. **no keepalive**
8. **exit**
9. **interface** *interface-id.subinterface*
10. **encapsulation dot1Q** *vlan-id*
11. **exit**
12. **interface pseudowire** *number-active*
13. **encapsulation mpls**
14. **neighbor** *active-peer-ip-addr vc-id*
15. **exit**
16. **interface pseudowire** *number-standby*
17. **encapsulation mpls**
18. **neighbor** *standby-peer-ip-addr vc-id*
19. **l2vpn xconnect context** *context-name*
20. **member** *interface-id.subinterface*
21. **member pseudowire** *number-active* **group** *group-name* [**priority value**]
22. **member pseudowire** *number-standby* **group** *group-name* [**priority value**]
23. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	port-channel load-balance dst-ip Example: Device(config)# port-channel load-balance dst-ip	Sets the load-distribution method to the destination IP address.
Step 4	interface <i>interface-id</i> Example: Device(config)# interface TenGigabitEthernet1/0/36	Defines the interface to be configured as a trunk, and enters interface configuration mode.
Step 5	no switchport Example: Device(config-if)# no switchport	Enters Layer 3 mode for physical ports only.
Step 6	no ip address Example: Device(config-if)# no ip address	Ensures that there is no IP address assigned to the physical port.
Step 7	no keepalive Example: Device(config-if)# no keepalive	Ensures that the device does not send keepalive messages.

	Command or Action	Purpose
Step 8	exit Example: Device(config-if) # exit	Exits interface configuration mode.
Step 9	interface <i>interface-id.subinterface</i> Example: Device(config) # interface TenGigabitEthernet1/0/36.1105	Defines the subinterface to be configured, and enters subinterface configuration mode.
Step 10	encapsulation dot1Q <i>vlan-id</i> Example: Device(config-subif) # encapsulation dot1Q 1105	Enables IEEE 802.1Q encapsulation of traffic on the subinterface.
Step 11	exit Example: Device(config-subif) # exit	Exits subinterface configuration mode.
Step 12	interface pseudowire <i>number-active</i> Example: Device(config) # interface pseudowire 17	Establishes an active pseudowire interface with a value that you specify, and enters pseudowire configuration mode.
Step 13	encapsulation mpls Example: Device(config-if) # encapsulation mpls	Specifies the tunneling encapsulation.
Step 14	neighbor <i>active-peer-ip-addr vc-id</i> Example: Device(config-if) # neighbor 10.10.0.10 17	Specifies the active peer IP address and virtual circuit (VC) ID value of a Layer 2 VPN (L2VPN) pseudowire.
Step 15	exit Example:	Exits interface configuration mode.

	Command or Action	Purpose
	Device(config-if) # exit	
Step 16	interface pseudowire <i>number-standby</i> Example: Device(config) # interface pseudowire 18	Establishes a standby pseudowire interface with a value that you specify, and enters pseudowire configuration mode.
Step 17	encapsulation mpls Example: Device(config-if) # encapsulation mpls	Specifies the tunneling encapsulation.
Step 18	neighbor <i>standby-peer-ip-addr vc-id</i> Example: Device(config-if) # neighbor 10.10.0.11 18	Specifies the standby peer IP address and VC ID value of an L2VPN pseudowire.
Step 19	l2vpn xconnect context <i>context-name</i> Example: Device(config-if) # l2vpn xconnect context vpws17	Creates an L2VPN cross-connect context, and attaches the VLAN mode EoMPLS attachment circuit to the active and standby pseudowire interfaces.
Step 20	member <i>interface-id.subinterface</i> Example: Device(config-if-xconn) # member TenGigabitEthernet1/0/36.1105	Specifies the interface that forms an L2VPN cross connect.
Step 21	member pseudowire <i>number-active group group-name</i> [priority <i>value</i>] Example: Device(config-if-xconn) # member pseudowire 17 group pwr10	Specifies the active pseudowire interface that forms an L2VPN cross connect.
Step 22	member pseudowire <i>number-standby group group-name</i> [priority <i>value</i>] Example:	Specifies standby pseudowire interface that forms an L2VPN cross connect.

	Command or Action	Purpose
	<pre>Device(config-if-xconn)# member pseudowire 18 group pwr10 priority 6</pre>	
Step 23	<p>end</p> <p>Example:</p> <pre>Device(config-if-xconn)# end</pre>	Exits Xconnect configuration mode and returns to privileged EXEC mode.

Configuration Examples for Pseudowire Redundancy

Table 4: Pseudowire Redundancy Port Mode Configuration

PE Configuration	CE Configuration
<pre> mpls ip mpls label protocol ldp mpls ldp graceful-restart mpls ldp router-id loopback 1 force ! interface Loopback1 ip address 10.1.1.1 255.255.255.255 ip ospf 100 area 0 router ospf 100 router-id 10.1.1.1 nsf ! interface gigabitethernet 2/0/39 no switchport no ip address no keepalive ! interface pseudowire101 encapsulation mpls neighbor 10.10.10.10 101 ! interface pseudowire102 encapsulation mpls neighbor 10.10.10.11 101 l2vpn xconnect context pw101 member pseudowire101 group pwgrp1 priority 1 member pseudowire102 group pwgrp1 priority 15 member GigabitEthernet2/0/39 ! interface tengigabitethernet 3/0/10 switchport trunk allowed vlan 142 switchport mode trunk channel-group 42 mode active ! interface Port-channel42 switchport trunk allowed vlan 142 switchport mode trunk ! interface Vlan142 ip address 10.11.11.11 255.255.255.0 ip ospf 100 area 0 mpls ip mpls label protocol ldp ! </pre>	<pre> interface gigabitethernet 1/0/33 switchport trunk allowed vlan 912 switchport mode trunk spanning-tree portfast trunk ! interface Vlan912 ip address 10.91.2.3 255.255.255.0 ! </pre>

Table 5: Pseudowire Redundancy VLAN Mode Configuration

PE Configuration	CE Configuration
<pre> interface tengigabitethernet 1/0/36 no switchport no ip address no keepalive exit ! interface tengigabitethernet 1/0/36.1105 encapsulation dot1Q 1105 exit ! interface pseudowire1105 encapsulation mpls neighbor 10.10.0.10 1105 exit ! interface pseudowire1106 encapsulation mpls neighbor 10.10.0.11 1106 ! l2vpn xconnect context vme1105 member tengigabitethernet 1/0/36.1105 member pseudowire1105 group pwr10 member pseudowire1106 group pwr10 priority 6 end ! </pre>	<pre> interface fortygigabitethernet 1/9 switchport switchport mode trunk switchport trunk allowed vlan 1105 mtu 9216 end ! </pre>

The following is a sample output of the **show mpls l2 vc vcid vc-id detail** command:

```

Device# show mpls l2 vc vcid 1105 detail
Local interface: TenGigabitEthernet1/0/36.1105 up, line protocol up, Eth VLAN 1105 up
  Interworking type is Ethernet
  Destination address: 10.11.11.11, VC ID: 1105, VC status: standby
    Output interface: Po10, imposed label stack {1616}
    Preferred path: not configured
    Default path: active
    Next hop: 10.10.0.1
  Create time: 00:04:09, last status change time: 00:02:13
  Last label FSM state change time: 00:02:15
  Signaling protocol: LDP, peer 10.11.11.11:0 up
  Targeted Hello: 10.10.0.10(LDP Id) -> 10.11.11.11, LDP is UP
  Graceful restart: configured and enabled
  Non stop routing: not configured and not enabled
  Status TLV support (local/remote)   : enabled/supported
    LDP route watch                    : enabled
    Label/status state machine         : established, LrdRru
  Last local dataplane   status rcvd: No fault
  Last BFD dataplane    status rcvd: Not sent
  Last BFD peer monitor  status rcvd: No fault
  Last local AC circuit  status rcvd: DOWN(standby)
  Last local AC circuit  status sent: No fault
  Last local PW i/f circ status rcvd: No fault
  Last local LDP TLV     status sent: DOWN(standby)
  Last remote LDP TLV    status rcvd: No fault
  Last remote LDP ADJ    status rcvd: No fault
  MPLS VC labels: local 125, remote 1616
  Group ID: local 336, remote 0

```



```

MTU: local 9198, remote 9198
Remote interface description:
MAC Withdraw: sent:1, received:0
Sequencing: receive disabled, send disabled
Control Word: On (configured: autosense)
SSO Descriptor: 10.11.11.11/1105, local label: 125
Dataplane:
  SSM segment/switch IDs: 96143/450671 (used), PWID: 110
VC statistics:
  transit packet totals: receive 0, send 0
  transit byte totals:  receive 0, send 0
  transit packet drops:  receive 0, seq error 0, send 0

```

The following is a sample output of the **show l2vpn atom vc vcid vc-id detail** command:

```

Device# show l2vpn atom vc vcid 1105 detail
pseudowire100110 is up, VC status is standby PW type: Ethernet
  Create time: 00:04:17, last status change time: 00:02:22
  Last label FSM state change time: 00:02:24
  Destination address: 10.11.11.11 VC ID: 1105
  Output interface: Po10, imposed label stack {1616}
  Preferred path: not configured
  Default path: active
  Next hop: 10.0.0.1
Member of xconnect service TenGigabitEthernet1/0/36.1105-1105, group right
Associated member TenGigabitEthernet1/0/36.1105 is up, status is up
Interworking type is Ethernet
Service id: 0x1f000037
Signaling protocol: LDP, peer 10.11.11.11:0 up
Targeted Hello: 10.0.0.10(LDP Id) -> 10.11.11.11, LDP is UP
Graceful restart: configured and enabled
Non stop routing: not configured and not enabled
PWid FEC (128), VC ID: 1105
Status TLV support (local/remote)      : enabled/supported
  LDP route watch                       : enabled
  Label/status state machine            : established, LrdRru
  Local dataplane status received       : No fault
  BFD dataplane status received         : Not sent
  BFD peer monitor status received      : No fault
  Status received from access circuit   : DOWN(standby)
  Status sent to access circuit         : No fault
  Status received from pseudowire i/f   : No fault
  Status sent to network peer           : DOWN(standby)
  Status received from network peer     : No fault
  Adjacency status of remote peer       : No fault
Sequencing: receive disabled, send disabled
Bindings
  Parameter      Local      Remote
  -----
Label           125          1616
Group ID        336          0
Interface
MTU             9198         9198
Control word on (configured: autosense) on
PW type         Ethernet    Ethernet
VCCV CV type 0x02
                LSPV [2]    LSPV [2]
VCCV CC type 0x06
                RA [2], TTL [3]  RA [2]
Status TLV      enabled     supported
SSO Descriptor: 10.11.11.11/1105, local label: 125
Dataplane:
  SSM segment/switch IDs: 96143/450671 (used), PWID: 110
Rx Counters

```

```

    0 input transit packets, 0 bytes
    0 drops, 0 seq err
    0 MAC withdraw
Tx Counters
    0 output transit packets, 0 bytes
    0 drops
    1 MAC withdraw

```

The following is a sample output of the **show mpls l2transport vc vc-id** command:

```
Device# show mpls l2transport vc 101
```

Local intf	Local circuit	Dest address	VC ID	Status
TenGigabitEthernet1/0/36.1105	Eth VLAN 1105	10.0.0.1	1105	UP
TenGigabitEthernet1/0/36.1105	Eth VLAN 1105	10.11.11.11	1105	STANDBY

Feature History for Ethernet-over-MPLS and Pseudowire Redundancy

This table provides release and related information for the features explained in this module.

These features are available in all the releases subsequent to the one they were introduced in, unless noted otherwise.

Release	Feature	Feature Information
Cisco IOS XE Everest 16.6.1	Ethernet-over-MPLS and Pseudowire Redundancy	<p>Ethernet-over-MPLS is one of the Any Transport over MPLS (AToM) transport types. EoMPLS works by encapsulating Ethernet protocol data units (PDUs) in MPLS packets and forwarding them across the MPLS network. Each PDU is transported as a single packet.</p> <p>The L2VPN pseudowire redundancy feature enables you to configure your network to detect a failure in the network and reroute the Layer 2 service to another endpoint that can continue to provide service.</p> <p>Port mode support is introduced.</p> <p>Support for this feature was introduced only on the C9500-12Q, C9500-16X, C9500-24Q, C9500-40X models of the Cisco Catalyst 9500 Series Switches.</p>

Release	Feature	Feature Information
Cisco IOS XE Fuji 16.9.1	Ethernet-over-MPLS and Pseudowire Redundancy	Support for this feature was introduced only on the C9500-32C, C9500-32QC, C9500-48Y4C, and C9500-24Y4C models of the Cisco Catalyst 9500 Series Switches.
Cisco IOS XE Gibraltar 16.12.1	VLAN support for Ethernet-over-MPLS	EoMPLS VLAN mode can be configured using either the Xconnect mode or protocol-CLI method.

Use the Cisco Feature Navigator to find information about platform and software image support. To access Cisco Feature Navigator, go to <https://cfng.cisco.com/>

<http://www.cisco.com/go/cfn>.

