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.

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- How to Configure L2VPN Pseudowire Switching using the commands associated with the L2VPN Protocol-Based CLIs feature, on page 6
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Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

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.

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
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 to 1.
- 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.
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

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** enable | Enables privileged EXEC mode.  
  Example:  
  `Router> enable`  
  • Enter your password if prompted. |
| **Step 2** `configure terminal` | Enters global configuration mode.  
  Example:  
  `Router# configure terminal` |
| **Step 3** `l2 vfi name point-to-point` | Creates a point-to-point Layer 2 virtual forwarding interface (VFI) and enters VFI configuration mode.  
  Example:  
  `Router(config)# l2 vfi atomtunnel point-to-point` |
| **Step 4** `neighbor ip-address vcid encapsulation mpls | pw-class pw-class-name` | 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.  
  Example:  
  `Router(config-vfi)# neighbor 10.0.0.1 100 pw-class mpls` |
| **Step 5** `exit` | Exits VFI configuration mode.  
  Example:  
  `Router(config-vfi)# exit` |
### Purpose

**Exit global configuration mode.**

**Example:**

```
Router(config)# exit
```

### Purpose

Verifies that the L2VPN Pseudowire Switching session has been established.

**Example:**

```
Router# show mpls l2transport vc
```

### Purpose

Verifies that a point-to-point VFI has been established.

**Example:**

```
Router# show vfi
```

### Purpose

When issued from the CE routers, this command verifies end-to-end connectivity.

**Example:**

```
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

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Device&gt; enable</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Specifies the pseudowire interface and enters interface configuration mode.</td>
</tr>
<tr>
<td><strong>Step 3</strong> interface pseudowire <em>number</em></td>
<td>Specifies that Multiprotocol Label Switching (MPLS) is used as the data encapsulation method.</td>
</tr>
<tr>
<td><strong>Step 4</strong> encapsulation mpls</td>
<td>Specifies the peer IP address and virtual circuit (VC) ID value of the Layer 2 VPN (L2VPN) pseudowire.</td>
</tr>
<tr>
<td><strong>Step 5</strong> neighbor <em>peer-address</em> <em>vcid-value</em></td>
<td>Specifies the peer IP address and virtual circuit (VC) ID value of the Layer 2 VPN (L2VPN) pseudowire.</td>
</tr>
<tr>
<td><strong>Step 6</strong> exit</td>
<td>Exits interface configuration mode.</td>
</tr>
<tr>
<td><strong>Step 7</strong> interface pseudowire <em>number</em></td>
<td>Specifies the pseudowire interface and enters interface configuration mode.</td>
</tr>
<tr>
<td><strong>Step 8</strong> encapsulation mpls</td>
<td>Specifies that Multiprotocol Label Switching (MPLS) is used as the data encapsulation method.</td>
</tr>
<tr>
<td><strong>Step 9</strong> neighbor <em>peer-address</em> <em>vcid-value</em></td>
<td>Specifies the peer IP address and virtual circuit (VC) ID value of the Layer 2 VPN (L2VPN) pseudowire.</td>
</tr>
<tr>
<td><strong>Step 10</strong> exit</td>
<td>Exits interface configuration mode.</td>
</tr>
<tr>
<td>Step</td>
<td>Command or Action</td>
</tr>
<tr>
<td>------</td>
<td>------------------</td>
</tr>
<tr>
<td>11</td>
<td><code>l2vpn xconnect context context-name</code> <strong>Example:</strong> Device(config)# l2vpn xconnect context con1</td>
</tr>
<tr>
<td>12</td>
<td><code>member pseudowire interface-number</code> <strong>Example:</strong> Router(config-xconnect)# member pseudowire 100</td>
</tr>
<tr>
<td>13</td>
<td><code>member ip-address vcid encapsulation mpls</code> <strong>Example:</strong> Device(config-xconnect)# member 10.0.0.1 123 encapsulation mpls</td>
</tr>
<tr>
<td>14</td>
<td><code>member pseudowire interface-number</code> <strong>Example:</strong> Router(config-xconnect)# member pseudowire 200</td>
</tr>
<tr>
<td>15</td>
<td><code>member ip-address vcid encapsulation mpls</code> <strong>Example:</strong> Device(config-xconnect)# member 10.0.0.2 124 encapsulation mpls</td>
</tr>
<tr>
<td>16</td>
<td><code>exit</code> <strong>Example:</strong> Device(config-xconnect)# exit</td>
</tr>
<tr>
<td>17</td>
<td><code>exit</code> <strong>Example:</strong> Device(config)# exit</td>
</tr>
<tr>
<td>18</td>
<td>`show l2vpn atom vc [vcid [vc-id</td>
</tr>
<tr>
<td>19</td>
<td>`ping [protocol] [tag] {hostname</td>
</tr>
</tbody>
</table>
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 [ve-id | [ve-id-min ve-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

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>enable:</td>
</tr>
<tr>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td></td>
<td>Router&gt; enable</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>configure terminal</td>
</tr>
<tr>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Router# configure terminal</td>
</tr>
</tbody>
</table>
### Command or Action

**Step 3**

**l2 vfi name point-to-point**  
**Example:**  
Router(config)# l2 vfi atomtunnel point-to-point  
**Purpose:** 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:**  
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
----------------  ------------------  -------------  ------  -------
```
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*
<table>
<thead>
<tr>
<th>CE1</th>
<th>CE2</th>
</tr>
</thead>
</table>

L2VPN Pseudowire Switching in an Inter-AS Configuration Example
<table>
<thead>
<tr>
<th>CE1</th>
<th>CE2</th>
</tr>
</thead>
<tbody>
<tr>
<td>version 12.0</td>
<td>version 12.0</td>
</tr>
<tr>
<td>service timestamps debug uptime</td>
<td>service timestamps debug uptime</td>
</tr>
<tr>
<td>service timestamps log uptime</td>
<td>service timestamps log uptime</td>
</tr>
<tr>
<td>service password-encryption</td>
<td>service password-encryption</td>
</tr>
<tr>
<td>!</td>
<td>!</td>
</tr>
<tr>
<td>hostname [ce1]</td>
<td>hostname [ce2]</td>
</tr>
<tr>
<td>!</td>
<td>!</td>
</tr>
<tr>
<td>boot-start-marker</td>
<td>boot-start-marker</td>
</tr>
<tr>
<td>boot-end-marker</td>
<td>boot-end-marker</td>
</tr>
<tr>
<td>!</td>
<td>!</td>
</tr>
<tr>
<td>enable secret 5 $1$iO9N6$LStxHu5T0VjCY0nW8bQX. enable secret 5 $1$iYHo6$LQ4z5PdrFSB9dnL75Xvvm1</td>
<td>enable secret 5 $1$iO9N6$LStxHu5T0VjCY0nW8bQX. enable secret 5 $1$iYHo6$LQ4z5PdrFSB9dnL75Xvvm1</td>
</tr>
<tr>
<td>!</td>
<td>!</td>
</tr>
<tr>
<td>ip subnet-zero</td>
<td>ip subnet-zero</td>
</tr>
<tr>
<td>ip cef</td>
<td>ip cef</td>
</tr>
<tr>
<td>no ip domain-lookup</td>
<td>no ip domain-lookup</td>
</tr>
<tr>
<td>!</td>
<td>!</td>
</tr>
<tr>
<td>interface FastEthernet0/0/0</td>
<td>interface FastEthernet0/0/0</td>
</tr>
<tr>
<td>ip address 10.0.0.1 255.255.255.252</td>
<td>ip address 10.0.0.2 255.255.255.252</td>
</tr>
<tr>
<td>no ip directed-broadcast</td>
<td>no ip directed-broadcast</td>
</tr>
<tr>
<td>!</td>
<td>!</td>
</tr>
<tr>
<td>ip classless</td>
<td>ip classless</td>
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<tr>
<td>!</td>
<td>!</td>
</tr>
<tr>
<td>control-plane</td>
<td>control-plane</td>
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<tr>
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<td>!</td>
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</table>
### Additional References

#### Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
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</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>MPLS commands</td>
<td>Cisco IOS Multiprotocol Label Switching Command Reference</td>
</tr>
<tr>
<td>L2VPN pseudowire redundancy</td>
<td>“L2VPN Pseudowire Redundancy” feature module in the MPLS Layer 2 VPNs Guide.</td>
</tr>
<tr>
<td>H-VPLS</td>
<td>“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.</td>
</tr>
</tbody>
</table>

#### Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Title</th>
</tr>
</thead>
</table>
Standard | Title
--- | ---
http://www3.ietf.org/proceedings/06mar/IDs/draft-ietf-l2vpn-vpls-ldp-08.txt | Virtual Private LAN Services over MPLS
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

<table>
<thead>
<tr>
<th>MIB</th>
<th>MIBs Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pseudowire Emulation Edge-to-Edge MIBs for Ethernet, Frame Relay, and ATM Services</td>
<td>To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>

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.
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`.

In Cisco IOS XE Fuji 16.9.1, the L2VPN Pseudowire Switching feature is supported on Cisco 1000 Series ISRs.

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>L2VPN Pseudowire Switching</td>
<td>Cisco IOS XE Release 2.4</td>
<td>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: <code>l2 vfi point-to-point, neighbor(L2VPN Pseudowire Switching), show vfi</code>.</td>
</tr>
<tr>
<td>L2VPN Pseudowire-Switching</td>
<td>Cisco IOS XE Fuji 16.9.1</td>
<td>In Cisco IOS XE Fuji 16.9.1, the L2VPN Pseudowire Switching feature is supported on Cisco 1000 Series ISRs.</td>
</tr>
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