Configuring Virtual Private LAN Services

This chapter describes Virtual Private LAN Services (VPLS). This chapter also describes procedures to configure VPLS.

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- NTP-J107 Configure a VPLS Circuit Using CTC, page 10
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Virtual Private LAN Services

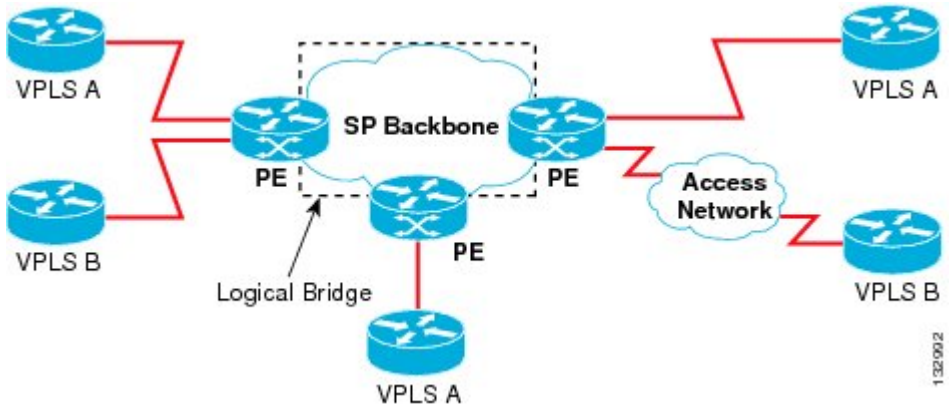
Virtual Private LAN Services (VPLS) is a multipoint Layer 2 VPN (L2VPN) technology that allows multiple sites to be connected over a simulated Ethernet broadcast domain, which is supported across a provider-provisioned IP/MPLS network. In other words, VPLS delivers multipoint Layer 2 connectivity over a Layer 3 network architecture. VPLS evolved as a logical extension of Ethernet over MPLS (EoMPLS), which was developed to enable point-to-point Ethernet-based L2VPN services.

At a basic level, VPLS can be defined as a group of Virtual Switch Instances (VSIs) that are interconnected using EoMPLS circuits to form a single, logical bridge. In concept, a VSI is similar to the bridging function found in IEEE 802.1q bridges where a frame is switched based on the destination MAC and membership in a Layer 2 VPN (a virtual LAN or VLAN). If the destination address is unknown, or is a broadcast or multicast address, the frame is flooded to all ports associated with the VSI, where a port, in the context of VPLS, is an EoMPLS virtual circuit (VC) pseudowire.

VPLS uses the provider core to join multiple attachment circuits together to simulate a virtual bridge that connects the multiple attachment circuits together. From a user-perspective, there is no topology for VPLS.

All of the customer edge (CE) devices appear to connect to a logical bridge emulated by the provider core. See the figure below:

Figure 1: Virtual Private LAN Services



With VPLS, all CE devices participating in a single VPLS instance appear to be on the same LAN; therefore, each CE device can communicate directly with one another in a multipoint topology, without requiring a full mesh of point-to-point circuits at the CE device. In a VPLS network, CE and provider edge (PE) devices are not routing peers, so there is no need for service providers to provision customer IP routers; this is a significant advantage over MPLS L3 VPN services. Compared to traditional LAN switching technologies, VPLS is also more flexible in its geographic scaling, so that CE sites may be within the same metropolitan domain, or may be geographically dispersed on a regional or national basis.

VPLS using Label Distribution Protocol (LDP) Signaling is supported in this release of Carrier Packet Transport(CPT). To enable VPLS over a CPT network, a full-mesh or ring configuration with bridge-domains (pseudowires or Ethernet Flow Points (EFPs)) must be established using the Label Distribution Protocol (LDP). Dynamic pseudowires over LDP signalled, Static Pseudowire, Traffic Engineering (TE), or Transport Profile (TP) label switched path is supported in this release.

VPLS can be enabled on these configurations:

- Full-mesh
- Ring

Full-Mesh Configuration

The full-mesh configuration requires a full mesh of label-switched paths (LSPs) tunnels between all the PEs that participate in the VPLS. The tunnel label switched paths are required only for TE and TP configurations and not for LDP. With a full-mesh configuration, signaling overhead and packet replication requirements for each provisioned VC on a PE can be high.

To set up a VPLS, a virtual forwarding instance (VFI) must be created on each participating PE router. The VFI specifies the VPN ID of a VPLS domain, the addresses of other PE routers in the domain, and the type of tunnel signaling and encapsulation mechanism for each peer PE router.

The set of VFIs formed by the interconnection of the emulated VCs is called a *VPLS instance*; it is the VPLS instance that forms the logic bridge over a packet-switched network (PSN). The VPLS instance is assigned a unique VPN ID.

The PE routers use the VFI to establish a full-mesh LSP of emulated VCs to all the other PE routers in the VPLS instance. PE routers obtain the membership of a VPLS instance.

The full-mesh configuration allows the PE router to maintain a single broadcast domain. The CE devices view the VPLS instance as an emulated LAN.

To avoid the problem of a packet looping in the provider core, the PE devices enforce a *split-horizon* principle for the emulated VCs. That means if a packet is received on an emulated VC, it is not forwarded on any other emulated VC.

After the VFI has been defined, it needs to be bound to a bridge-domain to the CE device.

The packet forwarding decision is made by looking up the Layer 2 VFI of a particular VPLS domain.

A VPLS instance on a particular PE router receives Ethernet frames that enter on specific physical or logical ports and populates a MAC table similarly to how an Ethernet switch works. The PE router can use the MAC address to switch those frames into the appropriate LSP to be delivered to another PE router at a remote site.

If the MAC address is not in the MAC address table, the PE router replicates the Ethernet frame and floods it to all logical ports associated with that VPLS instance, except the ingress port where it just entered. The PE router updates the MAC table as it receives packets on specific ports and removes addresses that are not used for specific periods.

Ring Configuration

Ring configuration reduces both signaling and replication overhead, and also the bandwidth utilization for multicast traffic. Ring VPLS has an interconnection of PEs in a ring fashion. The main difference between ring and mesh VPLS is that in mesh VPLS, split horizon is enabled between the core PWs, and in a ring VPLS, split horizon is disabled. To prevent the consequential loop, at least one span in the ring is deprived of the PW configuration, that is, in a ring formed from X number of PEs, there will be (X-1) PWs with split horizon disabled.

Comparison of Mesh VPLS with Ring VPLS

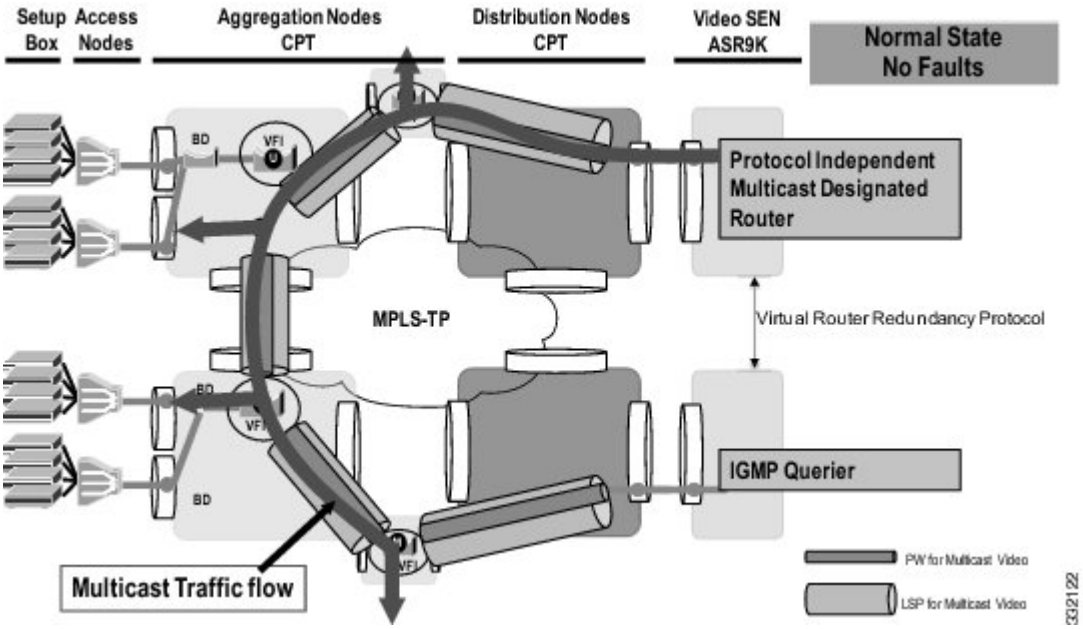
VPLS builds a full mesh of connections by default. In full mesh VPLS, multiple copies of customer traffic is present in the network path. In full mesh VPLS, if the number of multicast receiving node is N, there will be around N/2~1 copies of traffic along the network path.

In ring VPLS, a single copy of customer traffic traverses the network path. IGMP snooping feature replicates multicast steam to all destination sites which have joined the multicast group. Its forwarding mechanism is similar to Ethernet multicast forwarding mechanism. Ring topology is best suited for multicast application where the receivers are distributed across the PEs. Flooding of multicast traffic in the ring can be controlled by enabling IGMP snooping on the VPLS service.

Fault Handling in Ring VPLS

It is recommended to have protected TP tunnels between all PEs for robust network. In such a topology, a single link fault has no effect on the multicast entries and has a switch time of 50 milli-seconds. To counter multiple failures in the ring, redundancy at the router end is relied upon as shown in the below figure.

Figure 2: Efficient Video Distribution Logical Topology



The active or the standby state at the router is handled by the native multicast protocol and redundancy configurations at the router end.

Configuring VPLS

Provisioning a VPLS link involves provisioning the associated bridge-domain and the VFI on the PE. Before you configure VPLS, ensure that the network is configured as follows:

- (Only Dynamic MPLS) Configure IP routing in the core network so that the PE routers can reach each other through the IP.
- Configure MPLS in the core network so that a LSP exists between the PE routers.
- Configure a loopback interface for originating and terminating Layer 2 traffic. Make sure that the PE routers can access the loopback interface of other routers.

VPLS configuration requires you to identify peer PE routers and to attach Layer 2 circuits to the VPLS at each PE router.

Restrictions of VPLS

- On the CPT platform, the attachment circuit (AC)-less model is used to provision PWs. There is no AC-VFI binding in any of the VPLS deployment scenarios. AC is transparent to VFI and is handled completely by the bridge-domain.
- VC Type 5 (Ethernet) is supported and not VC Type 4 pseudowire for VPLS.

- Double tag encapsulation with rewrite POP 1 operation is not supported for VPLS EFP.

Supported Features on VPLS

- Multicast ring topology
- Internet Group Management Protocol (IGMP) Snooping
- MAC learning and flushing
- Port-based Quality of Service (QoS) for MPLS core port
- Service-based QoS for VPLS EFP
- Split-horizon and shut or no shut operations on VPLS EFP

Interaction of VPLS with other Features

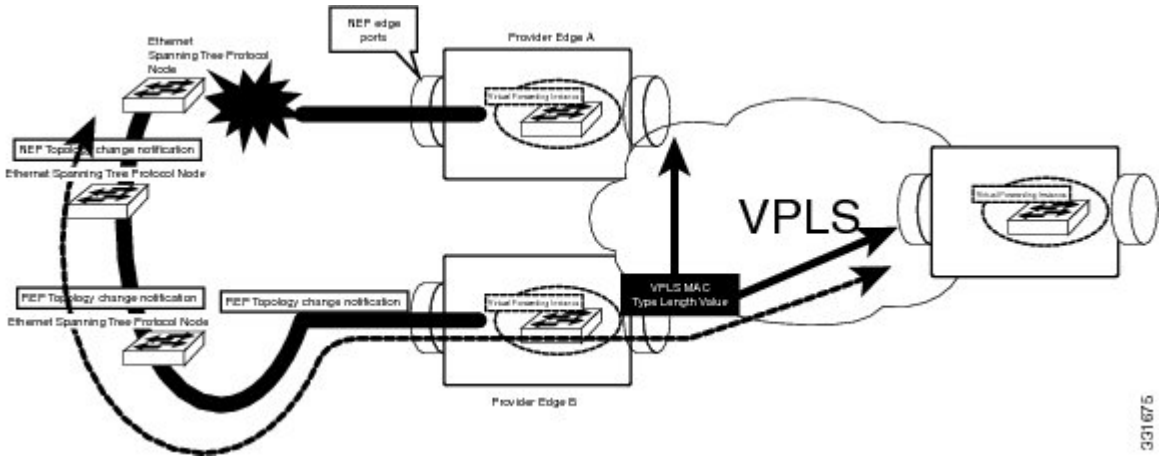
The CPT VPLS feature supports QoS, In-Service Software Upgrade (ISSU), High Availability (HA), and active-active forwarding. Active-Active forwarding is supported by VPLS only when graceful-restart is enabled.

The CPT VPLS feature provides multicast support that is required for efficient video traffic distribution. This is achieved by enabling IGMP snooping on the VPLS bridge-domain. The IGMP snooping for VPLS on CPT, provides the ability to send Layer 2 multicast frames from the CE in a VPLS VFI only to those remote peer CEs that have sent an IGMP request to join the multicast group. To configure IGMP on VPLS, follow the restrictions and usage guidelines stated in the chapter, *Configuring IGMP Snooping*. IGMP on VPLS does not support static multicast routers.

The CPT VPLS feature supports MAC learning and MAC flush on the VPLS bridge-domain and MAC withdrawal, based on the LDP update. VPLS-capable systems must dynamically learn MAC addresses on the EFPs and PWs and must be able to forward and replicate packets across both EFPs and PWs. MAC entries are learnt per VFI. The CPT system is a distributed system that has fabric cards, line cards, and CPT-50 shelf. Therefore, the MAC addresses learned on one line card needs to be learned (or distributed) on the other line cards as well. The CPT VPLS feature distributes the MAC addresses learnt on one line card to other line cards and thereby avoids flooding even after a PW switchover. Also, a software MAC address table is maintained on the fabric cards. This MAC address table contains all the MAC addresses learned on all the line cards. This table is used to distribute the MAC addresses in case of a line card reboot or a line card Online Insertion and Removal (OIR). The MAC address learned are distributed to all the cards and are stored in their respective hardware tables. The CPT system supports static MAC entry commands.

The CPT VPLS feature supports Link Aggregation (LAG) on the EFP side and not the PW side.

On the EFP side, if Resilient Ethernet Protocol (REP) is enabled, the CPT VPLS feature supports MAC flush and withdrawal when REP switchover is triggered. MAC flush is triggered when access PW switchover occurs and when the VPLS EFP comes up per bridge-domain. When the core PW goes down, the MAC flush occurs per PW. The following figure explains the REP and VPLS interaction:



When there is a link failure, the REP ports are unblocked and the REP ring is restored in less than a second. REP access failure is propagated through REP Topology Change Notification (TCN) across the ring. REP TCN triggers MAC withdrawal and the traffic can be quickly restored over the VPLS domain

Supported Encapsulation and Rewrite Operations

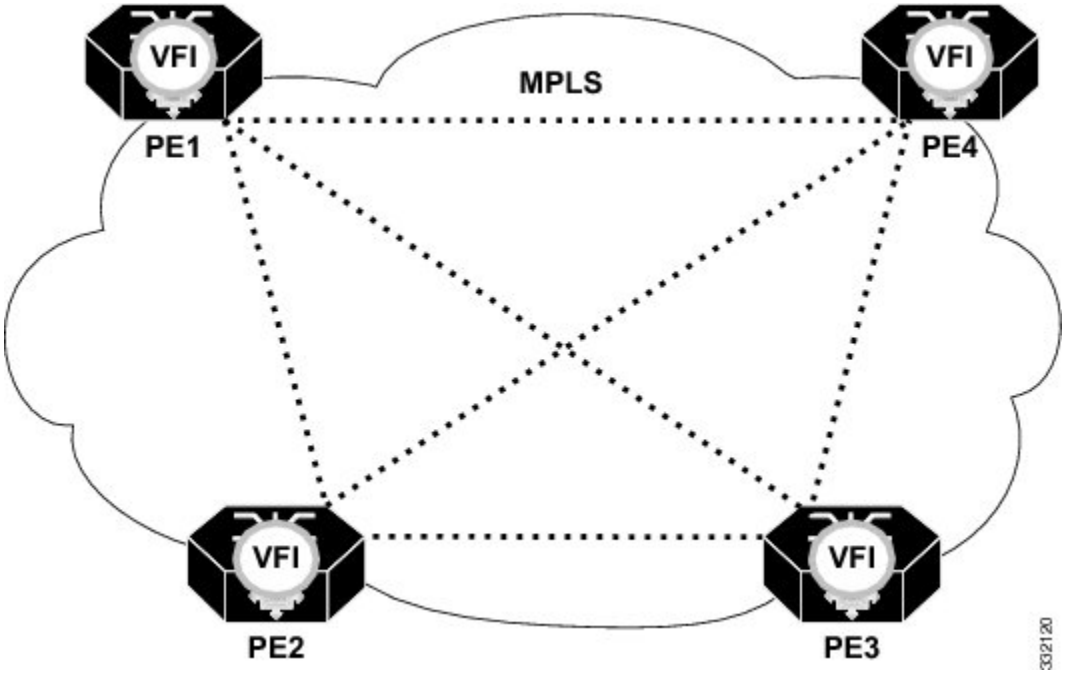
The supported encapsulation and rewrite operations for VPLS are listed in Table 2.

This section contains examples that show how to configure VPLS using Cisco IOS commands.

Example: Mesh Topology

The example in this section explains how to configure VPLS in case of a mesh topology that is shown in the below figure:

Figure 3: Mesh Topology




```
! Configuration on PE1
bridge-domain 100
mode vpls

l2 vfi vpls-100 manual
vpn id 100
bridge-domain 100
neighbor 2.2.2.2 encapsulation mpls
neighbor 3.3.3.3 encapsulation mpls
neighbor 4.4.4.4 encapsulation mpls

! Configuration on PE2
bridge-domain 100
mode vpls

l2 vfi vpls-100 manual
vpn id 100
bridge-domain 100
neighbor 1.1.1.1 encapsulation mpls
neighbor 3.3.3.3 encapsulation mpls
neighbor 4.4.4.4 encapsulation mpls

! Configuration on PE3
bridge-domain 100
mode vpls

l2 vfi vpls-100 manual
vpn id 100
bridge-domain 100
neighbor 1.1.1.1 encapsulation mpls
neighbor 2.2.2.2 encapsulation mpls
neighbor 4.4.4.4 encapsulation mpls
```

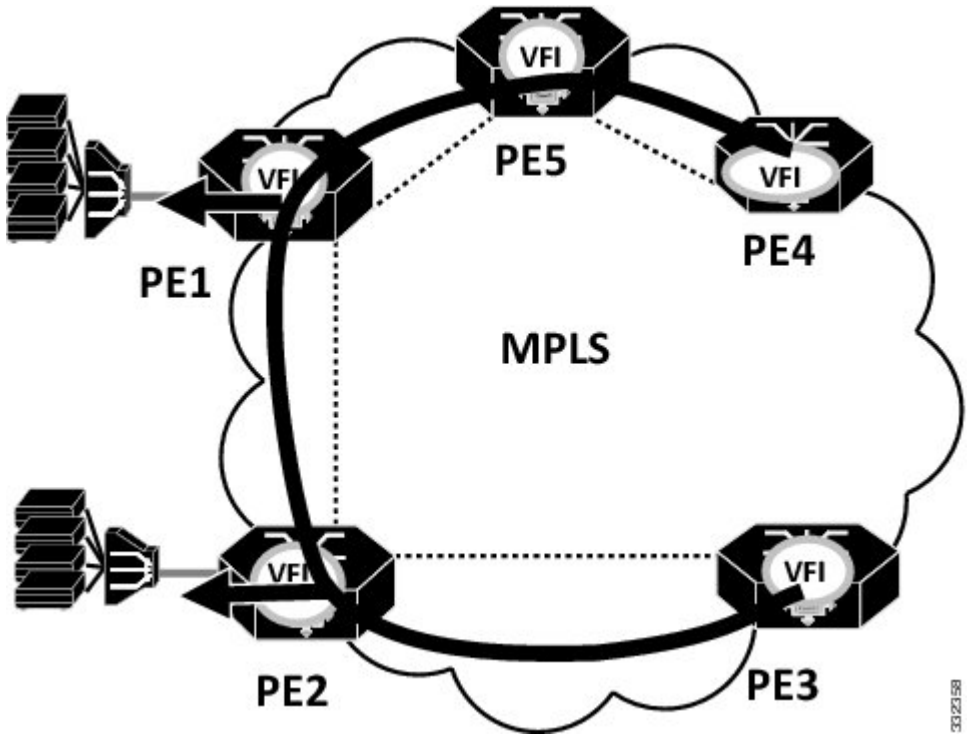
```
! Configuration on PE4
bridge-domain 100
mode vpls

l2 vfi vpls-100 manual
vpn id 100
bridge-domain 100
neighbor 1.1.1.1 encapsulation mpls
neighbor 2.2.2.2 encapsulation mpls
neighbor 3.3.3.3 encapsulation mpls
```

Example: Ring Topology

The example in this section explains how to configure VPLS in case of a ring topology that is shown in the below figure:

Figure 4: Ring Topology



Note Split-horizon is disabled on PE1 and PE2 to allow packet to go from one VPLS PW to another VPLS PW

```
! Configuration on PE1
bridge-domain 100
mode vpls

l2 vfi vpls-100 manual
vpn id 100
bridge-domain 100
neighbor 2.2.2.2 encapsulation mpls no-split-horizon
neighbor 4.4.4.4 encapsulation mpls no-split-horizon

Interface 36/11
```

```
Service instance 10 ethernet
Encap dot1q 10
Bridge-domain 100

! Configuration on PE2
bridge-domain 100
mode vpls

l2 vfi vpls-100 manual
vpn id 100
bridge-domain 100
neighbor 1.1.1.1 encapsulation mpls no-split-horizon
neighbor 3.3.3.3 encapsulation mpls no-split-horizon

Interface 36/12
Service instance 10 ethernet
Encap dot1q 10
Bridge-domain 100


! Configuration on PE3
bridge-domain 100
mode vpls

l2 vfi vpls-100 manual
vpn id 100
bridge-domain 100
neighbor 2.2.2.2 encapsulation mpls

Interface 4/2
Service instance 10 ethernet
Encap dot1q 10
Bridge-domain 100

! Configuration on PE4
bridge-domain 100
mode vpls

l2 vfi vpls-100 manual
vpn id 100
bridge-domain 100
neighbor 1.1.1.1 encapsulation mpls

Interface 4/2
Service instance 10 ethernet
Encap dot1q 10
Bridge-domain 100
```

Example: IGMP Snooping

The following example shows how to enable IGMP snooping on the VPLS bridge-domain and how to configure the source and host ports:

```
! Configuration on the bridge-domain
Router(config)# bridge-domain 200
Router(config-bdomain)# mode vpls
Router(config-bdomain)# ip igmp snooping

! Configuration on port 1
Router(config)# interface gi 36/1
Router(config-if)# service instance 10 ethernet
Router(config-if-srv)# encapsulation untagged
Router(config-if-srv)# bridge-domain 30

! Configuration on port 2
Router(config)# interface gi 36/2
Router(config-if)# service instance 10 ethernet
Router(config-if-srv)# encapsulation dot1q 200
Router(config-if-srv)# rewrite ingress pop 1 symmetric
```

```
Router(config-if-srv)# bridge-domain 30

! Configuration on port 3
Router(config)# interface gi 36/6
Router(config-if)# service instance 10 ethernet
Router(config-if-srv)# encapsulation dot1q 101 second-dot1q 20
Router(config-if-srv)# rewrite ingress pop 2 symmetric
Router(config-if-srv)# bridge-domain 30
```

The following example shows how to enable IGMP immediate leave on the VPLS bridge-domain:

```
Router(config)# bridge-domain 200
Router(config-bdomain)# mode vpls
Router(config-bdomain)# ip igmp snooping immediate-leave
```

The following example shows how to disable IGMP report suppression on the VPLS bridge-domain:

```
Router(config)# bridge-domain 200
Router(config-bdomain)# mode vpls
Router(config-bdomain)# no ip igmp snooping report-suppression
```

NTP-J107 Configure a VPLS Circuit Using CTC

Purpose	This procedure configures a VPLS circuit using CTC.
Tools/Equipment	None
Prerequisite Procedures	None
Required/As Needed	As needed
Onsite/Remote	Onsite or remote
Security Level	Provisioning or higher

Procedure

Step 1 Complete DLP-J335 Create a VPLS Circuit Using CTC, on page 10.

Step 2 Create an access pseudowire on the node (user provider edge (U-PE)) that must be added to the existing VPLS circuit. The access pseudowire must be created from U-PE to an unmanaged node only. To create an access pseudowire, see DLP-J91 Create a Pseudowire Using CTC.

Step 3 Complete DLP-J336 Edit a VPLS Circuit Using CTC, on page 12.

DLP-J335 Create a VPLS Circuit Using CTC

Purpose	This procedure creates a VPLS circuit using CTC.
Tools/Equipment	None

Prerequisite Procedures	• Create loopback addresses on the nodes. • Enable Open Shortest Path First (OSPF) (for a TP tunnel, enable OSPF on loopback interface). • Enable OSPF on the physical interface (for a TP tunnel without IP, enabling OSPF is not required). • Establish LDP, TE, or TP connectivity between the nodes. • Enable OSPF on the TP or TE interface or create a static route for the destination IP using tunnel interface. • DLP-J89 Create a Pseudowire Class Using CTC.
Required/As Needed	As needed
Onsite/Remote	Onsite or remote
Security Level	Provisioning or higher

Procedure

Step 1 Complete the NTP-J22 Log into CTC procedure at a node on the network where you want to create a VPLS circuit.

Step 2 From the View menu, choose **Go to Network View**.

Step 3 Click the **Layer2+** tab.

Step 4 From the left pane, click **Circuits**.

Step 5 Click the **VPLS** tab.

Step 6 Click **Create**. The Circuit Creation wizard appears.

Step 7 In the Global Attributes area of the Circuit Attributes screen, specify the global attributes:

a) Enter the name of the VPLS circuit that you want to create.
b) Enter the description of the VPLS circuit.
c) Enter the VPN ID.
d) From the Admin State drop–down list, choose **UP** or **DOWN** . The default value is UP.
e) Specify the bandwidth of the VPLS circuit in Kbps, Mbps, or Gbps.
f) In the VPLS Type area of the Circuit Attributes screen, choose any one of the following VPLS types:

- Open Ring
- Mesh

Step 8 Click **Next**. The VPLS Configuration screen is displayed.

Step 9 Click **Select Nodes for the VPLS Network**. The Select Nodes for the VPLS Network screen is displayed.

Step 10 To select the nodes for the VPLS network:

a) Select a node from the network map and click **Add**. The Add node dialog box appears.

b) Check the **Unmanaged Node** check box when the node is not a CPT node. If this check box is checked, enter the IP address of the unmanaged node.
c) From the list of nodes, choose nodes and click **Apply**.
d) Click **Apply**. The nodes are added to the VPLS network and are displayed in the VPLS Configuration screen.

Step 11 In the VPLS Configuration screen, choose NONE as the pseudowire class from the PW Class A and PW Class Z drop-down lists.

Note Ethernet and VLAN options are not supported as a pseudowire class.

The available attributes are:

- Span—(Display only) Indicates the circuit span information.
- VC ID A—(Display only) Indicates the VC ID of the first node in the span.
- VC ID Z—(Display only) Indicates the VC ID of the second node in the span.
- Split Horizon A—(Display only) Indicates the split horizon status (enabled or disabled) of the first node in the span.
- Split Horizon Z—(Display only) Indicates the split horizon status (enabled or disabled) of the second node in the span.
- Manual Route—Adds an intermediate node between the first and the second nodes in the span.
- S-PE Right—(Display only) Indicates that the intermediate service provider edge (S-PE) node is present on the right side of the first node in the span.
- S-PE Left—(Display only) Indicates that the intermediate S-PE node is present on the left side of the second node in the span.

Step 12 Click **Finish**.

Step 13 Return to your originating procedure (NTP).

DLP-J336 Edit a VPLS Circuit Using CTC

Purpose	This procedure edits a VPLS circuit using CTC: • Create new endpoint PWs for the VPLS circuit • Create new endpoint EFPs for the VPLS circuit • Specify the QoS policies to apply on individual EFPs • Specify the IGMP snooping settings for the bridge-domain • Specify the MAC learning settings for the bridge-domain

Tools/Equipment	None
Prerequisite Procedures	DLP-J335 Create a VPLS Circuit Using CTC, on page 10
Required/As Needed	As needed
Onsite/Remote	Onsite or remote
Security Level	Provisioning or higher

Procedure

Step 1 Complete the NTP-J22 Log into CTC procedure at a node where you want to edit a VPLS circuit.

Step 2 From the View menu, choose **Go to Home View**.

Step 3 Click the **Layer2+** tab.

Step 4 Click **VPLS**.

Step 5 From the list of VPLS circuits, select a VPLS circuit to edit.

Step 6 Click **Edit**. The Edit Circuit dialog box appears.

Step 7 In the General tab, view the name, description, service ID, and MTU of the VPLS circuit.

Step 8 In the Endpoint PWs tab, view the node list that are part of the selected VPLS circuit. Select the node in the VPLS Node List area to view the details of its neighbor node in the Neighbors area.
You can create new endpoints only for Ethernet Private LAN and Ethernet Virtual Private LAN.

To create new endpoint PWs for this VPLS circuit:

a) Click **Create**. The Define New Drop wizard appears.
b) In the New Drop screen of the wizard, choose a VPLS type.
c) Click **Next**. The VPLS Configuration screen is displayed.
d) Click **Select Nodes for the VPLS Network**. The Select Nodes for the VPLS Network screen is displayed.
e) To select the nodes for the VPLS network:

1. Select a node from the network map and click **Add**. The Add node dialog box appears.
2. Check the **Unmanaged Node** check box when the node is not a CPT node. If this check box is checked, enter the IP address of the unmanaged node.
3. From the Node drop-down list, choose a node and click **Apply**.
4. Repeat Step 8ei to Step 8eiii to add the remaining nodes.
5. Click **Apply**. The nodes are added to the VPLS network and are displayed in the VPLS Configuration screen.

f) In the VPLS Configuration screen, choose NONE as the pseudowire class from the PW Class A and PW Class Z drop-down lists.

Note Ethernet and VLAN options are not supported as a pseudowire class.

The available attributes are:

- Span—(Display only) Indicates the circuit span information.

- VC ID A—(Display only) Indicates the VC ID of the first node in the span.
- VC ID Z—(Display only) Indicates the VC ID of the second node in the span.
- Split Horizon A—(Display only) Indicates the split horizon status (enabled or disabled) of the first node in the span.
- Split Horizon Z—(Display only) Indicates the split horizon status (enabled or disabled) of the second node in the span.
- Manual Route—Adds an intermediate node between the first and the second nodes in the span.
- S-PE Right—(Display only) Indicates that the intermediate S-PE node is present on the right side of the first node in the span.
- S-PE Left—(Display only) Indicates that the intermediate S-PE node is present on the left side of the second node in the span.

g) Click **Finish**.
To delete an endpoint PW, select the node in the VPLS Node List area and click **Delete Node**.

Note If you delete an endpoint PW neighbor in a mesh VPLS circuit containing EFPs, the VPLS circuit moves to Partial and UP state. When you clear and re-query the VPLS circuit, the circuits do not merge and two VPLS circuits are observed in Partial and DOWN state. This is because the neighbor IP of one of the nodes is deleted.

Step 9 In the S-PE Nodes tab, view the node list that is part of the selected VPLS circuit. Select the node in the VPLS Node List area to view the details of its neighbor node in the Neighbors area. You can delete the neighbor and node by selecting them and clicking the **Delete Neighbor** or the **Delete Node** button.

Step 10 In the Endpoint EFPs tab, view the EFPs that are part of the selected VPLS. You can create new endpoints only for Ethernet Private LAN and Ethernet Virtual Private LAN. To create a new endpoint EFP for this VPLS:

a) Click **Create**. The Define New Drop wizard appears.
b) In the New Drop screen of the wizard, choose a node from the Node drop-down list.
c) To choose a port to serve as the EFP:

1. From the Fabric/Line/Satellite Slot drop-down list, choose a slot.
2. From the Port drop-down list, choose a port to serve as the EFP.

d) To choose a channel group to serve as the EFP:

1. Check the **CHGRP as EFP** check box.
2. From the CHGRP drop-down list, choose a channel group to serve as the EFP.
3. Click **Manual Load Balancing** to configure manual load balancing on the ports of the channel group. The Manual Load Balancing dialog box appears.

e) Click **Next**. In the EFP Configuration Preview screen of the wizard, CTC displays the VPLS path.
f) Select the Node from the network map. The EFP Selection area displays the node selected.
g) From the Available Ports drop-down list, choose the ports.
h) In the EFP Configuration tab, specify the VLAN configuration for this EFP.
i) Click **Finish** to create a new EFP for this VPLS.

Note After you have completed the DLP-J335 Create a VPLS Circuit Using CTC, on page 10 procedure, you can create new endpoints EFPs/PWs or add existing EFPs/PWs to this VPLS circuit. CTC allows you to add only until 127 entries; EFPs or neighbor nodes. This number includes the total number of entries made in both, Endpoint PWs tab and Endpoint EFP tab. CTC blocks any attempts to add more than 127 entries to this VPLS circuit.

Step 11 In the EFP Configuration tab, specify the VLAN configuration for the selected EFP and click **Apply**.

Step 12 In the QoS tab, specify the QoS policies to apply on the individual EFPs:

a) From the Ingress Policy drop-down list, choose the required policy.
b) From the Egress Policy drop-down list, choose the required policy.
c) Click **Apply**.

Step 13 (Only for Ethernet Virtual Private LAN type) In the IGMP Snooping tab, specify the settings for the bridge domain:

a) Check the **IGMP Snooping** check box to enable IGMP snooping on this bridge domain.
b) Check the **Immediate Leave** check box to enable IGMP snooping to immediately remove a port when it detects an IGMP version 2 leave a message on that port.
c) Check the **Report Suppression** check box to ensure that the bridge domain forwards only one IGMP report for each multicast query.
d) Click **Apply**.

Step 14 (Only for Ethernet Private LAN and Ethernet Virtual Private LAN types) In the MAC Learning tab, specify the MAC learning settings for the bridge domain:

a) Check the **MAC Learning** check box to enable MAC learning on this bridge domain. MAC learning is enabled by default for Ethernet Private LAN and Ethernet Virtual Private LAN.
b) Enter the upper limit on the number of MAC addresses that reside in a bridge domain.
The maximum MAC address limit on a bridge domain is 128000.
c) Click **Apply**.
d) Click **Static MAC Address Configuration**. The EFP Static MAC Address Configuration dialog box appears. Enter the static MAC addresses for each EFP or PW.
e) Select the **EFP** or the **PW** radio button and from the drop-down list, choose an EFP or the PW.
f) Enter one or more static MAC addresses for the EFP or the PW in the MAC Address field and click **Add**. The added MAC addresses appear in the Entered MAC Addresses area.
g) Click **Apply** and close the EFP Static MAC Address Configuration dialog box.
h) Click **Clear MAC Address(es)**. The Clear MAC Addresses dialog box appears. Select the specific MAC address to remove from the MAC address table.
i) Select the **CPT System**, **EFP** or the **PW** radio button and from the drop-down list, choose the CPT system, EFP or the PW where you want to clear the MAC address.
j) Enter the MAC address in the MAC Address field and click **Add**.
k) Click **Clear** to clear all the MAC addresses in the MAC Addresses to clear area.
l) Click **Clear All** to clear all the MAC addresses learned on the CPT system, EFP, or PW.
m) Close the Clear MAC Addresses dialog box.
n) Click **Display MAC Address(es)** to display the configured static MAC addresses for each EFP or the PW. The Configured EFP Static MAC Addresses dialog box appears.
o) Select the **EFP** or the **PW** radio button and from the drop-down list, choose an EFP or the PW.
The MAC addresses configured on the EFP or the PW appear in the Configured MAC Addresses area.
p) Close the Configured EFP Static MAC Addresses dialog box.

Step 15 In the State tab, edit the state of the VPLS circuit:

a) From the Target VPLS Admin state drop-down menu, select **UP** or **DOWN**.
b) Click **Apply**.

Step 16 Return to your originating procedure (NTP).

NTP-J108 Configure a VPLS Circuit Using Cisco IOS Commands

Purpose	This procedure configures a VPLS circuit using Cisco IOS commands.
Tools/Equipment	None
Prerequisite Procedures	None
Required/As Needed	As needed
Onsite/Remote	Onsite or remote
Security Level	Provisioning or higher

Procedure

Step 1 Complete DLP-J216 Configure a Bridge Domain Using Cisco IOS Commands.

Step 2 (Optional) Complete DLP-J1 Configure an Ethernet Service Instance Using Cisco IOS Commands when the CE is connected to the PE using Ethernet services.

Step 3 Complete any one of the following procedures as applicable:

- DLP-J119 Enable MPLS LDP-IGP Synchronization Using Cisco IOS Commands.
- NTP-J48 Configure MPLS-TE Parameters.
- NTP-J41 Configure an MPLS-TP Tunnel.

Step 4 Complete DLP-J337 Create a Layer 2 Virtual Forwarding Instance Using Cisco IOS Commands, on page 17.

Step 5 Complete DLP-J90 Create a Pseudowire Using Cisco IOS Commands when the PE (U-PE) is connected to another PE using MPLS services.

DLP-J337 Create a Layer 2 Virtual Forwarding Instance Using Cisco IOS Commands

Purpose	This procedure creates a layer 2 virtual forwarding instance (VFI) using Cisco IOS commands.
Tools/Equipment	None
Prerequisite Procedures	DLP-J216 Configure a Bridge Domain Using Cisco IOS Commands (with VPLS mode)
Required/As Needed	As needed
Onsite/Remote	Onsite or remote
Security Level	Provisioning or higher

Procedure

	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* **manual** **Example:** Router(config)# l2 vfi VPLSA manual	Creates a named Layer 2 Virtual Forwarding Instance (VFI) and enters the L2 VFI manual configuration mode.
Step 4	**vpn id** *vpnid* **Example:** Router(config-vfi)# vpn id 100	Configures a VPN ID for the VPLS domain.
Step 5	**bridge-domain** *bridge-id* **Example:** Router(config-vfi)# Bridge-domain 22	Specifies the bridge-domain number.
Step 6	**neighbor** *ip-address id* **{encapsulation mpls | pw-class** *pw-class-name*} **[no-split-horizon]** **Example:**	Specifies the remote peer router ID and the IP address of the router, and the tunnel encapsulation type (always set to mpls), or the pseudowire property.

	Command or Action	Purpose
	Router(config-vfi)# neighbor 33.33.33.33 6 encapsulation mpls	
Step 7	**exit** **Example:** Router(config-vfi)# exit	Exits the L2 VFI manual configuration mode.