Configuring Ethernet-over-MPLS and Pseudowire Redundancy

Configuring Ethernet-over-MPLS

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

Information About EoMPLS

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.

Only the following mode is 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.

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 EoMPLS

- VLAN mode is not supported. Ethernet Flow Point is not supported.
- QoS : Customer DSCP Re-marking is not supported with VPWS and EoMPLS.
- VCCV Ping with explicit null is not supported.
- L2 VPN Interworking is not supported.
- L2 Protocol Tunneling CLI is not supported.
- Untagged, tagged and 802.1Q in 802.1Q are supported as incoming traffic.

Note Flow Load balance for 802.1Q in 802.1Q over EoMPLS is not supported.

- Flow Aware Transport Pseudowire Redundancy (FAT PW) is supported only in Protocol-CLI mode. Supported load balancing parameters are Source IP, Source MAC address, Destination IP and Destination MAC address.
- Enabling or disabling Control word is supported.
- MPLS QoS is supported in Pipe and Uniform Mode. Default mode is Pipe Mode.
- Both – the legacy xconnect and Protocol-CLI (interface pseudowire configuration) modes are supported.
- 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 between CE devices.
- By default, EoMPLS PW tunnels all protocols like CDP, STP. EoMPLS PW cannot perform selective protocol tunneling as part of L2 Protocol Tunneling CLI.

Configuring Port-Mode EoMPLS

Port-Mode EoMPLS can be configured in two modes :

- Xconnect Mode
- Protocol CLI Method

Xconnect Mode

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

Procedure

	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** *interface-id* **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** *peer-device-id vc-id* **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:

Procedure

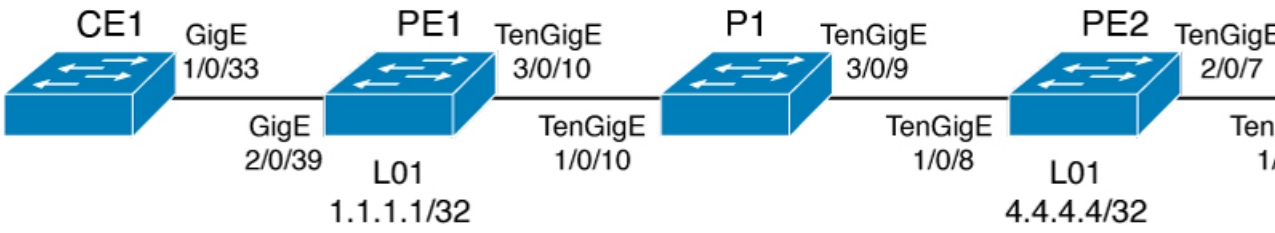
	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**port-channel load-balance dst-ip** **Example:** `Device(config)# port-channel load-balance dst-ip`	Sets the load distribution method to the destination IP address.
Step 4	**interface** *interface-id* **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.

	Command or Action	Purpose
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** *number* **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.
Step 11	**neighbor** *peer-ip-addr vc-id* **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** *context-name* **Example:** `Device(config-if)# l2vpn xconnect context vpws17`	Creates an L2VPN cross connect context and enters Xconnect context configuration mode.

	Command or Action	Purpose
Step 13	**member** *interface-id* **Example:** `Device(config-if-xconn)# member TenGigabitEthernet1/0/21`	Specifies interface that forms an L2VPN cross connect.
Step 14	**member pseudowire** *number* **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.

Configuration Examples for EoMPLS

Figure 1: EoMPLS Topology



PE Configuration	CE Configuration
mpls ip mpls label protocol ldp mpls ldp graceful-restart mpls ldp router-id loopback 1 force interface Loopback1 ip address 1.1.1.1 255.255.255.255 ip ospf 100 area 0 router ospf 100 router-id 1.1.1.1 nsf system mtu 9198 port-channel load-balance dst-ip ! interface GigabitEthernet2/0/39 no switchport no ip address no keepalive ! interface pseudowire101 encapsulation mpls neighbor 4.4.4.4 101 load-balance flow ip dst-ip load-balance flow-label both l2vpn xconnect context pw101 member pseudowire101 member GigabitEthernet2/0/39 ! interface TenGigabitEthernet3/0/10 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 142.1.1.1 255.255.255.0 ip ospf 100 area 0 mpls ip mpls label protocol ldp !	interface GigabitEthernet1/0/33 switchport trunk allowed vlan 912 switchport mode trunk spanning-tree portfast trunk ! interface Vlan912 ip address 10.91.2.3 255.255.255.0 !

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

```
Local interface: Gi1/0/1 up, line protocol up, Ethernet up
 Destination address: 1.1.1.1, VC ID: 101, VC status: up
Output interface: Vl182, imposed label stack {17 16}
Preferred path: not configured
Default path: active
Next hop: 182.1.1.1
Load Balance: ECMP
flow classification: ip dst-ip
Create time: 06:22:11, last status change time: 05:58:42
Last label FSM state change time: 05:58:42  Signaling protocol:
LDP, peer 1.1.1.1:0 up
Targeted Hello: 4.4.4.4(LDP Id) -> 1.1.1.1, LDP is UP
```

```
Graceful restart: not configured and not 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 512, remote 16
Group ID: local n/a, remote 0
MTU: local 9198, remote 9198
Remote interface description:   Sequencing: receive disabled, send disabled
Control Word: On (configured: autosense)
SSO Descriptor: 1.1.1.1/101, local label: 512
Dataplane:
SSM segment/switch IDs: 4096/4096 (used), PWID: 1
VC statistics:    transit packet totals: receive 172116845, send 172105364
transit byte totals:   receive 176837217071, send 172103349728
 transit packet drops:  receive 0, seq error 0, send 0
```

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

```
pseudowire101 is up, VC status is up PW type: Ethernet
Create time: 06:30:41, last status change time: 06:07:12
Last label FSM state change time: 06:07:12
Destination address: 1.1.1.1 VC ID: 101
Output interface: Vl182, imposed label stack {17 16}
 Preferred path: not configured
 Default path: active    Next hop: 182.1.1.1
Load Balance: ECMP  Flow classification: ip dst-ip
Member of xconnect service pw101
Associated member Gi1/0/1 is up, status is up
Interworking type is Like2Like    Service id: 0xe5000001
Signaling protocol: LDP, peer 1.1.1.1:0 up
Targeted Hello: 4.4.4.4(LDP Id) -> 1.1.1.1, LDP is UP
Graceful restart: not configured and not enabled
Non stop routing: not configured and not enabled
PWid FEC (128), VC ID: 101    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        512                            16
Group ID     n/a                            0
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
Flow Label   T=1, R=1                       T=1, R=1
SSO Descriptor: 1.1.1.1/101, local label: 512
Dataplane:
SSM segment/switch IDs: 4096/4096 (used), PWID: 1
Rx Counters    176196691 input transit packets, 181028952597 bytes
 0 drops, 0 seq err
Tx Counters    176184928 output transit packets, 176182865992 bytes
0 drops
```

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

```
Local      Outgoing   Prefix           Bytes Label   Outgoing   Next Hop
Label      Label      or Tunnel Id     Switched      interface
57         18         1.1.1.1/32       0             Po45       145.1.1.1
           No Label   1.1.1.1/32       0             Te1/0/2    147.1.1.1
           No Label   1.1.1.1/32       0             Te1/0/11   149.1.1.1
           No Label   1.1.1.1/32       0             Te1/0/40   155.1.1.1
```

Configuring Pseudowire Redundancy

This section provides information about how to configure pseudowire redundancy.

Overview of 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.

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

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

- VLAN mode, EFP (Ethernet Flow Point) and IGMP Snooping is not supported.
- PWR is supported with port mode EoMPLS only.
- Untagged, tagged and 802.1Q in 802.1Q are supported as incoming traffic.

Note Load balance for 802.1Q in 802.1Q with Pseudowire Redundancy is not supported.

- Flow Label for ECMP Load balancing in core network based on customer's source IP, destination IP, source MAC and destination MAC.
- Enabling or disabling Control word is supported.
- MPLS QoS is supported in Pipe and Uniform Mode. Default mode is Pipe Mode.
- Port-channel as attachment circuit is not supported.
- QoS : Customer DSCP Re-marking is not supported with VPWS and EoMPLS.
- VCCV Ping with explicit null is not supported.
- L2 VPN Interworking is not supported.
- **ip unnumbered** command is not supported in MPLS configuration.
- Not more than one backup pseudowire supported.
- PW redundancy group switchover is not supported

Configuring Pseudowire Redundancy

Pseudowire Redundancy can be configured in two modes :

- Xconnect Mode
- 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.

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface** *interface-id* **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.
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.
Step 7	**xconnect** *peer-device-id vc-id* **encapsulation mpls** **Example:** `Device(config-if)# xconnect 10.1.1.1 117 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 8	**backup peer** *peer-router-ip-addr* **vcid** *vc-id* [**priority** *value*] **Example:** `Device(config-if)# backup peer`	Specifies a redundant peer for a pseudowire VC.

	Command or Action	Purpose
	`10.11.11.11 118 priority 9`	
Step 9	**end** **Example:** `Device(config)# end`	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:

Procedure

	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** *interface-id* **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** *number-active* **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** *active-peer-ip-addr vc-id* **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.

	Command or Action	Purpose
Step 13	**interface pseudowire** *number-standby* **Example:** `Device(config)# interface pseudowire 18`	Establishes a standby pseudowire interface with a value that you specify and enters pseudowire configuration mode.
Step 14	**encapsulation mpls** **Example:** `Device(config-if)# encapsulation mpls`	Specifies the tunneling encapsulation.
Step 15	**neighbor** *standby-peer-ip-addr vc-id* **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** *context-name* **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** *interface-id* **Example:** `Device(config-if-xconn)# member TenGigabitEthernet1/0/36`	Specifies interface that forms a L2VPN cross connect.
Step 18	**member pseudowire** *number-active* **group** *group-name* [**priority** *value*] **Example:** `Device(config-if-xconn)# member pseudowire 17 group pwr10`	Specifies active pseudowire interface that forms a L2VPN cross connect.
Step 19	**member pseudowire** *number-standby* **group** *group-name* [**priority** *value*] **Example:**	Specifies standby pseudowire interface that forms a L2VPN cross connect.

	Command or Action	Purpose
	`Device(config-if-xconn)# member pseudowire 18 group pwr10 priority 6`	
Step 20	**end** **Example:** `Device(config-if-xconn)# end`	Exits Xconnect configuration mode and returns to privileged EXEC mode.

Configuration Examples for Pseudowire Redundancy

PE Configuration	CE Configuration
mpls ip mpls label protocol ldp mpls ldp graceful-restart mpls ldp router-id loopback 1 force ! interface Loopback1 ip address 1.1.1.1 255.255.255.255 ip ospf 100 area 0 router ospf 100 router-id 1.1.1.1 nsf ! interface GigabitEthernet2/0/39 no switchport no ip address no keepalive ! interface pseudowire101 encapsulation mpls neighbor 4.4.4.4 101 ! interface pseudowire102 encapsulation mpls neighbor 3.3.3.3 101 l2vpn xconnect context pw101 member pseudowire101 group pwgrp1 priority 1 member pseudowire102 group pwgrp1 priority 15 member GigabitEthernet2/0/39 ! interface TenGigabitEthernet3/0/10 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 142.1.1.1 255.255.255.0 ip ospf 100 area 0 mpls ip mpls label protocol ldp !	interface GigabitEthernet1/0/33 switchport trunk allowed vlan 912 switchport mode trunk spanning-tree portfast trunk ! interface Vlan912 ip address 10.91.2.3 255.255.255.0 !

The following is 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
-------------- -------------------------- ---------------      ---------- ----------
Gi2/0/39       Ethernet                   4.4.4.4              101        UP


Device# show mpls l2transport vc 102
Local intf     Local circuit              Dest address         VC ID      Status
-------------- -------------------------- ---------------      ---------- ----------
```

```
Gi2/0/39       Ethernet                 3.3.3.3             102         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	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. 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. Port mode support is introduced.

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

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