L2VPN Pseudowire Switching

This feature module explains how to configure L2VPN Pseudowire Switching, which extends layer 2 virtual private network (L2VPN) pseudowires across an interautonomous system (inter-AS) boundary or across two separate multiprotocol label switching (MPLS) networks.

Restrictions for L2VPN Pseudowire Switching

- In Cisco IOS XE Release 2.4, Pseudowire Switching is supported on Ethernet over MPLS attachment circuits.
- L2VPN Pseudowire Switching is supported with AToM.
- Only static, on-box provisioning is supported.
- Sequencing numbers in AToM packets are not processed by L2VPN Pseudowire Switching. The feature blindly passes the sequencing data through the xconnect packet paths, a process that is called transparent sequencing. The endpoint PE-CE connections enforce the sequencing.
- You can ping the adjacent next-hop PE router. End-to-end LSP pings are not supported.
- Do not configure IP or Ethernet interworking on a router where L2VPN Pseudowire Switching is enabled. Instead, configure interworking on the routers at the edge PEs of the network.
- The control word negotiation results must match. If either segment does not negotiate the control word, the control word is disabled for both segments.
- AToM Graceful Restart is negotiated independently on each pseudowire segment. If there is a transient loss of the LDP session between two AToM PE routers, packets continue to flow.
- Per-pseudowire quality of service (QoS) is not supported. Traffic Engineering (TE) tunnel selection is supported.

- Attachment circuit interworking is not supported.

Information About L2VPN Pseudowire Switching

How L2VPN Pseudowire Switching Works

L2VPN Pseudowire Switching allows the user to extend L2VPN pseudowires across an inter-AS boundary or across two separate MPLS networks, as shown in the figures below. L2VPN Pseudowire Switching connects two or more contiguous pseudowire segments to form an end-to-end multihop pseudowire. This end-to-end pseudowire functions as a single point-to-point pseudowire.

As shown in the second figure below, L2VPN Pseudowire Switching enables you to keep the IP addresses of the edge PE routers private across inter-AS boundaries. You can use the IP address of the autonomous system boundary routers (ASBRs) and treat them as pseudowire aggregation (PE-agg) routers. The ASBRs join the pseudowires of the two domains.

L2VPN Pseudowire Switching also enables you to keep different administrative or provisioning domains to manage the end-to-end service. At the boundaries of these networks, PE-agg routers delineate the management responsibilities.

Figure 1: L2VPN Pseudowire Switching in an Intra-AS Topology

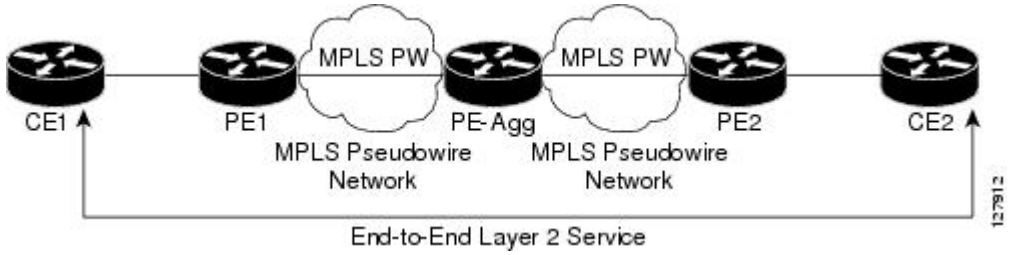
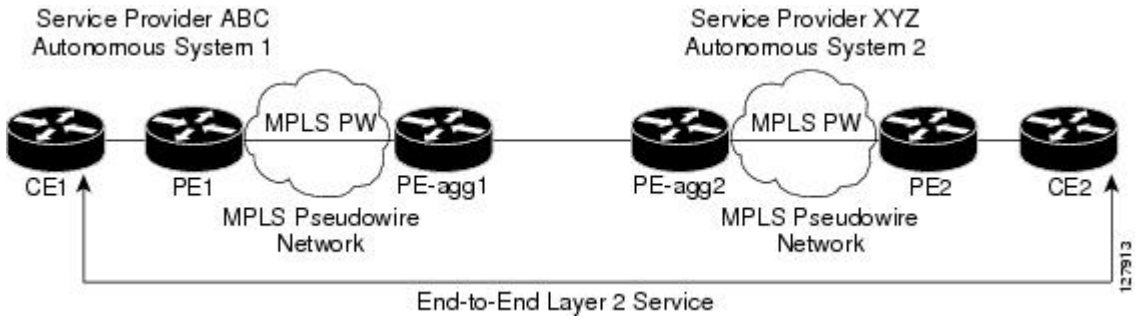


Figure 2: L2VPN Pseudowire Switching in an Inter-AS Topology



How Packets Are Manipulated at the Aggregation Point

Switching AToM packets between two AToM pseudowires is the same as switching any MPLS packet. The MPLS switching data path switches AToM packets between two AToM pseudowires. The following list explains exceptions:

- The outgoing virtual circuit (VC) label replaces the incoming VC label in the packet. New Internal Gateway Protocol (IGP) labels and Layer 2 encapsulation are added.
- The incoming VC label time-to-live (TTL) field is decremented by one and copied to the outgoing VC label TTL field.
- The incoming VC label EXP value is copied to the outgoing VC label EXP field.
- The outgoing VC label 'Bottom of Stack' S bit in the outgoing VC label is set to1.
- AToM control word processing is not performed at the L2VPN Pseudowire Switching aggregation point. Sequence numbers are not validated. Use the Router Alert label for LSP Ping; do not require control word inspection to determine an LSP Ping packet.

How to Configure L2VPN Pseudowire Switching

Configuring

Use the following procedure to configure L2VPN Pseudowire Switching on each of the PE-agg routers.

Before you begin

- This procedure assumes that you have configured basic AToM L2VPNs. This procedure does not explain how to configure basic AToM L2VPNs that transport Layer 2 packets over an MPLS backbone. For information on the basic configuration, see Any Transport over MPLS.
- For inter-Autonomous configurations, ASBRs require a labeled interface.

Note In this configuration, you are limited to two **neighbor**commands after entering the **l2 vfi**command.

>

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **l2 vfi** *name* **point-to-point**
4. **neighbor** *ip-address vcid* **encapsulation mpls** | **pw-class** *pw-class-name*
5. **exit**
6. **exit**
7. **show mpls l2transport vc** [**vcid** [*vc-id* | [*vc-id-min vc-id-max*]] [**interface** *name*[*local-circuit-id*]] [**destination** *ip-address* | *name*] [**detail**]
8. **show vfi** [*vfi-name*]
9. **ping** [*protocol*] [**tag**] {*host-name*| *system-address*}

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**l2 vfi** *name* **point-to-point** **Example:** `Router(config)# l2 vfi atomtunnel point-to-point`	Creates a point-to-point Layer 2 virtual forwarding interface (VFI) and enters VFI configuration mode.
Step 4	**neighbor** *ip-address vcid* **encapsulation mpls** | **pw-class** *pw-class-name* **Example:** `Router(config-vfi)# neighbor 10.0.0.1 100 pw-class mpls`	Sets up an emulated VC. Specify the IP address and the VC ID of the remote router. Also specify the pseudowire class to use for the emulated VC. **Note** Only two **neighbor**commands are allowed for each **l2 vfi point-to-point** command.
Step 5	**exit** **Example:** `Router(config-vfi)# exit`	Exits VFI configuration mode.
Step 6	**exit** **Example:** `Router(config)# exit`	Exits global configuration mode.
Step 7	**show mpls l2transport vc** [**vcid** [*vc-id* | [*vc-id-min vc-id-max*]] [**interface** *name*[*local-circuit-id*]] [**destination** *ip-address* | *name*] [**detail**] **Example:** `Router# show mpls l2transport vc`	Verifies that the L2VPN Pseudowire Switching session has been established.
Step 8	**show vfi** [*vfi-name*] **Example:** `Router# show vfi atomtunnel`	Verifies that a point-to-point VFI has been established.
Step 9	**ping** [*protocol*] [**tag**] {*host-name*| *system-address*} **Example:**	When issued from the CE routers, this command verifies end-to-end connectivity.

	Command or Action	Purpose
	`Router# ping 10.1.1.1`	

Examples

The following example displays the output of the **show mpls l2transport vc** command:

```
Router# show mpls l2transport vc
Local intf     Local circuit              Dest address    VC ID Status
-------------  -------------------------- --------------- ----- ----
MPLS PW        10.0.1.1:100               10.0.1.1        100   UP
MPLS PW        10.0.1.1:100               10.0.1.1        100   UP
```

The following example displays the output of the **show vfi**command:

```
Router# show vfi
VFI name: test, type: point-to-point
 Neighbors connected via pseudowires:
   Router ID        Pseudowire ID
   10.0.1.1         100
   10.0.1.1         100
```

How to Configure L2VPN Pseudowire Switching using the commands associated with the L2VPN Protocol-Based CLIs feature

Perform this task to configure L2VPN Pseudowire Switching on each of the PE-agg routers. In this configuration, you are limited to two **neighbor** commands after entering the **l2vpn xconnect** command.

Before you begin

- This task assumes that you have configured basic AToM L2VPNs. This task does not explain how to configure basic AToM L2VPNs that transport Layer 2 packets over an MPLS backbone. For information on the basic configuration, see the “Any Transport over MPLS” section.
- For interautonomous configurations, autonomous system boundary routers (ASBRs) require a labeled interface.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface pseudowire** *number*
4. **encapsulation mpls**
5. **neighbor** *peer-address vcid-value*
6. **exit**

7. **interface pseudowire** *number*
8. **encapsulation mpls**
9. **neighbor** *peer-address vcid-value*
10. **exit**
11. **l2vpn xconnect context** *context-name*
12. **member pseudowire** *interface-number*
13. **member** *ip-address vcid* **encapsulation mpls**
14. **member pseudowire** *interface-number*
15. **member** *ip-address vcid* **encapsulation mpls**
16. **exit**
17. **exit**
18. **show l2vpn atom vc** [**vcid** [*vc-id* | *vc-id-min vc-id-max*]] [**interface** *type number* [*local-circuit-id*]] [**destination** *ip-address* | *name*] [**detail**]
19. **ping** [*protocol*] [**tag**] {*hostname*| *system-address*}

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 pseudowire** *number* **Example:** `Router(config)# interface pseudowire 100`	Specifies the pseudowire interface and enters interface configuration mode.
Step 4	**encapsulation mpls** **Example:** `Router(config-if)# encapsulation mpls`	Specifies that Multiprotocol Label Switching (MPLS) is used as the data encapsulation method.
Step 5	**neighbor** *peer-address vcid-value* **Example:** `Router(config-if)# neighbor 10.0.0.1 123`	Specifies the peer IP address and virtual circuit (VC) ID value of the Layer 2 VPN (L2VPN) pseudowire.
Step 6	**exit** **Example:** `Router(config-if)# exit`	Exits interface configuration mode.

	Command or Action	Purpose
Step 7	**interface pseudowire** *number* **Example:** `Router(config)# interface pseudowire 200`	Specifies the pseudowire interface and enters interface configuration mode.
Step 8	**encapsulation mpls** **Example:** `Router(config-if)# encapsulation mpls`	Specifies that Multiprotocol Label Switching (MPLS) is used as the data encapsulation method.
Step 9	**neighbor** *peer-address vcid-value* **Example:** `Router(config-if)# neighbor 10.0.0.2 124`	Specifies the peer IP address and virtual circuit (VC) ID value of the Layer 2 VPN (L2VPN) pseudowire.
Step 10	**exit** **Example:** `Router(config-if)# exit`	Exits interface configuration mode.
Step 11	**l2vpn xconnect context** *context-name* **Example:** `Device(config)# l2vpn xconnect context con1`	Creates a Layer 2 VPN (L2VPN) cross connect context and enters xconnect configuration mode.
Step 12	**member pseudowire** *interface-number* **Example:** `Router(config-xconnect)# member pseudowire 100`	Specifies a member pseudowire to form a Layer 2 VPN (L2VPN) cross connect.
Step 13	**member** *ip-address vcid* **encapsulation mpls** **Example:** `Device(config-xconnect)# member 10.0.0.1 123 encapsulation mpls`	Specifies the devices that form a point-to-point Layer 2 VPN (L2VPN) virtual forwarding interface (VFI) connection. **Note** Only two **member** commands are allowed for each **l2vpn xconnect context** command.
Step 14	**member pseudowire** *interface-number* **Example:** `Router(config-xconnect)# member pseudowire 200`	Specifies a member pseudowire to form a Layer 2 VPN (L2VPN) cross connect.
Step 15	**member** *ip-address vcid* **encapsulation mpls** **Example:** `Device(config-xconnect)# member 10.0.0.2 124 encapsulation mpls`	Specifies the devices that form a point-to-point Layer 2 VPN (L2VPN) virtual forwarding interface (VFI) connection. **Note** Only two **member** commands are allowed for each **l2vpn xconnect context** command.

	Command or Action	Purpose
Step 16	**exit** **Example:** `Device(config-xconnect)# exit`	Exits Xconnect configuration mode.
Step 17	**exit** **Example:** `Device(config)# exit`	Exits global configuration mode.
Step 18	**show l2vpn atom vc** [**vcid** [*vc-id* | *vc-id-min vc-id-max*]] [**interface** *type number* [*local-circuit-id*]] [**destination** *ip-address* | *name*] [**detail**] **Example:** `Device# show l2vpn atom vc`	Displays information about Any Transport over MPLS (AToM) virtual circuits (VCs) and static pseudowires that have been enabled to route Layer 2 packets on a device.
Step 19	**ping** [*protocol*] [**tag**] {*hostname*| *system-address*} **Example:** `Device# ping 10.1.1.1`	When issued from the CE routers, verifies end-to-end connectivity.

Configuring

Use the following procedure to configure L2VPN Pseudowire Switching on each of the PE-agg routers.

Before you begin

- This procedure assumes that you have configured basic AToM L2VPNs. This procedure does not explain how to configure basic AToM L2VPNs that transport Layer 2 packets over an MPLS backbone. For information on the basic configuration, see Any Transport over MPLS.
- For inter-Autonomous configurations, ASBRs require a labeled interface.

Note In this configuration, you are limited to two **neighbor**commands after entering the **l2 vfi**command.

>

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **l2 vfi** *name* **point-to-point**
4. **neighbor** *ip-address vcid* **encapsulation mpls** | **pw-class** *pw-class-name*
5. **exit**

6. **exit**
7. **show mpls l2transport vc** [**vcid** [*vc-id* | [*vc-id-min vc-id-max*]] [**interface** *name*[*local-circuit-id*]] [**destination** *ip-address* | *name*] [**detail**]
8. **show vfi** [*vfi-name*]
9. **ping** [*protocol*] [**tag**] {*host-name*| *system-address*}

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**l2 vfi** *name* **point-to-point** **Example:** `Router(config)# l2 vfi atomtunnel point-to-point`	Creates a point-to-point Layer 2 virtual forwarding interface (VFI) and enters VFI configuration mode.
Step 4	**neighbor** *ip-address vcid* **encapsulation mpls** | **pw-class** *pw-class-name* **Example:** `Router(config-vfi)# neighbor 10.0.0.1 100 pw-class mpls`	Sets up an emulated VC. Specify the IP address and the VC ID of the remote router. Also specify the pseudowire class to use for the emulated VC. **Note** Only two **neighbor**commands are allowed for each **l2 vfi point-to-point** command.
Step 5	**exit** **Example:** `Router(config-vfi)# exit`	Exits VFI configuration mode.
Step 6	**exit** **Example:** `Router(config)# exit`	Exits global configuration mode.
Step 7	**show mpls l2transport vc** [**vcid** [*vc-id* | [*vc-id-min vc-id-max*]] [**interface** *name*[*local-circuit-id*]] [**destination** *ip-address* | *name*] [**detail**] **Example:** `Router# show mpls l2transport vc`	Verifies that the L2VPN Pseudowire Switching session has been established.

	Command or Action	Purpose
Step 8	**show vfi** [*vfi-name*] **Example:** `Router# show vfi atomtunnel`	Verifies that a point-to-point VFI has been established.
Step 9	**ping** [*protocol*] [**tag**] {*host-name*| *system-address*} **Example:** `Router# ping 10.1.1.1`	When issued from the CE routers, this command verifies end-to-end connectivity.

Examples

The following example displays the output of the **show mpls l2transport vc** command:

```
Router# show mpls l2transport vc
Local intf     Local circuit              Dest address    VC ID Status
-------------  -------------------------- --------------- ----- ----
MPLS PW        10.0.1.1:100               10.0.1.1        100   UP
MPLS PW        10.0.1.1:100               10.0.1.1        100   UP
```

The following example displays the output of the **show vfi**command:

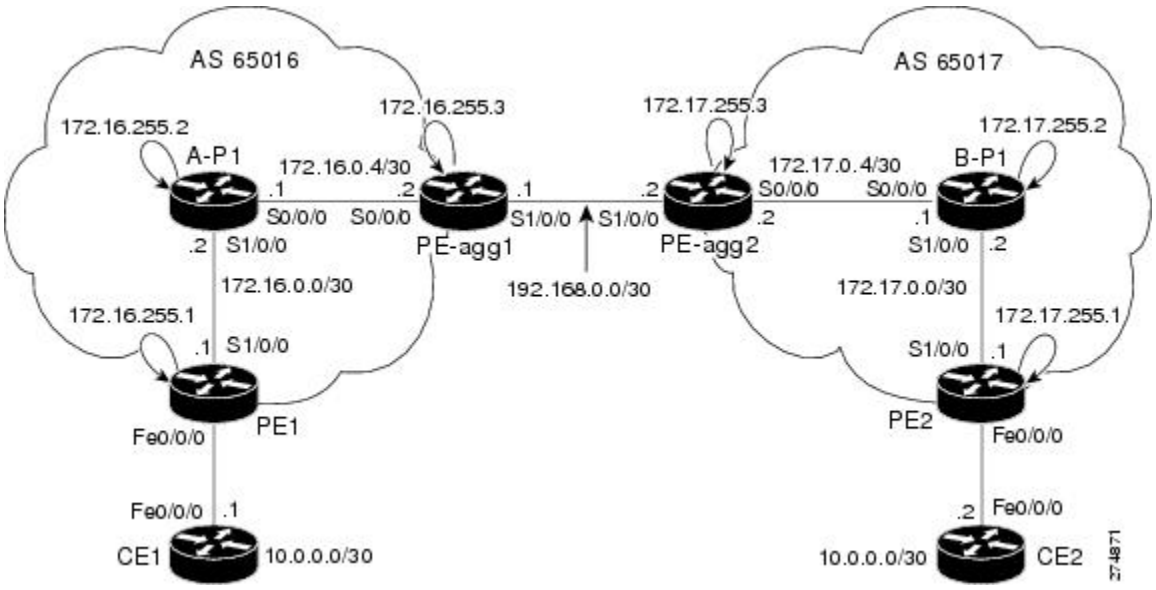
```
Router# show vfi
VFI name: test, type: point-to-point
 Neighbors connected via pseudowires:
   Router ID        Pseudowire ID
   10.0.1.1         100
   10.0.1.1         100
```

Configuration Examples for L2VPN Pseudowire Switching

L2VPN Pseudowire Switching in an Inter-AS Configuration Example

Two separate autonomous systems are able to pass L2VPN packets, because the two PE-agg routers have been configured with L2VPN Pseudowire Switching. This example configuration is shown in the figure below.

Figure 3: L2VPN Pseudowire Switching in an InterAutonomous System



CE1	CE2

CE1	CE2
version 12.0	version 12.0
service timestamps debug uptime	service timestamps debug uptime
service timestamps log uptime	service timestamps log uptime
service password-encryption	service password-encryption
!	!
hostname [ce1]	hostname [ce2]
!	!
boot-start-marker	boot-start-marker
boot-end-marker	boot-end-marker
!	!
enable secret 5 1o9N6$LSrxHufTn0vjCY0nW8hQX.	enable secret 5 1YHo6$LQ4z5PdrF5B9dnL75Xvvm1
!	!
ip subnet-zero	ip subnet-zero
ip cef	ip cef
no ip domain-lookup	no ip domain-lookup
!	!
interface FastEthernet0/0/0	interface FastEthernet0/0/0
ip address 10.0.0.1 255.255.255.252	ip address 10.0.0.2 255.255.255.252
no ip directed-broadcast	no ip directed-broadcast
!	!
ip classless	ip classless
!	!
control-plane	control-plane
!	!

CE1	CE2
line con 0 exec-timeout 0 0 line aux 0 line vty 0 4 login ! no cns aaa enable end	line con 0 exec-timeout 0 0 line aux 0 line vty 0 4 login ! no cns aaa enable end

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Command List, All Releases
MPLS commands	Cisco IOS Multiprotocol Label Switching Command Reference
L2VPN pseudowire redundancy	"L2VPN Pseudowire Redundancy" feature module in the *MPLS Layer 2 VPNs Configuration Guide*.
H-VPLS	" Configuring VPLS " in the "Configuring Multiprotocol Label Switching on the Optical Services Modules" chapter in the *Optical Services Modules Installation and Configuration Notes*, 12.2SR document.
MPLS traffic engineering	"MPLS Traffic Engineering Fast Reroute Link and Node Protection" feature module in the *MPLS Traffic Engineering: Path, Link, and Node Protection Configuration Guide* (part of the Multiprotocol Label Switching Configuration Guide Library)

Standards

Standard	Title
http://www.ietf.org/rfc/rfc4447.txt	*Pseudowire Setup and Maintenance Using the Label Distribution Protocol (LDP)*

Standard	Title
http://www3.ietf.org/proceedings/06mar/IDs/draft-ietf-l2vpn-vpls-ldp-08.txt	*Virtual Private LAN Services over MPLS*
http://www.ietf.org/internet-drafts/draft-ietf-pwe3-segmented-pw-02.txt	*Segmented Pseudo Wire*
draft-ietf-pwe3-vccv-10.txt	*Pseudo Wire Virtual Circuit Connectivity Verification (VCCV)*
draft-ietf-pwe3-oam-msg-map-03.txt	*Pseudo Wire (PW) OAM Message Mapping*

MIBs

MIB	MIBs Link
Pseudowire Emulation Edge-to-Edge MIBs for Ethernet, Frame Relay, and ATM Services	To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for L2VPN Pseudowire Switching

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

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

Table 1: Feature Information for L2VPN Pseudowire Switching

Feature Name	Releases	Feature Information
L2VPN Pseudowire Switching	Cisco IOS XE Release 2.4	The L2VPN Pseudowire Switching feature extends layer 2 virtual private network (L2VPN) pseudowires across an interautonomous system (inter-AS) boundary or across two separate multiprotocol label switching (MPLS) networks. In Cisco IOS XE Release 2.4, the L2VPN Pseudowire Switching feature is supported with Ethernet over MPLS. The following commands were introduced or modified: **l2 vfi point-to-point**, **neighbor**(L2VPN Pseudowire Switching), **show vfi**.
L2VPN Pseudowire-Switching	Cisco IOS XE Fuji 16.9.1	In Cisco IOS XE Fuji 16.9.1, the L2VPN Pseudowire Switching feature is supported on Cisco 1000 Series ISRs.