



Configure Point-to-Point Layer 2 Services

This section introduces you to point-to-point Layer 2 services, and also describes the configuration procedures to implement it.

The following point-to-point services are supported:

- Local Switching—A point-to-point internal circuit on a router, also known as local connect.
- Attachment circuit—A connection between a PE-CE router pair.
- Pseudowires—A virtual point-to-point circuit from one PE router to another. Pseudowires are implemented over the MPLS network.



Note

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

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Ethernet over MPLS

Ethernet-over-MPLS (EoMPLS) provides a tunneling mechanism for Ethernet traffic through an MPLS-enabled Layer 3 core, and encapsulates Ethernet protocol data units (PDUs) inside MPLS packets (using label stacking) to forward them across the MPLS network.

The following sections describe the different modes of implementing EoMPLS.

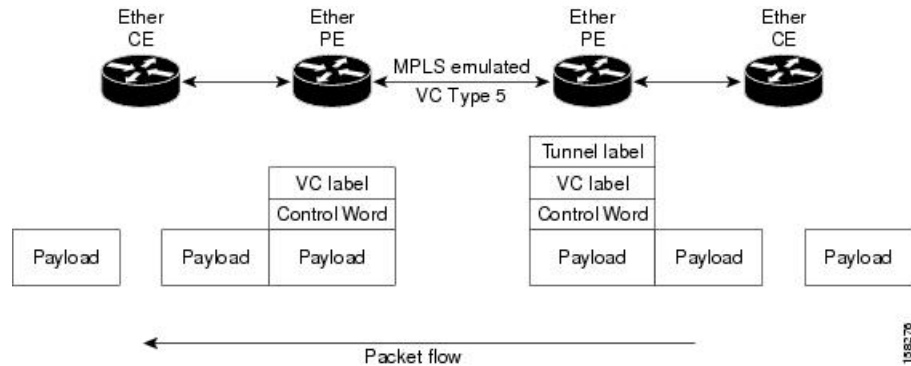
Ethernet Port Mode

In Ethernet port mode, both ends of a pseudowire are connected to Ethernet ports. In this mode, the port is tunneled over the pseudowire or, using local switching (also known as an *attachment circuit-to-attachment*

circuit cross-connect) switches packets or frames from one attachment circuit (AC) to another AC attached to the same PE node.

This figure shows a sample ethernet port mode packet flow:

Figure 1: Ethernet Port Mode Packet Flow

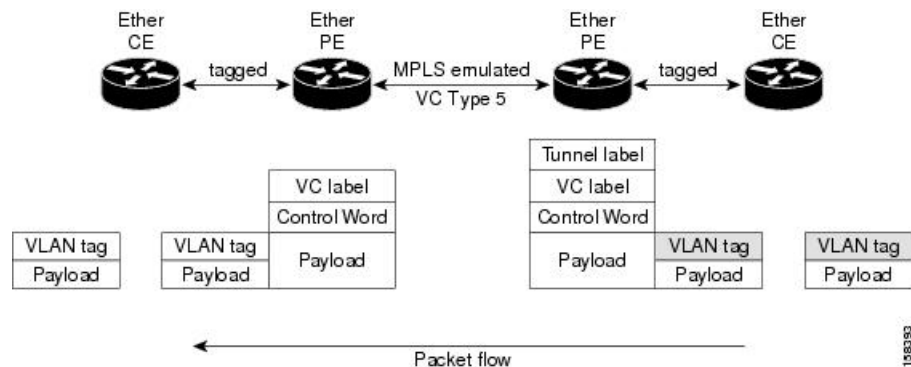


VLAN Mode

In VLAN mode, each VLAN on a customer-end to provider-end link can be configured as a separate L2VPN connection using virtual connection (VC) type 4 or VC type 5. VC type 5 is the default mode.

As illustrated in the following figure, the Ethernet PE associates an internal VLAN-tag to the Ethernet port for switching the traffic internally from the ingress port to the pseudowire; however, before moving traffic into the pseudowire, it removes the internal VLAN tag.

Figure 2: VLAN Mode Packet Flow



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



Note

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

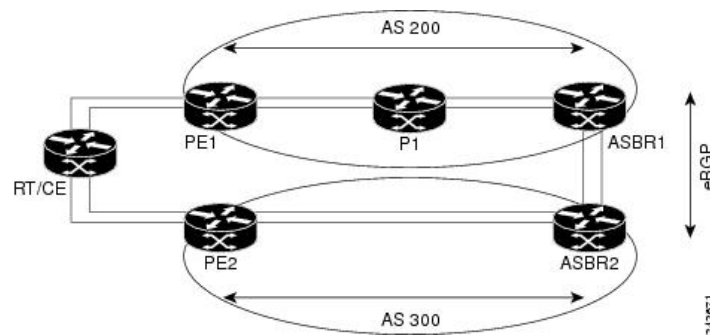
Inter-AS Mode

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

EoMPLS support can assume a single AS topology where the pseudowire connecting the PE routers at the two ends of the point-to-point EoMPLS cross-connects resides in the same autonomous system; or multiple AS topologies in which PE routers can reside on two different ASs using iBGP and eBGP peering.

The following figure illustrates MPLS over Inter-AS with a basic double AS topology with iBGP/LDP in each AS.

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



QinQ Mode

QinQ is an extension of 802.1Q for specifying multiple 802.1Q tags (IEEE 802.1QinQ VLAN Tag stacking). Layer 3 VPN service termination and L2VPN service transport are enabled over QinQ sub-interfaces.

Cisco NCS 500x Series Router implement the Layer 2 tunneling or Layer 3 forwarding depending on the sub-interface configuration at provider edge routers. This function only supports up to two QinQ tags on the router:

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

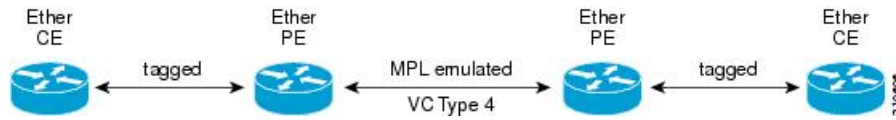
Layer 3 services over QinQ include:

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

In QinQ mode, each CE VLAN is carried into an SP VLAN. QinQ mode should use VC type 5, but VC type 4 is also supported. On each Ethernet PE, you must configure both the inner (CE VLAN) and outer (SP VLAN).

The following figure illustrates QinQ using VC type 4.

Figure 4: EoMPLS over QinQ Mode



Note EoMPLS does not support pseudowire stitching or multi segments.

QinAny Mode

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

Configure Local Switching Between Attachment Circuits

Local switching involves the exchange of L2 data from one attachment circuit (AC) to the other, and between two interfaces of the same type on the same router. The two ports configured in a local switching connection form an attachment circuit (AC). A local switching connection works like a bridge domain that has only two bridge ports, where traffic enters from one port of the local connection and leaves through the other.

These are some of the characteristics of Layer 2 local switching:

- Layer 2 local switching uses Layer 2 MAC addresses instead of the Layer 3 IP addresses.
- Because there is no bridging involved in a local connection, there is neither MAC learning nor flooding.
- Unlike in a bridge domain, the ACs in a local connection are not in the UP state if the interface state is DOWN.
- Local switching ACs utilize a full variety of Layer 2 interfaces, including Layer 2 trunk (main) interfaces, bundle interfaces, and EFPs.
- Same-port local switching allows you to switch Layer 2 data between two circuits on the same interface.

Restrictions

- All sub-interfaces under the given physical port support only two Tag Protocol Identifiers (TPIDs), such as:
 - 0x88a8, 0x8100
 - 0x9100, 0x8100

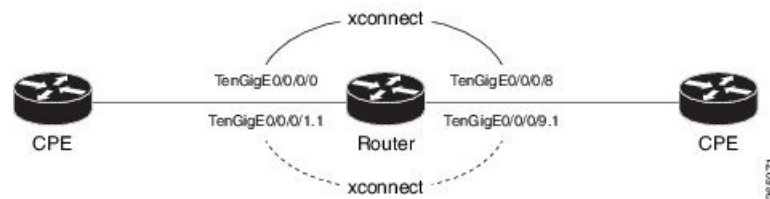
- 0x9200, 0x8100
- VLAN and TPID-based ingress packet filtering is not supported.
- Egress TPID rewrite is not supported.

Topology

An Attachment Circuit (AC) binds a Customer Edge (CE) router to a Provider Edge (PE) router. The PE router uses a pseudowire over the MPLS network to exchange routes with a remote PE router. To establish a point-to-point connection in a Layer 2 VPN from one Customer Edge (CE) router to another (remote router), a mechanism is required to bind the attachment circuit to the pseudowire. A Cross-Connect Circuit (CCC) is used to bind attachment circuits to pseudowires to emulate a point-to-point connection in a Layer 2 VPN.

The following topology is used for configuration.

Figure 5: Local Switching Between Attachment Circuits



Configuration

To configure an AC-AC local switching, complete the following configuration:

- Enable Layer 2 transport on main interfaces.
- Create sub-interfaces with Layer 2 transport enabled, and specify the respective encapsulation for each.
- Enable local switching between the main interfaces, and between the sub-interfaces.
 - Create a cross-connect group.
 - Create a point-to-point cross connect circuit (CCC).
 - Assign interface(s) to the point-to-point cross connect group.

```
/* Enter the interface configuration mode and configure
   L2 transport on the TenGigE interfaces */
Router# configure
Router(config)# interface TenGigE 0/0/0/1 l2transport
Router(config-if-l2)# no shutdown
Router(config-if)# exit
Router(config)# interface TenGigE 0/0/0/9 l2transport
Router(config-if-l2)# no shutdown
Router(config-if-l2)# commit

/* Configure L2 transport and encapsulation on the VLAN sub-interfaces */
Router# configure
Router(config)# interface TenGigE 0/0/0/0.1 l2transport
Router(config-subif)# encapsulation dot1q 5
Router(config-subif)# exit
```

```

Router(config)# interface TenGigE 0/0/0/8.1 l2transport
Router(config-subif)# encapsulation dot1q 5
Router(config-subif)# commit

/* Configure ethernet link bundles */
Router# configure
Router(config)# interface Bundle-Ether 3
Router(config-if)# ipv4 address 10.1.3.3 255.0.0.0
Router(config-if)# bundle maximum-active links 32 hot-standby
Router(config-if)# bundle minimum-active links 1
Router(config-if)# bundle minimum-active bandwidth 30000000
Router(config-if)# exit

Router(config)# interface Bundle-Ether 2
Router(config-if)# ipv4 address 10.1.2.2 255.0.0.0
Router(config-if)# bundle maximum-active links 32 hot-standby
Router(config-if)# bundle minimum-active links 1
Router(config-if)# bundle minimum-active bandwidth 30000000
Router(config-if)# exit

/* Add physical interfaces to the ethernet link bundles */
Router(config)# interface TenGigE 0/0/0/1
Router(config-if)# bundle id 3 mode on
Router(config-if)# no shutdown
Router(config)# exit
Router(config)# interface TenGigE 0/0/0/2
Router(config-if)# bundle id 3 mode on
Router(config-if)# no shutdown
Router(config)# exit
Router(config)# interface TenGigE 0/0/0/9
Router(config-if)# bundle id 2 mode on
Router(config-if)# no shutdown
Router(config-if)# exit
Router(config)# interface TenGigE 0/0/0/8
Router(config-if)# bundle id 2 mode on
Router(config-if)# no shutdown
Router(config-if)# exit

/* Configure Layer 2 transport on the ethernet link bundles */
Router(config)# interface Bundle-Ether 3 l2transport
Router(config-if-l2)# no shutdown
Router(config-if)# exit
Router(config)# interface Bundle-Ether 2 l2transport
Router(config-if-l2)# no shutdown
Router(config-if-l2)# commit

/* Configure local switching on the TenGigE Interfaces */
Router(config)# l2vpn
Router(config-l2vpn)# xconnect group XCON1
Router(config-l2vpn-xc)# p2p XCON1_P2P3
Router(config-l2vpn-xc-p2p)# interface TenGigE0/0/0/1
Router(config-l2vpn-xc-p2p)# interface TenGigE0/0/0/9
Router(config-l2vpn-xc-p2p)# commit
Router(config-l2vpn-xc-p2p)# exit

/* Configure local switching on the VLAN sub-interfaces */
Router(config-l2vpn-xc)# p2p XCON1_P2P1
Router(config-l2vpn-xc-p2p)# interface TenGigE0/0/0/0.1
Router(config-l2vpn-xc-p2p)# interface TenGigE0/0/0/8.1
Router(config-l2vpn-xc-p2p)# commit
Router(config-l2vpn-xc-p2p)# exit

```

```
/* Configure local switching on ethernet link bundles */
Router(config-l2vpn-xc) # p2p XCON1_P2P4
Router(config-l2vpn-xc-p2p) # interface Bundle-Ether 3
Router(config-l2vpn-xc-p2p) # interface Bundle-Ether 2
Router(config-l2vpn-xc-p2p) # commit
```

Running Configuration

```
configure
interface tenGigE 0/0/0/1 l2transport
!
interface tenGigE 0/0/0/9 l2transport
!
!

interface tenGigE 0/0/0/0.1 l2transport
encapsulation dot1q 5
rewrite ingress tag push dot1q 20 symmetric
!
interface tenGigE 0/0/0/8.1 l2transport
encapsulation dot1q 5
!
interface Bundle-Ether 3 l2transport
!
interface Bundle-Ether 2 l2transport
!

l2vpn
xconnect group XCON1
p2p XCON1_P2P3
interface TenGigE0/0/0/1
interface TenGigE0/0/0/9
!
!
!

l2vpn
xconnect group XCON1
p2p XCON1_P2P1
interface TenGigE0/0/0/0.1
interface TenGigE0/0/0/8.1
!
!
!

l2vpn
xconnect group XCON1
p2p XCON1_P2P4
interface Bundle-Ether 3
interface Bundle-Ether 2
!
!
!
```

Verification

- Verify if the configured cross-connect is UP

```
router# show l2vpn xconnect brief
```

Locally Switching

Like-to-Like	UP	DOWN	UNR
EFP	1	0	0
Total	1	0	0
Total	1	0	0

Total: 1 UP, 0 DOWN, 0 UNRESOLVED

router# **show l2vpn xconnect**

Legend: ST = State, UP = Up, DN = Down, AD = Admin Down, UR = Unresolved,
 SB = Standby, SR = Standby Ready, (PP) = Partially Programmed

XConnect Group	Name	ST	Segment 1 Description	ST	Segment 2 Description	ST
XCON1	XCON_P2P1	UP	Te0/0/0/1	UP	Te0/0/0/9	UP
XCON1	XCON_P2P3	UP	Te0/0/0/0.1	UP	Te0/0/0/8.1	UP

Associated Commands

- [interface \(p2p\)](#)
- [l2vpn](#)
- [p2p](#)
- [xconnect group](#)

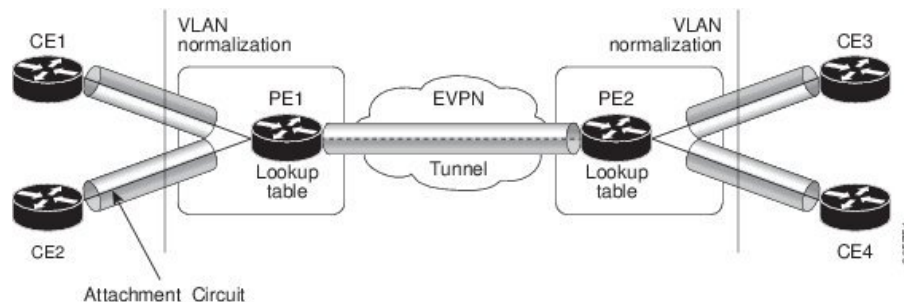
Flexible Cross-Connect Service

The flexible cross-connect service feature enables aggregation of attachment circuits (ACs) across multiple endpoints in a single Ethernet VPN Virtual Private Wire Service (EVPN-VPWS) service instance, on the same Provider Edge (PE). ACs are represented either by a single VLAN tag or double VLAN tags. The associated AC with the same VLAN tag(s) on the remote PE is cross-connected. The VLAN tags define the matching criteria to be used in order to map the frames on an interface to the appropriate service instance. As a result, the VLAN rewrite value must be unique within the flexible cross-connect (FXC) instance to create the lookup table. The VLAN tags can be made unique using the rewrite configuration. The lookup table helps determine the path to be taken to forward the traffic to the corresponding destination AC. This feature reduces the number of tunnels by muxing VLANs across many interfaces. It also reduces the number of MPLS labels used by a router. This feature supports both single-homing and multi-homing.

Flexible Cross-Connect Service - Single-Homed

Consider the following topology in which the traffic flows from CE1 and CE2 to PE1 through ACs. ACs are aggregated across multiple endpoints on the same PE. The VLAN (rewrite) creates the lookup table based on the rewrite configured at AC interfaces on PE1. PE1 uses BGP to exchange routes with PE2 and creates a tunnel over EVPN MPLS network. The VLANs (rewrite) on PE2 must match the rewrite configured on PE1. Based on the rewrite tag, the PE2 forwards the traffic to the corresponding ACs. For example, if the ACs for CE1 and CE3 are configured with the same rewrite tag, the end-to-end traffic is sent from CE1 to CE3.

Figure 6: Flexible Cross-Connect Service

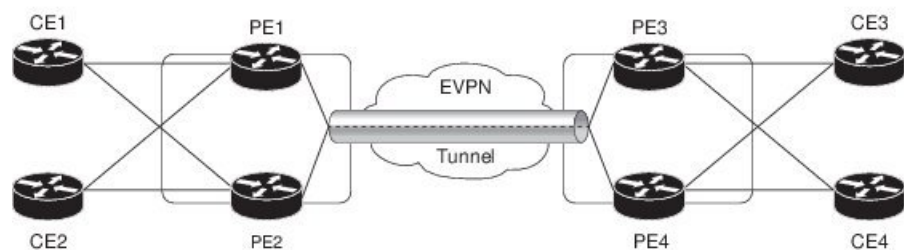


Flexible Cross-Connect Service - Multi-Homed

The Flexible Cross-Connect Service multihoming capability enables you to connect a customer edge (CE) device to two or more provider edge (PE) devices to provide load balancing and redundant connectivity. Flow-based load balancing is used to send the traffic between PEs and CEs. Flow-based load balancing is used to connect source and remote PEs as well. The customer edge device is connected to PE through Ethernet bundle interface.

When a CE device is multi-homed to two or more PEs and when all PEs can forward traffic to and from the multi-homed device for the VLAN, then such multihoming is referred to as all-active multihoming.

Figure 7: Flexible Cross-Connect Service Multi-Homed



Consider the topology in which CE1 and CE2 are multi-homed to PE1 and PE2; CE3 and CE4 are multi-homed to PE3 and PE4. PE1 and PE2 advertise Ethernet A-D Ethernet Segment (ES-EAD) route to remote PEs that is PE3 and PE4. Similarly, PE3 and PE4 advertise ES-EAD route to remote PEs that is PE1 and PE2. The ES-EAD route is advertised per main interface.

Consider a traffic flow from CE1 to CE3. Traffic is sent to either PE1 or PE2. The selection of path is dependent on the CE implementation for forwarding over a LAG. Traffic is encapsulated at each PE and forwarded to the remote PEs (PE 3 and PE4) through the MPLS tunnel. Selection of the destination PE is established by flow-based load balancing. PE3 and PE4 send the traffic to CE3. The selection of path from PE3 or PE4 to CE3 is established by flow-based load balancing.

Flexible Cross-Connect Service Supported Modes

The Flexible Cross-Connect Service feature supports the following modes:

- VLAN Unaware
- VLAN Aware
- Local Switching

VLAN Unaware

In this mode of operation, a group of normalized ACs on a single ES that are destined to a single endpoint or interface are multiplexed into a single EVPN VPWS tunnel represented by a single VPWS service ID. The VLAN-Unaware FXC reduces the number of BGP states. VLAN failure is not signaled over BGP. One EVI/EAD route is advertised per VLAN-Unaware FXC rather than per AC. In multihoming scenario, there will be ES-EAD route as well. EVI can be shared with other VLAN-Unaware FXC or EVPN VPWS. If AC goes down on PE1, the remote PE is not be informed of the failure, and PE3 or PE4 continues to send the traffic to PE1 and PE2 resulting in packet drop.

Multihoming is supported on VLAN Unaware FXC only if all ACs belong to the same main interface.

If you have multiple ESIs, regardless of whether it is a zero-ESI or non-zero ESI, only ESI 0 is signalled. Only single-home mode is supported in this scenario.

Configure Single-Homed Flexible Cross-Connect Service using VLAN Unaware

This section describes how you can configure single-homed flexible cross-connect service using VLAN unaware

```
/* Configure PE1 */
Router# configure
Router(config)# interface GigabitEthernet 0/2/0/3.1 l2transport
Router(config-l2vpn-subif)# encapsulation dot1q 1
Router(config-l2vpn-subif)# rewrite ingress tag translate 1-to-2 dot1q 500 second-dot1q 100
symetric
Router(config-l2vpn-subif)# commit
Router(config-l2vpn-subif)# exit
Router(config)# interface GigabitEthernet 0/2/0/0.1 l2transport
Router(config-l2vpn-subif)# encapsulation dot1q 1
Router(config-l2vpn-subif)# rewrite ingress tag translate 1-to-2 dot1q 600 second-dot1q 200
symetric
Router(config-l2vpn-subif)# commit
Router(config-l2vpn-subif)# exit
Router(config)# l2vpn
Router(config-l2vpn)# flexible-xconnect-service vlan-unaware fxs1
Router(config-l2vpn-fxs-vu)# interface GigabitEthernet 0/2/0/3.1
Router(config-l2vpn-fxs-vu)# interface GigabitEthernet 0/2/0/0.1
Router(config-l2vpn-fxs-vu)# neighbor evpn evi 1 target 1
Router(config-l2vpn-fxs-vu)# commit

/* Configure PE2 */
Router# configure
Router(config)# interface GigabitEthernet 0/0/0/3.1 l2transport
Router(config-l2vpn-subif)# encapsulation dot1q 1
Router(config-l2vpn-subif)# rewrite ingress tag translate 1-to-2 dot1q 500 second-dot1q 100
symetric
```

```

Router(config-l2vpn-subif)# commit
Router(config-l2vpn-subif)# exit
Router(config)# interface GigabitEthernet 0/0/0/0.1 l2transport
Router(config-l2vpn-subif)# encapsulation dot1q 1
Router(config-l2vpn-subif)# rewrite ingress tag translate 1-to-2 dot1q 600 second-dot1q 200
symetric
Router(config-l2vpn-subif)# commit
Router(config-l2vpn-subif)# exit
Router(config)# l2vpn
Router(config-l2vpn)# flexible-xconnect-service vlan-unaware fxs1
Router(config-l2vpn-fxs-vu)# interface GigabitEthernet 0/0/0/3.1
Router(config-l2vpn-fxs-vu)# interface GigabitEthernet 0/0/0/0.1
Router(config-l2vpn-fxs-vu)# neighbor evpn evi 1 target 1
Router(config-l2vpn-fxs-vu)# commit

```

Running Configuration

```

/* On PE1 */
!
Configure
interface GigabitEthernet 0/2/0/3.1 l2transport
    encapsulation dot1q 1
    rewrite ingress tag translate 1-to-2 dot1q 500 second-dot1q 100 symetric
!

Configure
interface GigabitEthernet 0/2/0/0.1 l2transport
    encapsulation dot1q 1
    rewrite ingress tag translate 1-to-2 dot1q 600 second-dot1q 200 symetric
!

l2vpn
    flexible-xconnect-service vlan-unaware fxs1
    interface GigabitEthernet 0/2/0/3.1
    interface GigabitEthernet0/2/0/0.1
    neighbor evpn evi 1 target 1

!

/* On PE2 */
!
Configure
interface GigabitEthernet 0/0/0/3.1 l2transport
    encapsulation dot1q 1
    rewrite ingress tag translate 1-to-2 dot1q 500 second-dot1q 100 symetric
!

Configure
interface GigabitEthernet 0/0/0/0.1 l2transport
    encapsulation dot1q 1
    rewrite ingress tag translate 1-to-2 dot1q 600 second-dot1q 200 symetric
!

l2vpn
    flexible-xconnect-service vlan-unaware fxs1
    interface GigabitEthernet 0/0/0/3.1
    interface GigabitEthernet0/0/0/0.1
    neighbor evpn evi 1 target 1

!

```

Configure Multi-Homed Flexible Cross-Connect Service using VLAN Unaware

This section describes how you can configure multi-homed flexible cross-connect service using VLAN unaware.

```

/* Configure PE1 */
Router# configure
Router(config)# l2vpn
Router(config-l2vpn)# flexible-xconnect-service vlan-unaware fxc1_16
Router(config-l2vpn-fxs)# interface Bundle-Ether10.11
Router(config-l2vpn-fxs)# interface Bundle-Ether10.12
Router(config-l2vpn-fxs)# neighbor evpn evi 1 target 16
Router(config-l2vpn-fxs)# commit
Router(config-l2vpn-fxs)# exit
Router(config-l2vpn)# exit
Router(config)# interface Bundle-Ether10.11 l2transport
Router(config-l2vpn-subif)# encapsulation dot1q 1
Router(config-l2vpn-subif)# rewrite ingress tag translate 1-to-1 dot1q 11 symmetric
Router(config-l2vpn-subif)# commit
Router(config-l2vpn-subif)# exit
Router(config)# interface Bundle-Ether10.12 l2transport
Router(config-l2vpn-subif)# encapsulation dot1q 2
Router(config-l2vpn-subif)# rewrite ingress tag translate 1-to-1 dot1q 12 symmetric
Router(config-subif)# commit
Router(config-subif)# exit
Router(config)# evpn
Router (config-evpn)# interface Bundle-Ether10
Router (config-evpn-ac)# ethernet-segment
Router (config-evpn-ac-es)# identifier type 0 00.01.00.ac.ce.55.00.0a.00
Router (config-evpn-ac-es)# commit

/* Configure PE2 */
Router# configure
Router(config)# l2vpn
Router(config-l2vpn)# flexible-xconnect-service vlan-unaware fxc1_16
Router(config-l2vpn-fxs-vu)# interface Bundle-Ether10.11
Router(config-l2vpn-fxs)# interface Bundle-Ether10.12
Router(config-l2vpn-fxs)# neighbor evpn evi 1 target 16
Router(config-l2vpn-fxs)# commit
Router(config-l2vpn-fxs)# exit
Router(config-l2vpn)# exit
Router(config)# interface Bundle-Ether10.11 l2transport
Router(config-l2vpn-subif)# encapsulation dot1q 1
Router(config-l2vpn-subif)# rewrite ingress tag translate 1-to-1 dot1q 11 symmetric
Router(config-l2vpn-subif)# commit
Router(config-l2vpn-subif)# exit
Router(config)# interface Bundle-Ether10.12 l2transport
Router(config-l2vpn-subif)# encapsulation dot1q 2
Router(config-l2vpn-subif)# rewrite ingress tag translate 1-to-1 dot1q 12 symmetric
Router(config-subif)# commit
Router(config-subif)# exit
Router(config)# evpn
Router (config-evpn)# interface Bundle-Ether10
Router (config-evpn-ac)# ethernet-segment
Router (config-evpn-ac-es)# identifier type 0 00.01.00.ac.ce.55.00.0a.00
Router (config-evpn-ac-es)# commit

/* Configure PE3 */
Router# configure
Router(config)# l2vpn
Router(config-l2vpn)# flexible-xconnect-service vlan-unaware fxc1_16
Router(config-l2vpn-fxs-vu)# interface Bundle-Ether20.11
Router(config-l2vpn-fxs)# interface Bundle-Ether20.12

```

```

Router(config-l2vpn-fxs)# neighbor evpn evi 1 target 16
Router(config-l2vpn-fxs)# commit
Router(config-l2vpn-fxs)# exit
Router(config-l2vpn)# exit
Router(config)# interface Bundle-Ether20.11 l2transport
Router(config-l2vpn-subif)# encapsulation dot1q 1
Router(config-l2vpn-subif)# rewrite ingress tag translate 1-to-1 dot1q 11 symmetric
Router(config-l2vpn-subif)# commit
Router(config-subif)# exit
Router(config)# interface Bundle-Ether20.12 l2transport
Router(config-l2vpn-subif)# encapsulation dot1q 2
Router(config-l2vpn-subif)# rewrite ingress tag translate 1-to-1 dot1q 12 symmetric
Router(config-l2vpn-subif)# commit
Router(config-subif)# exit
Router(config)# evpn
Router (config-evpn)# interface Bundle-Ether20
Router (config-evpn-ac)# ethernet-segment
Router (config-evpn-ac-es)# identifier type 0 00.01.00.ac.ce.55.00.14.00
Router (config-evpn-ac-es)# commit

/* Configure PE4 */
Router# configure
Router(config)# l2vpn
Router(config-l2vpn)# flexible-xconnect-service vlan-unaware fxc1_16
Router(config-l2vpn-fxs-vu)# interface Bundle-Ether20.11
Router(config-l2vpn-fxs)# interface Bundle-Ether20.12
Router(config-l2vpn-fxs)# neighbor evpn evi 1 target 16
Router(config-l2vpn-fxs)# commit
Router(config-l2vpn-fxs)# exit
Router(config-l2vpn)# exit
Router(config)# interface Bundle-Ether20.11 l2transport
Router(config-l2vpn-subif)# encapsulation dot1q 1
Router(config-l2vpn-subif)# rewrite ingress tag translate 1-to-1 dot1q 11 symmetric
Router(config-l2vpn-subif)# commit
Router(config-subif)# exit
Router(config)# interface Bundle-Ether20.12 l2transport
Router(config-l2vpn-subif)# encapsulation dot1q 2
Router(config-l2vpn-subif)# rewrite ingress tag translate 1-to-1 dot1q 12 symmetric
Router(config-l2vpn-subif)# commit
Router(config-subif)# exit
Router(config)# evpn
Router (config-evpn)# interface Bundle-Ether20
Router (config-evpn-ac)# ethernet-segment
Router (config-evpn-ac-es)# identifier type 0 00.01.00.ac.ce.55.00.14.00
Router (config-evpn-ac-es)# commit

```

Running Configuration

```

/* On PE1 */

configure
l2vpn
flexible-xconnect-service vlan-unaware fxc1_16
interface Bundle-Ether10.11
interface Bundle-Ether10.12
neighbor evpn evi 1 target 16

!

configure
interface Bundle-Ether10.11 l2transport
encapsulation dot1q 1

```

```

rewrite ingress tag translate 1-to-1 dot1q 11 symmetric
!

configure
interface Bundle-Ether10.12 l2transport
encapsulation dot1q 2
rewrite ingress tag translate 1-to-1 dot1q 12 symmetric
!

evpn
interface Bundle-Ether10
ethernet-segment identifier type 0 00.01.00.ac.ce.55.00.0a.00
!

/* On PE2 */

configure
l2vpn
flexible-xconnect-service vlan-unaware fxc1_16
interface Bundle-Ether10.11
interface Bundle-Ether10.12
neighbor evpn evi 1 target 16
!

configure
interface Bundle-Ether10.11 l2transport
encapsulation dot1q 1
rewrite ingress tag translate 1-to-1 dot1q 11 symmetric
!

configure
interface Bundle-Ether10.12 l2transport
encapsulation dot1q 2
rewrite ingress tag translate 1-to-1 dot1q 12 symmetric
!

evpn
interface Bundle-Ether10
ethernet-segment identifier type 0 00.01.00.ac.ce.55.00.0a.00
!

/* On PE3 */

configure
l2vpn
flexible-xconnect-service vlan-unaware fxc1_16
interface Bundle-Ether20.11
interface Bundle-Ether20.12
neighbor evpn evi 1 target 16
!

configure
interface Bundle-Ether20.11 l2transport
encapsulation dot1q 1

```

```

        rewrite ingress tag translate 1-to-1 dot1q 11 symmetric
    !

    configure
    interface Bundle-Ether20.12 l2transport
        encapsulation dot1q 2
        rewrite ingress tag translate 1-to-1 dot1q 12 symmetric
    !

    evpn
        interface Bundle-Ether20
            ethernet-segment identifier type 0 00.01.00.ac.ce.55.00.14.00
    !

/* On PE4 */

    configure
    l2vpn
        flexible-xconnect-service vlan-unaware fxc1_16
        interface Bundle-Ether20.11
        interface Bundle-Ether20.12
        neighbor evpn evi 1 target 16
    !

    configure
    interface Bundle-Ether20.11 l2transport
        encapsulation dot1q 1
        rewrite ingress tag translate 1-to-1 dot1q 11 symmetric
    !

    configure
    interface Bundle-Ether20.12 l2transport
        encapsulation dot1q 2
        rewrite ingress tag translate 1-to-1 dot1q 12 symmetric
    !

    evpn
        interface Bundle-Ether20
            ethernet-segment identifier type 0 00.01.00.ac.ce.55.00.14.00
    !

```

VLAN Aware

In this mode of operation, normalized ACs across different Ethernet segments and interfaces are multiplexed into a single EVPN VPWS service tunnel. This single tunnel is represented by many VPWS service IDs (one per normalized VLAN ID (VID)) and these normalized VIDs are signaled using EVPN BGP. The VLAN-Aware FXC reduces the number of PWs; but it does not reduce the BGP states. VLAN failure is signaled over BGP. The VLAN-Aware FXC advertises one EAD route per AC rather than per FXC. For VLAN-Aware FXC, the EVI must be unique to the FXC itself. It cannot be shared with any other service such as FXC, EVPN, EVPN-VPWS, PBB-EVPN. If a single AC goes down on PE1, it withdraws only the EAD routes associated with that AC. The ES-EAD route will also be withdrawn on failure of the main interface. The equal-cost multipath (ECMP) on PE3 or PE4 stops sending traffic for this AC to PE1, and only sends it to PE2.

For the same VLAN-Aware FXC, you can either configure all non-zero ESIs or all zero-ESIs. You cannot configure both zero-ESI and non-zero ESI for the same VLAN-Aware FXC. This applies only to single-home mode.

Configure Single-Homed Flexible Cross-Connect using VLAN Aware

This section describes how you can configure single-homed flexible cross-connect service using VLAN aware.

```
/* Configure PE1 */
Router# configure
Router(config)# interface GigabitEthernet 0/2/0/7.1 l2transport
Router(config-l2vpn-subif)# encapsulation dot1q 1
Router(config-l2vpn-subif)# rewrite ingress tag translate 1-to-2 dot1q 500 second-dot1q 100
symetric
Router(config-l2vpn-subif)# commit
Router(config-l2vpn-subif)# exit
Router(config)# interface GigabitEthernet 0/2/0/7.2 l2transport
Router(config-l2vpn-subif)# encapsulation dot1q 2
Router(config-l2vpn-subif)# rewrite ingress tag translate 1-to-2 dot1q 600 second-dot1q 200
symetric
Router(config-l2vpn-subif)# commit
Router(config-l2vpn-subif)# exit
Router(config)# l2vpn
Router(config-l2vpn)# flexible-xconnect-service vlan-aware evi 4
Router(config-l2vpn-fxs-va)# interface GigabitEthernet 0/2/0/7.1
Router(config-l2vpn-fxs-va)# interface GigabitEthernet 0/2/0/7.2
Router(config-l2vpn-fxs-va)# commit

/* Configure PE2 */
Router# configure
Router(config)# interface GigabitEthernet 0/0/0/7.1 l2transport
Router(config-l2vpn-subif)# encapsulation dot1q 1
Router(config-l2vpn-subif)# rewrite ingress tag translate 1-to-2 dot1q 500 second-dot1q 100
symetric
Router(config-l2vpn-subif)# commit
Router(config-l2vpn-subif)# exit
Router(config)# interface GigabitEthernet 0/0/0/7.2 l2transport
Router(config-l2vpn-subif)# encapsulation dot1q 2
Router(config-l2vpn-subif)# rewrite ingress tag translate 1-to-2 dot1q 600 second-dot1q 200
symetric
Router(config-l2vpn-subif)# commit
Router(config-l2vpn-subif)# exit
Router(config)# l2vpn
Router(config-l2vpn)# flexible-xconnect-service vlan-aware evi 4
Router(config-l2vpn-fxs-va)# interface GigabitEthernet 0/0/0/7.1
Router(config-l2vpn-fxs-va)# interface GigabitEthernet 0/0/0/7.2
Router(config-l2vpn-fxs-va)# commit
```

Running Configuration

```
/* On PE1 */
!
Configure
interface GigabitEthernet 0/2/0/7.1 l2transport
    encapsulation dot1q 1
    rewrite ingress tag translate 1-to-2 dot1q 500 second-dot1q 100 symetric
!

Configure
interface GigabitEthernet 0/2/0/7.2 l2transport
    encapsulation dot1q 2
    rewrite ingress tag translate 1-to-2 dot1q 600 second-dot1q 200 symetric
```



```

!

l2vpn
flexible-xconnect-service vlan-aware evi 4
interface GigabitEthernet 0/2/0/7.1
interface GigabitEthernet 0/2/0/7.2

!

/* On PE2 */
!
Configure
interface GigabitEthernet 0/0/0/7.1 l2transport
encapsulation dot1q 1
rewrite ingress tag translate 1-to-2 dot1q 500 second-dot1q 100 symmetric
!

Configure
interface GigabitEthernet 0/0/0/7.2 l2transport
encapsulation dot1q 2
rewrite ingress tag translate 1-to-2 dot1q 600 second-dot1q 200 symmetric
!

l2vpn
flexible-xconnect-service vlan-aware evi 4
interface GigabitEthernet 0/0/0/7.1
interface GigabitEthernet 0/0/0/7.2

!

```

Configure Multi-Homed Flexible Cross-Connect Service using VLAN Aware

This section describes how you can configure multi-homed flexible cross-connect service using VLAN aware.

```

/* Configure PE1 */
Router# configure
Router(config)# l2vpn
Router(config-l2vpn)# flexible-xconnect-service vlan-aware evi 6
Router(config-l2vpn-fxs-va)# interface Bundle-Ether2.1
Router(config-l2vpn-fxs-va)# interface Bundle-Ether3.1
Router(config-l2vpn-fxs-va)# commit
Router(config-l2vpn-fxs-va)# exit
Router(config-l2vpn)# exit
Router(config)# interface Bundle-Ether2.1 l2transport
Router(config-l2vpn-subif)# encapsulation dot1q 1
Router(config-l2vpn-subif)# rewrite ingress tag translate 1-to-1 dot1q 11 symmetric
Router(config-l2vpn-subif)# commit
Router(config-l2vpn-subif)# exit
Router(config)# interface Bundle-Ether3.1 l2transport
Router(config-l2vpn-subif)# encapsulation dot1q 2
Router(config-l2vpn-subif)# rewrite ingress tag translate 1-to-1 dot1q 12 symmetric
Router(config-l2vpn-subif)# commit
Router(config-l2vpn-subif)# exit
Router(config)# evpn
Router(config-evpn)# interface Bundle-Ether2
Router(config-evpn-ac)# ethernet-segment
Router(config-evpn-ac-es)# identifier type 0 22.33.44.55.66.77.88.99.aa
Router(config-evpn-ac-es)# commit
Router(config-evpn-ac-es)# exit
Router(config-evpn-ac)# exit
Router(config-evpn)# interface Bundle-Ether3
Router(config-evpn-ac)# ethernet-segment

```

```

Router(config-evpn-ac-es)# identifier type 0 33.44.55.66.77.88.99.aa.bb
Router(config-evpn-ac-es)# commit

/* Configure PE2 */
Router# configure
Router(config)# l2vpn
Router(config-l2vpn)# flexible-xconnect-service vlan-aware evi 6
Router(config-l2vpn-fxs-va)# interface Bundle-Ether2.1
Router(config-l2vpn-fxs-va)# interface Bundle-Ether3.1
Router(config-l2vpn-fxs-va)# commit
Router(config-l2vpn-fxs-va)# exit
Router(config-l2vpn)# exit
Router(config)# interface Bundle-Ether2.1 l2transport
Router(config-l2vpn-subif)# encapsulation dot1q 1
Router(config-l2vpn-subif)# rewrite ingress tag translate 1-to-1 dot1q 11 symmetric
Router(config-l2vpn-subif)# commit
Router(config-l2vpn-subif)# exit
Router(config)# interface Bundle-Ether3.1 l2transport
Router(config-l2vpn-subif)# encapsulation dot1q 2
Router(config-l2vpn-subif)# rewrite ingress tag translate 1-to-1 dot1q 12 symmetric
Router(config-l2vpn-subif)# commit
Router(config-l2vpn-subif)# exit
Router(config)# evpn
Router(config-evpn)# interface Bundle-Ether2
Router(config-evpn-ac)# ethernet-segment
Router(config-evpn-ac-es)# identifier type 0 22.33.44.55.66.77.88.99.aa
Router(config-evpn-ac-es)# commit
Router(config-evpn-ac-es)# exit
Router(config-evpn-ac)# exit
Router(config-evpn)# interface Bundle-Ether3
Router(config-evpn-ac)# ethernet-segment
Router(config-evpn-ac-es)# identifier type 0 33.44.55.66.77.88.99.aa.bb
Router(config-evpn-ac-es)# commit

/* Configure PE3 */
Router# configure
Router(config)# l2vpn
Router(config-l2vpn)# flexible-xconnect-service vlan-aware evi 6
Router(config-l2vpn-fxs-va)# interface Bundle-Ether4.1
Router(config-l2vpn-fxs-va)# interface Bundle-Ether5.1
Router(config-l2vpn-fxs-va)# commit
Router(config-l2vpn-fxs-va)# exit
Router(config-l2vpn)# exit
Router(config)# interface Bundle-Ether4.1 l2transport
Router(config-l2vpn-subif)# encapsulation dot1q 1
Router(config-l2vpn-subif)# rewrite ingress tag translate 1-to-1 dot1q 11 symmetric
Router(config-l2vpn-subif)# commit
Router(config-l2vpn-subif)# exit
Router(config)# interface Bundle-Ether5.1 l2transport
Router(config-l2vpn-subif)# encapsulation dot1q 2
Router(config-l2vpn-subif)# rewrite ingress tag translate 1-to-1 dot1q 12 symmetric
Router(config-l2vpn-subif)# commit
Router(config-l2vpn-subif)# exit
Router(config)# evpn
Router(config-evpn)# interface Bundle-Ether4
Router(config-evpn-ac)# ethernet-segment
Router(config-evpn-ac-es)# identifier type 0 00.01.00.ac.ce.55.00.14.00
Router(config-evpn-ac-es)# commit
Router(config-evpn-ac-es)# exit
Router(config-evpn-ac)# exit
Router(config-evpn)# interface Bundle-Ether5
Router(config-evpn-ac)# ethernet-segment

```

```

Router(config-evpn-ac-es)# identifier type identifier type 0 00.01.00.ac.ce.55.00.15.00
Router(config-evpn-ac-es)# commit

/* Configure PE4 */
Router# configure
Router(config)# l2vpn
Router(config-l2vpn)# flexible-xconnect-service vlan-aware evi 6
Router(config-l2vpn-fxs-va)# interface Bundle-Ether4.1
Router(config-l2vpn-fxs-va)# interface Bundle-Ether5.1
Router(config-l2vpn-fxs-va)# commit
Router(config-l2vpn-fxs-va)# exit
Router(config-l2vpn)# exit
Router(config)# interface Bundle-Ether4.1 l2transport
Router(config-l2vpn-subif)# encapsulation dot1q 1
Router(config-l2vpn-subif)# rewrite ingress tag translate 1-to-1 dot1q 11 symmetric
Router(config-l2vpn-subif)# commit
Router(config-l2vpn-subif)# exit
Router(config)# interface Bundle-Ether5.1 l2transport
Router(config-l2vpn-subif)# encapsulation dot1q 2
Router(config-l2vpn-subif)# rewrite ingress tag translate 1-to-1 dot1q 12 symmetric
Router(config-l2vpn-subif)# commit
Router(config-l2vpn-subif)# exit
Router(config)# evpn
Router(config-evpn)# interface Bundle-Ether4
Router(config-evpn-ac)# ethernet-segment
Router(config-evpn-ac-es)# identifier type 0 00.01.00.ac.ce.55.00.14.00
Router(config-evpn-ac-es)# commit
Router(config-evpn-ac-es)# exit
Router(config-evpn-ac)# exit
Router(config-evpn)# interface Bundle-Ether5
Router(config-evpn-ac)# ethernet-segment
Router(config-evpn-ac-es)# identifier type identifier type 0 00.01.00.ac.ce.55.00.15.00
Router(config-evpn-ac-es)# commit

```

Running Configuration

```

/* On PE1 */
!
configure
l2vpn
    flexible-xconnect-service vlan-aware evi 6
    interface Bundle-Ether2.1
    interface Bundle-Ether3.1

!

configure
interface Bundle-Ether2.1 l2transport
    encapsulation dot1q 1
    rewrite ingress tag translate 1-to-1 dot1q 11 symmetric

!

configure
interface Bundle-Ether3.1 l2transport
    encapsulation dot1q 2
    rewrite ingress tag translate 1-to-1 dot1q 12 symmetric
!

evpn
    interface Bundle-Ether2
    ethernet-segment identifier type 0 22.33.44.55.66.77.88.99.aa
    interface Bundle-Ether3

```

```

        ethernet-segment identifier type 0 33.44.55.66.77.88.99.aa.bb
    !
/* On PE2 */
!
configure
l2vpn
    flexible-xconnect-service vlan-aware evi 6
    interface Bundle-Ether2.1
    interface Bundle-Ether3.1
!
configure
interface Bundle-Ether2.1 l2transport
    encapsulation dot1q 1
    rewrite ingress tag translate 1-to-1 dot1q 11 symmetric
!
configure
interface Bundle-Ether3.1 l2transport
    encapsulation dot1q 2
    rewrite ingress tag translate 1-to-1 dot1q 12 symmetric
!
evpn
    interface Bundle-Ether2
        ethernet-segment identifier type 0 22.33.44.55.66.77.88.99.aa
    interface Bundle-Ether3
        ethernet-segment identifier type 0 33.44.55.66.77.88.99.aa.bb
!
/* On PE3 */
!
configure
l2vpn
    flexible-xconnect-service vlan-aware evi 6
    interface Bundle-Ether4.1
    interface Bundle-Ether5.1
!
configure
interface Bundle-Ether4.1 l2transport
    encapsulation dot1q 1
    rewrite ingress tag translate 1-to-1 dot1q 11 symmetric
!
configure
interface Bundle-Ether5.1 l2transport
    encapsulation dot1q 2
    rewrite ingress tag translate 1-to-1 dot1q 12 symmetric
!
evpn
    interface Bundle-Ether4
        ethernet-segment identifier type 0 00.01.00.ac.ce.55.00.14.00
    interface Bundle-Ether5
        ethernet-segment identifier type 0 00.01.00.ac.ce.55.00.15.00

```

```

!
/* On PE4 */
!
configure
l2vpn
flexible-xconnect-service vlan-aware evi 6
interface Bundle-Ether4.1
interface Bundle-Ether5.1

!

configure
interface Bundle-Ether4.1 l2transport
encapsulation dot1q 1
rewrite ingress tag translate 1-to-1 dot1q 11 symmetric

!

configure
interface Bundle-Ether5.1 l2transport
encapsulation dot1q 2
rewrite ingress tag translate 1-to-1 dot1q 12 symmetric

!

evpn
interface Bundle-Ether4
ethernet-segment identifier type 0 00.01.00.ac.ce.55.00.14.00
interface Bundle-Ether5
ethernet-segment identifier type 0 00.01.00.ac.ce.55.00.15.00

!

```

Local Switching

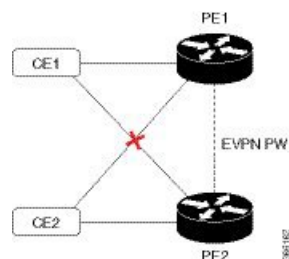
Traffic between the two ACs is locally switched within the PE when two ACs belonging to different Ethernet Segment have the same normalization VLANs. Local switching is supported only on FXC VLAN-aware.

Consider a topology in which CE1 and CE2 have different Ethernet Segment. However, they both have the same normalized VLANs. Hence, when a traffic is sent from CE1 to CE2, PE1 routes the traffic to CE2 using local switching.

If there is a failure and when the link from CE1 to PE1 goes down, PE1 sends the traffic to PE2 through EVPN pseudowire. Then the PE2 sends the traffic to CE2.

CE1 and CE2 must be on different non-zero ESI.

Figure 8: Local Switching



Configure Multi-Homed Flexible Cross-Connect Service using Local Switching

This section describes how you can configure multi-homed flexible cross-connect service using local switching.

```

/* Configure PE1 */
Router# configure
Router(config)# l2vpn
Router(config-l2vpn)# flexible-xconnect-service vlan-aware evi 6
Router(config-l2vpn-fxs-va)# interface Bundle-Ether2.1
Router(config-l2vpn-fxs-va)# interface Bundle-Ether3.1
Router(config-l2vpn-fxs-va)# commit
Router(config-l2vpn-fxs)# exit
Router(config-l2vpn)# exit
Router(config)# interface Bundle-Ether2.1 l2transport
Router(config-l2vpn-subif)# encapsulation dot1q 1
Router(config-l2vpn-subif)# rewrite ingress tag translate 1-to-2 dot1q 3 second-dot1q 3
symmetric
Router(config-l2vpn-subif)# commit
Router(config-l2vpn-subif)# exit
Router(config)# interface Bundle-Ether3.1 l2transport
Router(config-l2vpn-subif)# encapsulation dot1q 1
Router(config-l2vpn-subif)# rewrite ingress tag translate 1-to-2 dot1q 3 second-dot1q 3
symmetric
Router(config-l2vpn-subif)# commit
Router(config-l2vpn-subif)# exit
Router(config)# evpn
Router(config-evpn)# interface Bundle-Ether2
Router(config-evpn-ac)# ethernet-segment
Router(config-evpn-ac-es)# identifier type 0 22.33.44.55.66.77.88.99.aa
Router(config-evpn-ac-es)# commit
Router(config-evpn-ac-es)# exit
Router(config-evpn-ac)# exit
Router(config-evpn)# interface Bundle-Ether3
Router(config-evpn-ac)# ethernet-segment
Router(config-evpn-ac-es)# identifier type 0 33.44.55.66.77.88.99.aa.bb
Router(config-evpn-ac-es)# commit

/* Configure PE2 */
Router# configure
Router(config)# l2vpn
Router(config-l2vpn)# flexible-xconnect-service vlan-aware evi 6
Router(config-l2vpn-fxs-va)# interface Bundle-Ether2.1
Router(config-l2vpn-fxs-va)# interface Bundle-Ether3.1
Router(config-l2vpn-fxs-va)# commit
Router(config-l2vpn-fxs)# exit
Router(config-l2vpn)# exit
Router(config)# interface Bundle-Ether2.1 l2transport
Router(config-l2vpn-subif)# encapsulation dot1q 1
Router(config-l2vpn-subif)# rewrite ingress tag translate 1-to-2 dot1q 3 second-dot1q 3
symmetric
Router(config-l2vpn-subif)# commit
Router(config-l2vpn-subif)# exit
Router(config)# interface Bundle-Ether3.1 l2transport
Router(config-l2vpn-subif)# encapsulation dot1q 1
Router(config-l2vpn-subif)# rewrite ingress tag translate 1-to-2 dot1q 3 second-dot1q 3
symmetric
Router(config-l2vpn-subif)# commit
Router(config-l2vpn-subif)# exit
Router(config)# evpn
Router(config-evpn)# interface Bundle-Ether2
Router(config-evpn-ac)# ethernet-segment
Router(config-evpn-ac-es)# identifier type 0 22.33.44.55.66.77.88.99.aa
Router(config-evpn-ac-es)# commit

```

```

Router(config-evpn-ac-es)# exit
Router(config-evpn-ac)# exit
Router(config-evpn)# interface Bundle-Ether3
Router(config-evpn-ac)# ethernet-segment
Router(config-evpn-ac-es)# identifier type 0 33.44.55.66.77.88.99.aa.bb
Router(config-evpn-ac-es)# commit

```

Running Configuration

```

/* On PE1 */

configure
l2vpn
flexible-xconnect-service vlan-aware evi 6
interface Bundle-Ether2.1
interface Bundle-Ether3.1

!

configure
interface Bundle-Ether2.1 l2transport
encapsulation dot1q 1
rewrite ingress tag translate 1-to-2 dot1q 3 second-dot1q 3 symmetric

!

configure
interface Bundle-Ether3.1 l2transport
encapsulation dot1q 1
rewrite ingress tag translate 1-to-2 dot1q 3 second-dot1q 3 symmetric

!

evpn
interface Bundle-Ether2
ethernet-segment identifier type 0 22.33.44.55.66.77.88.99.aa
interface Bundle-Ether3
ethernet-segment identifier type 0 33.44.55.66.77.88.99.aa.bb

!

/* On PE2 */

configure
l2vpn
flexible-xconnect-service vlan-aware evi 6
interface Bundle-Ether2.1
interface Bundle-Ether3.1

!

configure
interface Bundle-Ether2.1 l2transport
encapsulation dot1q 1
rewrite ingress tag translate 1-to-2 dot1q 3 second-dot1q 3 symmetric

!

configure
interface Bundle-Ether3.1 l2transport
encapsulation dot1q 1
rewrite ingress tag translate 1-to-2 dot1q 3 second-dot1q 3 symmetric

!

evpn

```

```

interface Bundle-Ether2
  ethernet-segment identifier type 0 22.33.44.55.66.77.88.99.aa
interface Bundle-Ether3
  ethernet-segment identifier type 0 33.44.55.66.77.88.99.aa.bb

```

```
!
```

Configure Preferred Tunnel Path

Preferred tunnel path functionality lets you map pseudowires to specific traffic-engineering tunnels. Attachment circuits are cross-connected to specific MPLS traffic engineering tunnel interfaces instead of remote PE router IP addresses (reachable using IGP or LDP).

When using a preferred tunnel path, it is assumed that the traffic engineering tunnel that transports the Layer 2 traffic runs between the two PE routers (that is, its head starts at the imposition PE router and its tail terminates on the disposition PE router).

Configuration

```

/* Enter global configuration mode */
Router# configure
Router(config)# l2vpn

/* Configure pseudowire class name */
Router(config-l2vpn)# pw-class path1

/* Configure MPLS encapsulation for the pseudowire */
Router(config-l2vpn-pwc)# encapsulation mpls

/* Configure preferred path tunnel settings.
If fallback disable configuration is used, and when
the TE/ tunnel is configured,
if the preferred path goes down,
the corresponding pseudowire can also go down. */

Router(config-l2vpn-pwc-encap-mpls)# preferred-path
                                interface tunnel-te 11 fallback disable

/* Commit your configuration */
Router(config-l2vpn-pwc)# exit
Router(config-l2vpn)# commit

```

Running Configuration

```

Router# show running-configuration
!
l2vpn
  pw-class path1
    encapsulation mpls
    preferred-path interface tunnel-te 11 fallback disable
  !
!
!

```


Multisegment Pseudowire

The Multisegment Pseudowire feature allows you to extend L2VPN pseudowires across an inter-AS boundary or across two separate MPLS networks. A multisegment pseudowire connects two or more contiguous pseudowire segments to form an end-to-end multi-hop pseudowire as a single point-to-point pseudowire. These segments act as a single pseudowire, allowing you to:

- Manage the end-to-end service by separating administrative or provisioning domains.
- Keep IP addresses of provider edge (PE) nodes private across interautonomous system (inter-AS) boundaries. Use IP address of autonomous system boundary routers (ASBRs) and treat them as pseudowire aggregation routers. The ASBRs join the pseudowires of the two domains.

A multisegment pseudowire can span either an inter-AS boundary or two multiprotocol label switching (MPLS) networks.

A pseudowire is a tunnel between two PE nodes. There are two types of PE nodes:

- A Switching PE (S-PE) node
 - Terminates PSN tunnels of the preceding and succeeding pseudowire segments in a multisegment pseudowire.
 - Switches control and data planes of the preceding and succeeding pseudowire segments of the multisegment pseudowire.
- A Terminating PE (T-PE) node
 - Located at both the first and last segments of a multisegment pseudowire.
 - Where customer-facing attachment circuits (ACs) are bound to a pseudowire forwarder.



Note Every end of a multisegment pseudowire must terminate at a T-PE.

A multisegment pseudowire is used in two general cases when:

- It is not possible to establish a PW control channel between the source and destination PE nodes.

For the PW control channel to be established, the remote PE node must be accessible. Sometimes, the local PE node may not be able to access the remote node due to topology, operational, or security constraints.

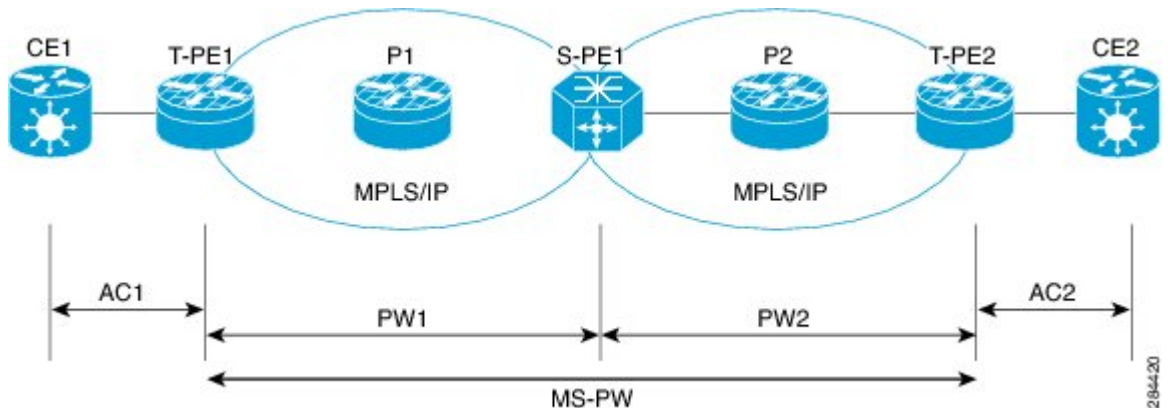
A multisegment pseudowire dynamically builds two discrete pseudowire segments and performs a pseudowire switching to establish a PW control channel between the source and destination PE nodes.

- Pseudowire Edge To Edge Emulation (PWE3) signaling and encapsulation protocols are different.

The PE nodes are connected to networks employing different PW signaling and encapsulation protocols. Sometimes, it is not possible to use a single segment PW.

A multisegment pseudowire, with the appropriate interworking performed at the PW switching points, enables PW connectivity between the PE nodes in the network.

Figure 9: Multisegment Pseudowire



The topology shows MS-PW stitching between PW1 and PW2. You can configure a set of two or more contiguous PW segments that behave and function as a single point-to-point PW. You can configure static or dynamic multisegment PW (MS-PW). The maximum number of contiguous PW segments is 254. Each end of an MS-PW terminates on a T-PE. A switching PE (S-PE) terminates the PSN tunnels of the preceding and succeeding PW segments in an MS-PW. The S-PE switches the control and data planes of the preceding and succeeding PW segments of the MS-PW. An MS-PW is up when all the SS-PWs are up.

Restrictions

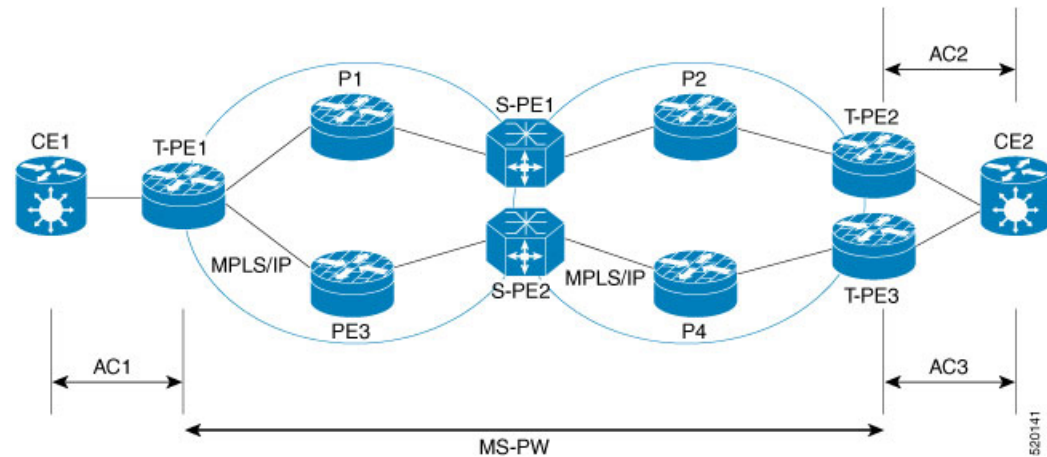
You must consider the following restrictions while configuring the Multisegment Pseudowire feature:

- Connect both segments of an MS-PW to different peers.
- Supports only LDP and does not support L2TPv3. Each PW segment in the MS-PW xconnect can be either static or dynamic.
- The neighbor pw-id pair of each PW segment of an MS-PW is unique on the node.
- The end-to-end pw-type has to be the same. Hence, both segments of an MS-PW must have the same transport mode.
- You cannot configure PW redundancy on an MS-PW xconnect at the S-PE. You can configure PW redundancy at the T-PEs.
- Both segments of an MS-PW xconnect can not have the same preferred path.
- Supports MS-PW over LDP, MPLS-TE, SR, and SR-TE as transport protocols.
- Does not support MS-PW over BGP-LU and LDPoTE.
- When you enable MSPW on an S-PE, configure the *ip-ttl-propagation disable* command for the MSPW ping and traceroute to work. Alternatively, use *segment-count 255 option* for MSPW ping to work from T-PE1. MSPW does not support the partial ping.

Multisegment Pseudowire Redundancy

Pseudowire redundancy enables you to create backup MS-PWs between the T-PEs. Pseudowire redundancy allows 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.

Figure 10: Multisegment Pseudowire Redundancy



Consider a topology where you create two MS-PWs and multihome CE2 to T-PE2 and T-PE3. Create a primary MS-PW between T-PE1 and T-PE2 connected through P1, S-PE1, and P2. Create a standby MS-PW between T-PE1 and T-PE3 connected through P3, S-PE2, and P4.

When a segment of the primary PW fails, the S-PE1 receives label withdraw message or LDP transport goes down. S-PE1 sends label withdraw message on the other PW segment and this triggers the switch-over to the backup at the T-PE. For example:

- T-PE1 detects LDP transport down, sends label withdraw message to S-PE1 and switches over to the backup MS-PW.
- S-PE1 receives the label withdraw message and sends a label withdraw message to T-PE2.
- T-PE2 performs “Tx Disable” of AC2 after it receives the label withdraw message.
- CE2 starts sending and receiving traffic on AC3.

Configure Pseudowire Redundancy

Pseudowire redundancy allows 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 of either the remote provider edge (PE) router or the link between the PE and customer edge (CE) routers.

L2VPNs can provide pseudowire resiliency through their routing protocols. When connectivity between end-to-end PE routers fails, an alternative path to the directed LDP session and the user data takes over. However, there are some parts of the network in which this rerouting mechanism does not protect against interruptions in service.

Pseudowire redundancy enables you to set up backup pseudowires. You can configure the network with redundant pseudowires and redundant network elements.

Prior to the failure of the primary pseudowire, the ability to switch traffic to the backup pseudowire is used to handle a planned pseudowire outage, such as router maintenance.



Note Pseudowire redundancy is provided only for point-to-point Virtual Private Wire Service (VPWS) pseudowires.

Configuration

This section describes the configuration for pseudowire redundancy.

```
/* Configure a cross-connect group with a static point-to-point
cross connect */
Router# configure
Router(config)# l2vpn
Router(config-l2vpn)# xconnect group A
Router(config-l2vpn-xc)# p2p xc1
Router(config-l2vpn-xc-p2p)# interface tengige 0/0/0/0.2
Router(config-l2vpn-xc-p2p)# neighbor 10.1.1.2 pw-id 2

/*Configure the pseudowire segment for the cross-connect group */
Router(config-l2vpn-xc-p2p-pw)#pw-class path1

/*Configure the backup pseudowire segment for the cross-connect group */
Router(config-l2vpn-xc-p2p-pw)# backup neighbor 10.2.2.2 pw-id 5
Router(config-l2vpn-xc-p2p-pw-backup)#end

/*Commit your configuration */
Router(config-l2vpn-xc-p2p-pw-backup)#commit
Uncommitted changes found, commit them before exiting(yes/no/cancel)?
[cancel]: yes
```

Running Configuration

```
Router# show-running configuration
...
l2vpn
encapsulation mpls
!
xconnect group A
p2p xc1
interface tengige 0/0/0/0.2
neighbor ipv4 10.1.1.2 pw-id 2
pw-class path1
backup neighbor 10.2.2.2 pw-id 5
!
!
...
```