L2VPN Pseudowire Switching

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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.

History for the L2VPN Pseudowire Switching Feature

Release	Modification
12.0(31)S	L2VPN Pseudowire Switching for Any Transport over MPLS (AToM) was introduced on the Cisco 12000 series routers.
12.2(28)SB	This feature was integrated into Cisco IOS Release 12.2(28)SB for the Cisco 7200 and 7301 series routers.
12.2(33)SRB	This feature was integrated into Cisco IOS Release 12.2(33)SRB.

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Contents

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Prerequisites for L2VPN Pseudowire Switching

For the Cisco 12000 series routers, the L2VPN Pseudowire Switching feature for AToM is supported on the following engines:

- E2
- E3
- E4+
- E5
- E6

For engines that do not support this feature, the packets are punted to the software and forwarded through the slow path.

Note Engines E1 and E4 do not support L2VPN Pseudowire Switching, even in the slow path.

Restrictions for L2VPN Pseudowire Switching

- 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

To configure the L2VPN Pseudowire Switching feature, you should understand the following concepts:

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 Figure 1 and Figure 2. 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 Figure 2, 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

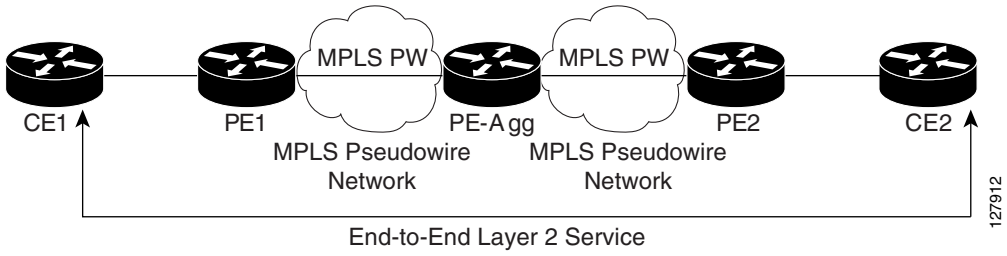
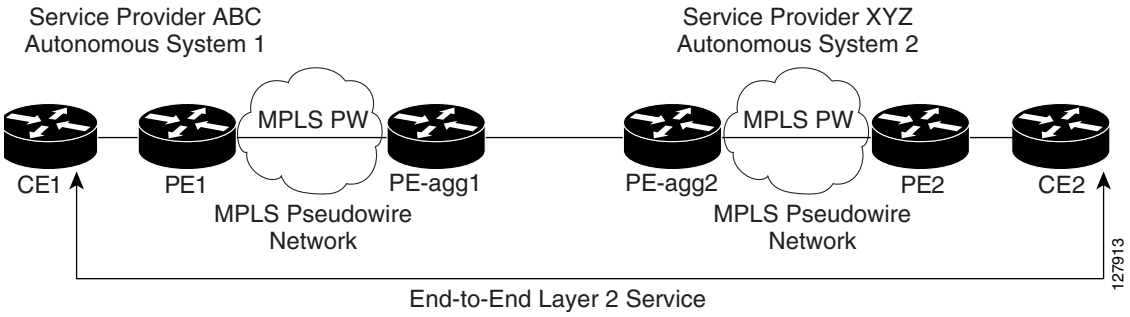


Figure 2 L2VPN Pseudowire Switching in an Inter-AS Topology



How Packets Are Manipulated at the L2VPN Pseudowire Switching 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

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

Prerequisites

- 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.

Restrictions

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 7s	**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
-------------  -------------------------- --------------- ----- ----
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

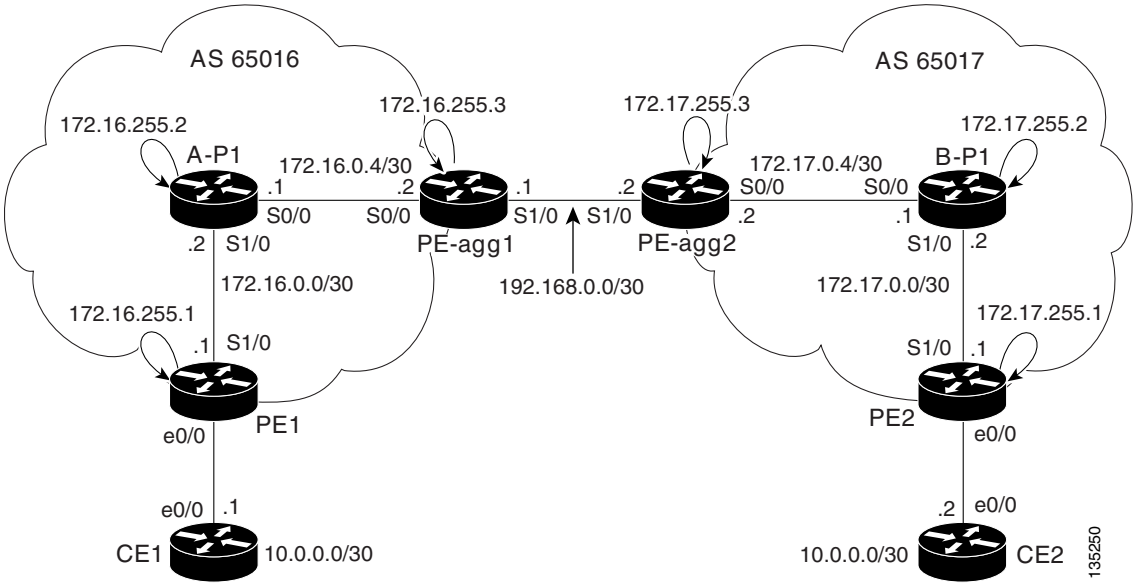
This section provides the following configuration example:

- L2VPN Pseudowire Switching in an Inter-AS Configuration: Example, page 6

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 Figure 3.

Figure 3 L2VPN Pseudowire Switching in an Inter-Autonomous Sytem



PE-agg-1

```
version 12.0
service timestamps debug uptime
service timestamps log uptime
service password-encryption
!
hostname [pe-agg1]
!
boot-start-marker
boot-end-marker
!
enable secret 5 $1$Q0Bb$32sIU82pHRgyddWaeB4zs/
!
ip subnet-zero
ip cef
no ip domain-lookup
mpls label protocol ldp
pseudowire-class SW-PW
 encapsulation mpls
!
l2 vfi PW-SWITCH-1 point-to-point
 neighbor 172.17.255.3 100 pw-class SW-PW
 neighbor 172.16.255.1 16 pw-class SW-PW
!
interface Loopback0
 ip address 172.16.255.3 255.255.255.255
 no ip directed-broadcast
!
interface Serial0/0
 ip address 172.16.0.6 255.255.255.252
 no ip directed-broadcast
 mpls ip
!
interface Serial1/0
 ip address 192.168.0.1 255.255.255.252
 no ip directed-broadcast
 mpls bgp forwarding
!
router ospf 16
 log-adjacency-changes
 network 172.16.0.0 0.0.255.255 area 0
!
router bgp 65016
 no synchronization
 bgp log-neighbor-changes
 network 172.16.255.3 mask 255.255.255.255
 neighbor 192.168.0.2 remote-as 65017
 neighbor 192.168.0.2 send-label
 no auto-summary
!
ip classless
control-plane
!
line con 0
 exec-timeout 0 0
line aux 0
line vty 0 4
 login
!
no cns aaa enable
end
```

PE-agg-2

```
version 12.0
service timestamps debug uptime
service timestamps log uptime
service password-encryption
!
hostname [pe-agg2]
!
boot-start-marker
boot-end-marker
!
enable secret 5 $1$32jd$zQRfxXzjstr4llV9DcWf7/
!
ip subnet-zero
ip cef
no ip domain-lookup
mpls label protocol ldp
pseudowire-class SW-PW
 encapsulation mpls
!
l2 vfi PW-SWITCH-1 point-to-point
 neighbor 172.16.255.3 100 pw-class SW-PW
 neighbor 172.17.255.1 17 pw-class SW-PW
!
interface Loopback0
 ip address 172.17.255.3 255.255.255.255
 no ip directed-broadcast
!
interface Serial0/0
 ip address 172.17.0.6 255.255.255.252
 no ip directed-broadcast
 mpls ip
!
interface Serial1/0
 ip address 192.168.0.2 255.255.255.252
 no ip directed-broadcast
 mpls bgp forwarding
!
router ospf 17
 log-adjacency-changes
 network 172.17.0.0 0.0.255.255 area 0
!
router bgp 65017
 no synchronization
 bgp log-neighbor-changes
 network 172.17.255.3 mask 255.255.255.255
 neighbor 192.168.0.1 remote-as 65016
 neighbor 192.168.0.1 send-label
 no auto-summary
!
ip classless
control-plane
!
line con 0
 exec-timeout 0 0
line aux 0
line vty 0 4
 login
!
no cns aaa enable
end
```

A-P1	B-P1
version 12.0 service timestamps debug uptime service timestamps log uptime service password-encryption ! hostname [a-p1] ! boot-start-marker boot-end-marker ! enable secret 5 1eiUn$rTMnZiYnJxtMTpO0NKpQQ/ ! ip subnet-zero ip cef no ip domain-lookup mpls label protocol ldp ! interface Loopback0 ip address 172.16.255.2 255.255.255.255 no ip directed-broadcast ! interface Serial0/0 ip address 172.16.0.5 255.255.255.252 no ip directed-broadcast mpls ip ! interface Serial1/0 ip address 172.16.0.2 255.255.255.252 no ip directed-broadcast mpls ip ! router ospf 16 log-adjacency-changes network 172.16.0.0 0.0.255.255 area 0 ! ip classless ! control-plane ! line con 0 exec-timeout 0 0 line aux 0 line vty 0 4 login ! no cns aaa enable end	version 12.0 service timestamps debug uptime service timestamps log uptime service password-encryption ! hostname [b-p1] ! boot-start-marker boot-end-marker ! enable secret 5 1svU/$2JmJZ/5gxlW4nVXVniIJe1 ! ip subnet-zero ip cef no ip domain-lookup mpls label protocol ldp ! interface Loopback0 ip address 172.17.255.2 255.255.255.255 no ip directed-broadcast ! interface Serial0/0 ip address 172.17.0.5 255.255.255.252 no ip directed-broadcast mpls ip ! interface Serial1/0 ip address 172.17.0.2 255.255.255.252 no ip directed-broadcast mpls ip ! router ospf 17 log-adjacency-changes network 172.17.0.0 0.0.255.255 area 0 ! ip classless ! control-plane ! line con 0 exec-timeout 0 0 line aux 0 line vty 0 4 login ! no cns aaa enable end

PE1	PE2
version 12.0 service timestamps debug uptime service timestamps log uptime service password-encryption ! hostname [pe1] ! boot-start-marker boot-end-marker ! enable secret 5 $1$9z8F$2A1/YLc6NB6d.WLQXF0Bz1 ! ip subnet-zero ip cef no ip domain-lookup mpls label protocol ldp pseudowire-class ETH-PW encapsulation mpls ! interface Loopback0 ip address 172.16.255.1 255.255.255.255 no ip directed-broadcast ! interface Ethernet0/0 no ip address no ip directed-broadcast no cdp enable xconnect 172.16.255.3 16 pw-class ETH-PW ! interface Serial1/0 ip address 172.16.0.1 255.255.255.252 no ip directed-broadcast mpls ip ! router ospf 16 log-adjacency-changes network 172.16.0.0 0.0.255.255 area 0 ! ip classless ! control-plane ! line con 0 exec-timeout 0 0 line aux 0 line vty 0 4 login ! no cns aaa enable end	version 12.0 service timestamps debug uptime service timestamps log uptime service password-encryption ! hostname [pe2] ! boot-start-marker boot-end-marker ! enable secret 5 1rT.V$8Z6Dy/r8/eaRdx2TR/O5r/ ! ip subnet-zero ip cef no ip domain-lookup mpls label protocol ldp pseudowire-class ETH-PW encapsulation mpls ! interface Loopback0 ip address 172.17.255.1 255.255.255.255 no ip directed-broadcast ! interface Ethernet0/0 no ip address no ip directed-broadcast no cdp enable xconnect 172.17.255.3 17 pw-class ETH-PW ! interface Serial1/0 ip address 172.17.0.1 255.255.255.252 no ip directed-broadcast mpls ip ! router ospf 17 log-adjacency-changes network 172.17.0.0 0.0.255.255 area 0 ! ip classless ! control-plane ! line con 0 exec-timeout 0 0 line aux 0 line vty 0 4 login ! no cns aaa enable end

CE1	CE2
version 12.0 service timestamps debug uptime service timestamps log uptime service password-encryption ! hostname [ce1] ! boot-start-marker boot-end-marker ! enable secret 5 1o9N6$LSrxHufTn0vjCY0nW8hQX. ! ip subnet-zero ip cef no ip domain-lookup ! interface Ethernet0/0 ip address 10.0.0.1 255.255.255.252 no ip directed-broadcast ! ip classless ! control-plane ! line con 0 exec-timeout 0 0 line aux 0 line vty 0 4 login ! no cns aaa enable end	version 12.0 service timestamps debug uptime service timestamps log uptime service password-encryption ! hostname [ce2] ! boot-start-marker boot-end-marker ! enable secret 5 1YHo6$LQ4z5PdrF5B9dnL75Xvvm1 ! ip subnet-zero ip cef no ip domain-lookup ! interface Ethernet0/0 ip address 10.0.0.2 255.255.255.252 no ip directed-broadcast ! ip classless ! control-plane ! line con 0 exec-timeout 0 0 line aux 0 line vty 0 4 login ! no cns aaa enable end

Additional References

The following sections provide references related to L2VPN Pseudowire Switching.

Related Documents

Related Topic	Document Title
Any Transport over MPLS	*Any Transport over MPLS*
Pseudowire redundancy	*L2VPN Pseudowire Redundancy*
High availability for AToM	*AToM Graceful Restart*
L2VPN interworking	*L2VPN Interworking*
Layer 2 local switching	*Layer 2 Local Switching*
PWE3 MIB	*Pseudowire Emulation Edge-to-Edge MIBs for Ethernet and Frame Relay Services*
Packet sequencing	*Any Transport over MPLS (AToM) Sequencing Support*

Standards

Standard	Title
draft-ietf-pwe3-control-protocol-14.txt	*Pseudowire Setup and Maintenance using LDP*
draft-martini-pwe3-pw-switching-01.txt	*Pseudo Wire Switching*

MIBs

MIB	MIBs Link
• CISCO-IETF-PW-MIB • CISCO-IETF-PW-MPLS-MIB • CISCO-IETF-PW-ENET-MIB • CISCO-IETF-PW-FR-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFCs	Title
None	—

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password. If you have a valid service contract but do not have a user ID or password, you can register on Cisco.com.	http://www.cisco.com/techsupport

Command Reference

This section documents modified commands only.

- **l2 vfi point-to-point**
- **neighbor (L2VPN Pseudowire Switching)**
- **show vfi**

l2 vfi point-to-point

To establish a point-to-point Layer 2 virtual forwarding interface (VFI) between two separate networks, use the **l2 vfi point-to-point** command in global configuration mode. To disable the connection, use the **no** form of this command.

l2 vfi *name* **point-to-point**

no l2 vfi *name* **point-to-point**

Syntax Description

name	Name of the connection between the two networks.

Command Default

Point-to-point Layer 2 virtual forwarding interfaces are not created.

Command Modes

Global configuration

Command History

Release	Modification
12.0(31)S	This command was introduced.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.
12.2(33)SRB	This command was integrated into Cisco IOS Release 12.2(33)SRB.

Usage Guidelines

If you disable L2VPN Pseudowire Switching with the **no l2 vfi point-to-point** command, the virtual circuits (VCs) are deleted.

Examples

The following example establishes a point-to-point Layer 2 VFI:

```
Router(config)# l2 vfi atomvfi point-to-point
```

Related Commands

Command	Description
neighbor (L2VPN Pseudowire Switching)	Establishes the two routers with which to form a connection.

neighbor (L2VPN Pseudowire Switching)

To specify the routers that should form a point-to-point Layer 2 virtual forwarding interface (VFI) connection, use the **neighbor** command in L2 VFI point-to-point configuration mode. To disconnect the routers, use the **no** form of this command.

neighbor *ip-address vc-id* {**encapsulation mpls** |**pw-class** *pw-class-name*}

no neighbor *ip-address vc-id* {**encapsulation mpls** |**pw-class** *pw-class-name*}

Syntax Description

ip-address	IP address of the VFI neighbor.
vc-id	Virtual circuit (VC) identifier.
encapsulation mpls	Encapsulation type.
pw-class	Pseudowire type.
pw-class-name	Name of the pseudowire you created when you established the pseudowire class.

Command Default

Routers do not form a point-to-point Layer 2 VFI connection.

Command Modes

L2 VFI point-to-point configuration

Command History

Release	Modification
12.0(31)S	This command was introduced.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.
12.2(33)SRB	This command was integrated into Cisco IOS Release 12.2(33)SRB.

Usage Guidelines

A maximum of two **neighbor** commands are allowed when you issue an **l2 vfi point-to-point** command.

Examples

The following example is a typical configuration of a Layer 2 VFI connection:

```
Router(config)# l2 vfi atom point-to-point
Router(config-vfi)# neighbor 10.10.10.10 1 encapsulation mpls
```

Related Commands

Command	Description
l2 vfi point-to-point	Establishes a point-to-point Layer 2 VFI between two separate networks.

show vfi

To display information related to the virtual forwarding instance (VFI), use the **show vfi** command in privileged EXEC mode.

show vfi *vfi-name*

Syntax Description

vfi-name	(Optional) Name of the VFI.

Command Modes

Privileged EXEC

Command History

Release	Modification
12.0(31)S	This command was introduced.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.
12.2(33)SRA	This command was extended to show VPN ID information.
12.2(33)SRB	This command was updated to display VPLS Autodiscovery information.

Examples

This example shows an example of VFI status. The VC ID in the output represents the VPN ID; the VC is identified by the combination of the destination address and the VC ID.

```
Router# show vfi VPLS-2

VFI name: VPLS-2, state: up
  VPN ID: 100
  Local attachment circuits:
    Vlan2
  Neighbors connected via pseudowires:
  Peer Address     VC ID     Split-horizon
  10.1.1.1          2             Y
  10.1.1.2          2             Y
  10.2.2.3          2             N
```

Table 1 explains the fields displayed in the output.

Table 1 show vfi Command Field Descriptions

Field	Description
VFI name	The name assigned to the VFI
state	The status of the VFI (up or down)
Local attachment circuits	The interface or VLAN assigned to the VFI
Peer Address	The IP address of the peer router
VC ID	The VC ID assigned to the pseudowire
Split-horizon	Whether split horizon is enabled (Y) or disabled (N)

For the VPLS Autodiscovery feature, the command output of the **show vfi** command includes autodiscovery information.

```
Router# show vfi

Legend: RT= Route-target, S=Split-horizon, Y=Yes, N=No

VFI name: VPLS1, state: up, type: multipoint
  VPN ID: 10, VPLS-ID: 9:10
  RD: 9:10, RT: 10.10.10.10:150
  Local attachment circuits:
    Ethernet0/0.2
  Neighbors connected via pseudowires:
  Peer Address      VC ID       Discovered Router ID       S
  10.7.7.1           10          10.7.7.1                  Y
  10.7.7.2           10          10.1.1.2                  Y
  10.7.7.3           10          10.1.1.3                  Y
  10.7.7.4           10          10.1.1.4                  Y
  10.7.7.5           10          -                         Y

VFI name: VPLS2 state: up, type: multipoint
  VPN ID: 11, VPLS-ID: 10.9.9.9:2345
  RD: 10:11, RT: 10.4.4.4:151
  Local attachment circuits:
    Ethernet0/0.3
  Neighbors connected via pseudowires:
  Peer Address      VC ID       Discovered Router ID      S
  10.7.7.1           11          10.7.7.1                 Y
  10.7.7.2           11          10.1.1.5                 Y
```

Table 2 explains the fields related to VPLS Autodiscovery displayed in the output.

Table 2 show vfi Field Descriptions for VPLS Autodiscovery

Field	Description
VPLS-ID	The identifier of the VPLS domain. VPLS Autodiscovery automatically generates a VPLS ID using the BGP autonomous system number and the configured VFI VPN ID.
RD	The route distinguisher (RD) to distribute end-point information. VPLS Autodiscovery automatically generates an RD using the BGP autonomous system number and the configured VFI VPN ID.
RT	The route target (RT). VPLS Autodiscovery automatically generates a route target using the lower 6 bytes of the RD and VPLS ID.
Discovered Router ID	A unique identifier assigned to the PE router. VPLS Autodiscovery automatically generates Router ID using the MPLS global router ID.

Related Commands

Command	Description
show xconnect	Displays information about xconnect attachment circuits and pseudowires.