# Network Configuration Example

## Virtual Private LAN Service Feature Guide

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*Network Configuration Example Virtual Private LAN Service Feature Guide*
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PART 1

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CHAPTER 1

# Virtual Private LAN Service Concepts and Reference Materials

This chapter covers these topics:



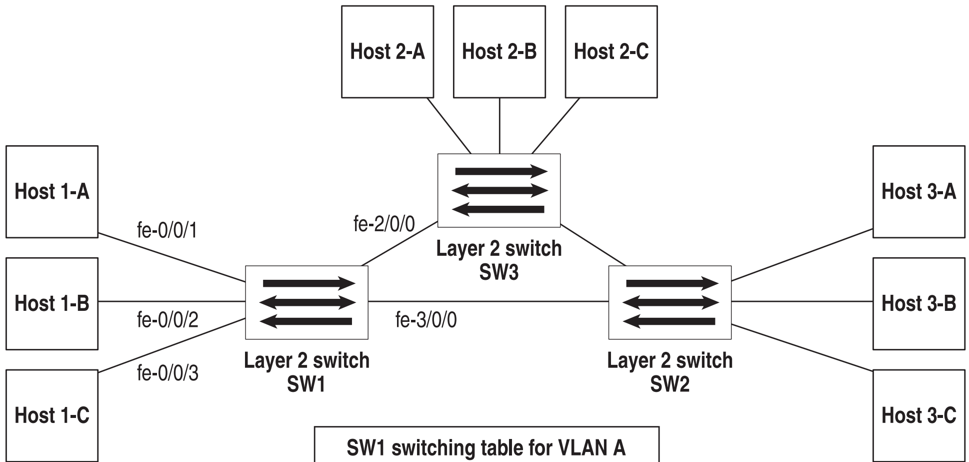
## Virtual Private LAN Service Overview

Ethernet is an increasingly important component of a service provider's slate of service offerings. Many customers are requesting the ability to connect LAN locations around the world. To fulfill customer needs, service providers have had to set up complex point-to-point Layer 2 virtual private networks (VPNs) or connect expensive Layer 2 switches to handle traffic.

Virtual private LAN service (VPLS) meets the growing Ethernet needs of service providers and their customers. VPLS is an Ethernet-based multipoint-to-multipoint Layer 2 VPN. With VPLS, multiple Ethernet LAN sites can be connected to each other across an MPLS backbone. To the customer, all sites interconnected by VPLS appear to be on the same Ethernet LAN (even though traffic travels across a service provider network).

Before VPLS, the only way you could connect Ethernet LAN sites together was to set up a non-VPLS Layer 2 VPN or install multiple Layer 2 Ethernet switches. Figure 1 on page 4 shows how three switches can be connected to each other.

### Figure 1: Ethernet Switching Example




**SW1 switching table for VLAN A**

| Port | MAC Address |
|---|---|
| fe-0/0/1 | 1a1a.1a1a.1a1a |
| fe-2/0/0 | 2a2a.2a2a.2a2a |
| fe-3/0/0 | 3a3a.3a3a.3a3a |

**SW1 switching table for VLAN B**

| Port | MAC Address |
|---|---|
| fe-0/0/2 | 1b1b.1b1b.1b1b |
| fe-2/0/0 | 2b2b.2b2b.2b2b |
| fe-3/0/0 | 3b3b.3b3b.3b3b |

**SW1 switching table for VLAN C**

| Port | MAC Address |
|---|---|
| fe-0/0/3 | 1c1c.1c1c.1c1c |
| fe-2/0/0 | 2c2c.2c2c.2c2c |
| fe-3/0/0 | 3c3c.3c3c.3c3c |

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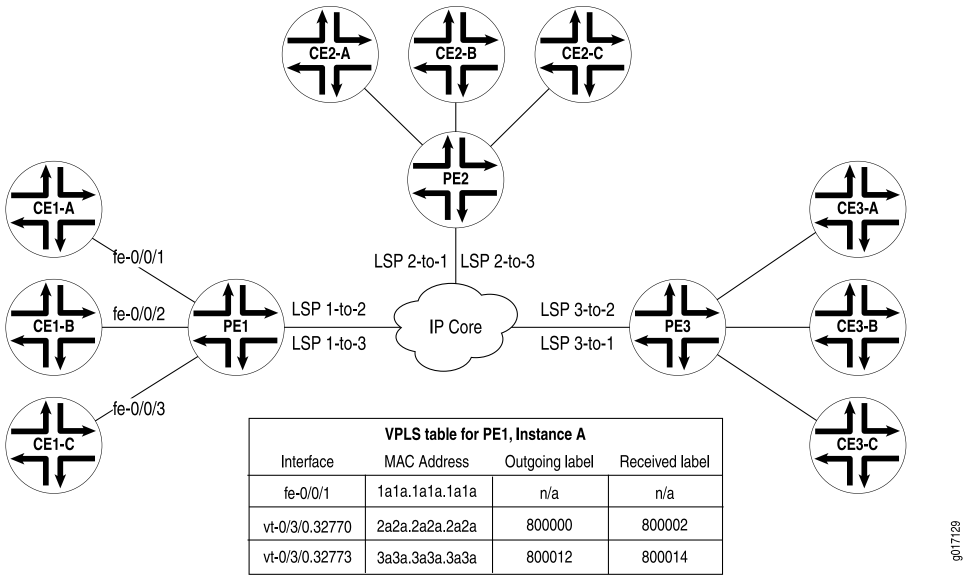
A typical switch builds its Layer 2 switching table with media access control (MAC) address and interface information learned from traffic received from other switches. If a switch does not have an exit port associated with a particular destination, it floods traffic for that destination to all ports except the port where the traffic originated. When reachability information for a destination is received, this information is added to the switching table. If the switching table has an entry for the destination, the switch sends the traffic directly to the intended recipient through the associated port listed in the switching table.

Figure 2 on page 5 shows a VPLS network comparable to the switch example and explains how VPLS functions similarly to Ethernet switches (assuming a Spanning Tree Protocol (STP) is configured).

## Figure 2: VPLS Introductory Example




**VPLS table for PE1, Instance A**

| Interface | MAC Address | Outgoing label | Received label |
|---|---|---|---|
| fe-0/0/1 | 1a1a.1a1a.1a1a | n/a | n/a |
| vt-0/3/0.32770 | 2a2a.2a2a.2a2a | 800000 | 800002 |
| vt-0/3/0.32773 | 3a3a.3a3a.3a3a | 800012 | 800014 |

**VPLS table for PE1, Instance B**

| Interface | MAC Address | Outgoing label | Received label |
|---|---|---|---|
| fe-0/0/2 | 1b1b.1b1b.1b1b | n/a | n/a |
| vt-0/3/0.32771 | 2b2b.2b2b.2b2b | 800004 | 800006 |
| vt-0/3/0.32774 | 3b3b.3b3b.3b3b | 800016 | 800018 |

**VPLS table for PE1, Instance C**

| Interface | MAC Address | Outgoing label | Received label |
|---|---|---|---|
| fe-0/0/3 | 1c1c.1c1c.1c1c | n/a | n/a |
| vt-0/3/0.32772 | 2c2c.2c2c.2c2c | 800008 | 800010 |
| vt-0/3/0.32775 | 3c3c.3c3c.3c3c | 800020 | 800022 |

Notice that Layer 2 information gathered by a switch (for example, MAC addresses and interface ports) is included in the VPLS instance table. However, instead of requiring all VPLS interfaces to be physical switch ports, the router allows remote traffic for a VPLS instance to be delivered across an MPLS label-switched path (LSP) and arrive on a virtual port. The virtual port emulates a local, physical port. Traffic can be learned, forwarded, or flooded to the virtual port similar to the way traffic is sent to a local port.

The VPLS table learns MAC address and interface information for both physical and virtual ports. If no activity is seen for a particular MAC address, it is purged from the table over time.

As shown in Figure 2 on page 5, the main difference between a physical port and a virtual port is that the router captures additional information from a virtual port—an outgoing MPLS label used to reach the remote site, and an incoming MPLS label for VPLS traffic received from the remote site.

When you configure VPLS on a routing platform, a virtual port is generated as a logical interface on a virtual loopback tunnel (**vt**) interface or a label-switched interface (LSI). On Juniper Networks M Series Multiservice Edge Routers and Juniper Networks T Series Core Routers, virtual ports are created dynamically on **vt** interfaces if you install a PIC that supports virtual tunnels. With VPLS, you must install at least one Tunnel Services, Link Services, or Adaptive Services PIC in each VPLS provider edge (PE) router. On Juniper Networks MX Series 3D Universal Edge Routers, virtual ports are created dynamically on **vt** interfaces if you configure tunnel services on one of the four Packet Forwarding Engines

(PFEs) included in each Dense Port Concentrator (DPC). If your routing platform does not offer tunnel services through a PIC or PFE, you can configure VPLS to create virtual ports on LSI logical interfaces.

One property of flooding behavior in VPLS is that traffic received from remote PE routers is never forwarded to other PE routers. This restriction helps prevent loops in the core network. If a customer edge (CE) Ethernet switch has redundant connections to the same PE router, you must enable the STP to prevent loops.

The paths that emulate a Layer 2 point-to-point connection over a packet-switched network are called *pseudowires*. The pseudowires are signaled using either BGP or LDP.

**Related Documentation**


- Example: VPLS Configuration (BGP Signaling) on page 43
- *Example: Configuring BGP Autodiscovery for LDP VPLS with User-Defined Mesh Groups*
- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71
- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55


## Virtual Private LAN Service System Requirements

To implement VPLS, your system must meet these minimum requirements:

- Junos OS Release 9.5 or later to implement Ethernet VPLS over Frame Relay interface encapsulation on M120 and M320 routers.
- Junos OS Release 9.5 or later to implement Ethernet VPLS over PPP interface encapsulation on M120 and M320 routers.
- Junos OS Release 9.1 or later for nonstop active routing (NSR), VPLS ping on M120, M320, and MX Series routers, and automatic site selection for BGP-signaled VPLS.
- Junos OS Release 9.0 or later for Virtual Spanning Tree Protocol (VSTP) support, 802.1p classification in Bridged Ethernet over ATM mode support, interworking between LDP and BGP signaling in a VPLS instance, and Layer 2 VPLS filters for MX960 routers.
- Junos OS Release 8.4 or later for VPLS with LDP signaling. Also, integrated routing and bridging (IRB) is supported starting in this release.
- Junos OS Release 8.3 or later for point-to-multipoint LSP support on VPLS.
- Junos OS Release 8.2 or later for VPLS support on MX Series routing platform, VPLS graceful Routing Engine switchover (GRES) support, and VPLS support on Gigabit Ethernet IQ2 aggregated Ethernet interfaces.
- Junos OS Release 7.6 or later for VPLS support on LSI logical interfaces.
- Junos OS Release 7.5 or later for multihoming a CE router to multiple PE routers.
- Junos OS Release 7.3 or later for VPLS per-packet load balancing, support for limiting MAC address learning per interface in a VPLS domain, and migration to the VPLS and Layer 2 VPN **signaling** statement at the **[edit protocols bgp groups *group-name* family l2vpn]** hierarchy level.

- Junos OS Release 6.4 or later to implement Ethernet VPLS over ATM LLC interface encapsulation on T Series and M320 routers, to select the tunnel-enabled PICs that provide virtual ports for VPLS operation, and to issue the **show vpls statistics** command.
- Junos OS Release 6.3 or later to clear MAC addresses from the VPLS table and to modify VPLS table timeout intervals.
- Junos OS Release 6.2 or later for VPLS class of service (CoS), VPLS graceful restart, VPLS interinstance bridging and routing, VPLS source and destination MAC address accounting, VPLS virtual port support on the Adaptive Services PIC for M Series routers, and general VPLS support for T Series and M320 routers.
- Junos OS Release 6.1 or later for VPLS policers and filters.
- Junos OS Release 6.0 or later for Ethernet VPLS over ATM LLC interface encapsulation on M Series routers.
- Junos OS Release 5.7 or later for VPLS with BGP signaling and Ethernet VPLS, VLAN VPLS, and extended VLAN VPLS interface encapsulations.
- Two Juniper Networks M Series (except the M160 router), MX Series, T Series, or TX Matrix routing platforms for the provider edge (PE).
- On M Series and T Series routers, one Adaptive Services PIC, Link Services PIC, or Tunnel Services PIC per routing platform to create VPLS virtual ports on **vt** interfaces.
- On M Series and T Series routers, one Fast Ethernet or Gigabit Ethernet PIC per routing platform (from this list):
  - 4-port Fast Ethernet PIC with 10/100 BASE-TX interfaces
  - 1-port, 2-port, or 10-port Gigabit Ethernet PIC
  - 4-port, quad-wide Gigabit Ethernet PIC
  - 1- and 2-port Gigabit Ethernet Intelligent Queuing (IQ) PIC
  - 4- and 8-port Gigabit Ethernet IQ2 PIC with small form-factor pluggable transceivers (SFPs)
  - 1-, 2-, and 4-port Gigabit Ethernet PIC with SFPs
  - 1-port 10-Gigabit Ethernet PIC

**Related Documentation**


- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71
- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55

## Virtual Private LAN Service Terms and Acronyms

### V

**virtual port** A special logical interface that is generated dynamically when you configure VPLS on a PE router. Virtual ports send and receive VPLS traffic for remote PE routers as if the remote VPLS sites had Ethernet-based interfaces directly connected to the local PE router. To generate virtual ports, VPLS PE routing platforms use logical interfaces on a **vt** interface (that is generated by the Tunnel Services PIC, Link Services PIC, Adaptive Services PIC, an LSI interface, or a tunnel services interface configured on MX Series routers).

**virtual private LAN service (VPLS)** An Ethernet-based multipoint-to-multipoint Layer 2 VPN service used for interconnecting multiple Ethernet LANs across an MPLS backbone. BGP-based VPLS is based on the Internet Engineering Task Force (IETF) Internet draft draft-ietf-l2vpn-vpls-bgp-08.txt, *Virtual Private LAN Service (VPLS) Using BGP for Auto-discovery and Signaling* (expires December 2006). LDP-based VPLS is specified in the IETF draft *Virtual Private LAN Service (VPLS) Using Label Distribution Protocol (LDP) Signaling*. For more information about VPLS, see the *Junos VPNs Configuration Guide*.

CHAPTER 2

# Virtual Private LAN Service Configuration

The following sections show the configuration steps necessary to implement VPLS:

## Configuring Routing Protocols on the PE and Core Routers

At a fundamental level, VPLS is a type of Layer 2 VPN. All forms of Layer 2 VPNs require that you configure network protocols to handle the following:

- *intradomain routing* — An interior gateway protocol (IGP) such as Open Shortest Path First (OSPF) or Intermediate System-to-Intermediate System (IS-IS)
- *interdomain routing* — Border Gateway Protocol (BGP)
- *label switching* — Multiprotocol Label Switching (MPLS)
- *path signaling* — Resource Reservation Protocol (RSVP) or Label Distribution Protocol (LDP)

For more information about these protocols and examples of how to configure these protocols to support a Layer 2 VPN, see the *Junos VPNs Configuration Guide*.

NOTE: The 8-port, 12-port, and 48-port dense Fast Ethernet Physical Interface Cards (PICs) cannot push more than two labels onto an MPLS packet. Because of this, we do not recommend that you configure these PICs as core-facing or equivalent interfaces.

**Related Documentation**


- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71
- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55

## Configuring VPLS Encapsulation on CE-Facing Interfaces

There are several types of VPLS interface encapsulation: Ethernet VPLS, Ethernet VPLS over ATM LLC, Ethernet VPLS over Frame Relay, Ethernet VPLS over PPP, VLAN VPLS, extended VLAN VPLS, and flexible Ethernet services. When one of these encapsulations is applied to an interface, a family type of VPLS is enabled by default. The encapsulation types are:

- **ethernet-vpls-fr**—Use Ethernet VPLS over Frame Relay in a VPLS setup when a CE device is connected to a PE device over a time division multiplexing (TDM) link. This encapsulation type enables the PE device to terminate the outer layer 2 Frame Relay connection, use the 802.1p bits inside the inner Ethernet header to classify the packets, look at the MAC address from the Ethernet header, and use it to forward the packet into a given VPLS instance.
- **ether-vpls-over-atm-llc**—Use Ethernet VPLS over ATM LLC encapsulation on ATM2 IQ logical interfaces. Use this encapsulation type to support IEEE 802.1p classification binding on ATM VCs. This encapsulation type enables a VPLS instance to support bridging between Ethernet interfaces and ATM interfaces, as described in RFC 2684, *Multiprotocol Encapsulation over ATM Adaptation Layer 5*. When you use this encapsulation type, you configure it on logical interfaces only and you cannot configure multipoint interfaces.
- **ethernet-vpls-fr**—Use in a VPLS setup when a CE device is connected to a PE device over a time division multiplexing (TDM) link. This encapsulation type enables the PE device to terminate the outer layer 2 Frame Relay connection, use the 802.1p bits inside the inner Ethernet header to classify the packets, look at the MAC address from the Ethernet header, and use it to forward the packet into a given VPLS instance.
- **ethernet-vpls-ppp**—Use in a VPLS setup when a CE device is connected to a PE device over a time division multiplexing (TDM) link. This encapsulation type enables the PE device to terminate the outer layer 2 PPP connection, use the 802.1p bits inside the inner Ethernet header to classify the packets, look at the MAC address from the Ethernet header, and use it to forward the packet into a given VPLS instance.
- **extended-vlan-vpls**—Use extended VLAN VPLS encapsulation on Ethernet interfaces that have VLAN 802.1Q tagging and VPLS enabled and that must accept packets carrying TPIDs 0x8100, 0x9100, and 0x9901.

  NOTE: **The built-in Gigabit Ethernet PIC on the M7i router does not support MPLS.**

- **ethernet-vpls**—Use Ethernet VPLS encapsulation on Ethernet interfaces that have VPLS enabled and must accept packets carrying standard Tag Protocol ID (TPID) values.

- **vlan-vpls**—Use VLAN VPLS encapsulation on Ethernet interfaces with VLAN tagging enabled. VLAN VPLS encapsulation supports TPID 0x8100 only. You must configure this encapsulation type on both the physical interface and the logical interface.
- **flexible-ethernet-services**—Use flexible Ethernet services encapsulation when you want to configure multiple per-unit Ethernet encapsulations. This encapsulation type allows you to configure any combination of route, TCC, CCC, and VPLS encapsulations on a single physical port.

Use the following guidelines to configure a VPLS interface:

- For encapsulation type **vlan-vpls**, VLAN IDs 1 through 511 are reserved for normal Ethernet VLANs, IDs 512 through 1023 are reserved for VPLS VLANs on Fast Ethernet interfaces, and IDs 512 through 4094 are reserved for VPLS VLANs on Gigabit Ethernet interfaces.
- For encapsulation type **extended-vlan-vpls**, all VLAN IDs from 1 through 1023 are valid for VPLS VLANs on Fast Ethernet interfaces, and all VLAN IDs from 1 through 4094 are valid for VPLS VLANs on Gigabit Ethernet interfaces. VLAN ID 0 is reserved for priority tagging. For encapsulation type **flexible-ethernet-services**, VLAN IDs from 1 through 511 are no longer reserved for normal VLANs.
- For encapsulation type **flexible-ethernet-services**, VLAN IDs from 1 through 511 are no longer reserved for normal VLANs.

### VPLS Interface Encapsulation for an Ethernet Interface

To configure VPLS interface encapsulation for an Ethernet interface, include the **encapsulation** statement at the **[edit interfaces *interface-fpc/pic/port*]** hierarchy level and select **ethernet-vpls**, **vlan-vpls**, **extended-vlan-vpls**, **flexible-ethernet-services** or **ether-vpls-over-atm-llc** as the encapsulation type. If you select the VLAN VPLS encapsulation, also include the **vlan-vpls** statement at the **[edit interfaces *ethernet-interface-fpc/pic/port* unit *unit-number* encapsulation]** logical interface hierarchy level. When using either VLAN VPLS or extended VLAN VPLS encapsulations, include the **vlan-tagging** statement at the **[edit interfaces *ethernet-interface-fpc/pic/port*]** hierarchy level.

### VPLS Interface Encapsulation for an ATM2 IQ Interface

To configure VPLS interface encapsulation for an ATM2 IQ interface, include the **encapsulation** statement at the **[edit interfaces at-*fpc/pic/port*]** hierarchy level and select **ether-vpls-over-atm-llc** as the encapsulation type. To configure VPLS interface encapsulation for a Gigabit Ethernet IQ interface or Gigabit Ethernet PICs with small form-factor pluggable transceivers (SFPs), include the **encapsulation** statement at the [**edit interfaces ge-*fe/pic/port***] hierarchy level and select **flexible-ethernet-services** as the encapsulation type.

```
[edit]
interfaces {
  ge-0/1/0 {
    vlan-tagging;
    encapsulation vlan-vpls;
    unit 0 {
      encapsulation vlan-vpls;
```

```
            vlan-id 600;
        }
    }
    at-0/2/0 {
        encapsulation ether-vpls-over-atm-llc;
    }
}
```

**Related Documentation**


- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71
- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55


## Configuring LDP Signaling for VPLS

Like other Layer 2 VPNs, you must enable a VPLS instance to isolate VPLS traffic from other network traffic. An important element of a VPLS instance is the signaling protocol. You can configure BGP signaling, LDP signaling, or both BGP and LDP signaling in a VPLS instance.

To configure LDP signaling, you must first enable a VPLS instance to isolate VPLS traffic from other network traffic. To enable a VPLS instance, include the **instance-type vpls** statement at the **[edit routing-instances *instance-name*]** hierarchy level. To configure LDP signaling within the instance, identify the virtual circuit with the **vpls-id** statement and specify the PE routers participating in the instance with the **neighbor** statement:

```
[edit]
routing-instances {
    instance-name {
        instance-type vpls;
        interface ge-0/1/0.0;
        protocols {
            vpls {
                vpls-id id-name;
                neighbor neighbor-id; # The neighbor-id should be the loopback address of # the
                    remote PE router.
            }
        }
    }
}
```

To fully enable LDP signaling on a PE in a VPLS instance, you must also enable LDP on the loopback interface of the router. To enable LDP on the loopback interface, include the **interface lo0.0** statement at the [**edit protocols ldp**] hierarchy level:

```
[edit]
protocols {
    ldp {
        interface lo0.0;
    }
}
```

For LDP signaling within a VPLS routing instance, the Junos OS supports the following values only:

- FEC—FEC 128 and FEC 129
- Control bit—0
- Ethernet pseudowire type—0x0005
- Ethernet tagged mode pseudowire type—0x0004

**Related Documentation**


- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71
- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55


## Configuring a VPLS Instance with BGP Signaling

Like other Layer 2 VPNs, you must enable a VPLS instance to isolate VPLS traffic from other network traffic. An important element of a VPLS instance is the signaling protocol. You can configure BGP signaling, LDP signaling, or both BGP and LDP signaling in a VPLS instance.

You must enable a VPLS instance to isolate VPLS traffic from other network traffic. To enable a VPLS instance, include the **instance-type vpls** statement at the **[edit routing-instances *instance-name*]** hierarchy level.

Within the instance, you can define the maximum number of sites that can participate in this VPLS instance, a local site name, and a local site identifier. To configure the maximum number of sites, include the **site-range** statement at the [**edit routing-instances *instance-name* protocols vpls**] hierarchy level. The maximum number of sites is 65,535.

NOTE: The site ID must be less than the site range. If you specify a site ID that is greater than the site range, your connections do not come up, even though the commit operation succeeds.

To configure a site name, include the **site** statement at the **[edit routing-instances *instance-name* protocols vpls]** hierarchy level. To configure the site ID, include the **site-identifier** statement at the **[edit routing-instances *instance-name* protocols vpls site *name*]** hierarchy level.

```
[edit]
routing-instances;
  instance-name {
    instance-type vpls;
    interface ge-0/1/0.0;
    route-distinguisher 10.245.14.218:1;
    vrf-target target:11111:1;
    protocols {
      vpls {
```

```
                site-range 10;
                site greenPE1 {
                    site-identifier 1;
                }
            }
        }
    }
```

To complete the configuration, you must configure the Layer 2 VPN family for BGP by including the **signaling** statement at the [**edit protocols bgp family l2vpn**] hierarchy level:

```
[edit]
protocols {
    bgp {
        family l2vpn;
            signaling;
        }
    }
}
```

**Related Documentation**


- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71
- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55


## Configuring Interworking Between BGP Signaling and LDP Signaling in VPLS Instances

If you want to configure a VPLS instance with both BGP and LDP-signaled pseudowires, you must configure a VPLS border router. Without a VPLS border router, LDP-signaled PEs and BGP-signaled PEs will be unaware of one another and the VPLS instance will not be fully meshed.

NOTE: Interworking between BGP signaling and LDP signaling in VPLS instances is supported only on MX Series and M320 routers.

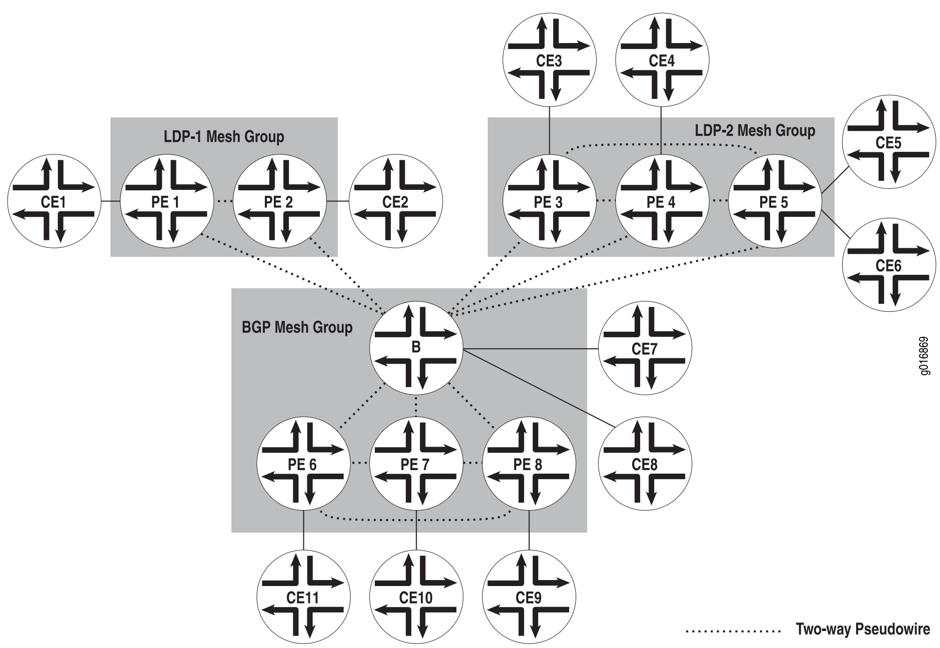
To enable interworking between BGP-signaled PE routers and LDP-signaled PE routers, you configure a border router to interconnect both sets of routers within the same VPLS routing instance. You also need to configure mesh groups on the border router to group the sets of PE routers that are fully meshed and which share the same signaling protocol, either BGP or LDP. You can configure multiple mesh groups to map each fully meshed LDP-signaled or BGP-signaled VPLS domain to a mesh group. In the data plane, the border router maintains a common MAC table used to forward traffic between the LDP-signaled and BGP-signaled mesh groups. When forwarding any VPLS traffic received over a PE router pseudowire, the border router ensures that traffic is not forwarded back to the PE routers, which are in same mesh group as the originating PE router.

There is always just one BGP mesh group in a VPLS instance, and it is created automatically when you configure BGP signaling for that instance. You can configure one or more LDP mesh groups. MX Series routers support up to 15 PE mesh groups (including the default BGP mesh group), and M Series and T Series routers support up to 127 PE mesh groups (including the default BGP mesh group).

In Figure 3 on page 16, Routers PE1 and PE2 are in the LDP-signaled mesh group “LDP-1”. Routers PE3, PE4, and PE5 are in the LDP-signaled mesh group “LDP-2”. Routers PE6, PE7, and PE8 are in the BGP-signaled mesh group. The border router acts as a traditional PE (by connecting to CEs) in addition to being a border router. Every router shown in the topology in Figure 3 on page 16 is in the same VPLS instance, **bgp-ldp-mesh1**.

When Router CE1 sends a frame whose destination MAC address is CE9, PE1 receives the frame and performs a MAC address lookup. The MAC address is not in the PE1 MAC table and so PE1 floods the frame to the other PEs in the LDP-1 mesh group (PE2) and also to Router B, which from the perspective of PE1, are the only members of the VPLS network. When Router B receives the data from PE1, it does not find the MAC address in its MAC table and so it floods the frame to PE3, PE4, PE5, PE6, PE7, and PE8, but not back to PE1 or PE2. The PE routers then perform a MAC table lookup and flood the data to their CE routers.

Figure 3: Topology for BGP/LDP Interworking in a VPLS Instance




In this topology, you configure routers PE6, PE7, and PE8 as you traditionally configure BGP-signaled VPLS routers. You configure routers PE1, PE2, PE3, PE4, and PE5 as you traditionally configure LDP-signaled VPLS routers. In addition, you create the mesh group LDP-1 for Routers PE1 and PE2 and mesh group LDP-2 for Routers PE3, PE4, and PE5 by including the **mesh-group** ***mesh-group-name*** statement at the [**edit routing-instances** ***routing-instance-name*** **protocols vpls**] hierarchy level.

NOTE: The border router can act as a normal PE in addition to being a border router and can support local CE-facing interfaces.

In the example below, the interfaces are CE interfaces. In this case, the router is acting as both a border router and a regular PE router.

To enable interworking between VPLS mesh groups, configure the border router by including the **site** ***site-name*** statement at the [**edit routing instances** ***routing-instance-name*** **protocols**] hierarchy level:

```
[edit]
routing-instances {
   bgp-ldp-mesh1 {
      instance-type vpls;
      route-distinguisher 10.245.14.218:1;
      interface fe-1/3/1.0;
      interface fe-1/3/2.0;
   vrf-target target:10:100;
}
protocols {
   vpls {
   site green {
      site-identifier 1;
   }
}
```

Configure LDP signaling with the **vpls-id** and **neighbor** ***neighbor-id*** statements. You can configure mesh groups LDP-1 and LDP-2 by including the **mesh-group** statement at the [**edit routing instances** ***routing-instance-name*** **protocols vpls** ***vpls-id*** and including the **neighbor** ***neighbor-id*** statement at the [**edit routing-instances** ***routing-instance-name*** **protocols vpls mesh-group** ***mesh-group-name***] hierarchy level:

```
[edit routing-instances bgp-ldp-mesh1 protocols vpls]
vpls-id 100;
mesh-group LDP-1 {
   neighbor 10.1.1.1;
   neighbor 20.1.1.1;
}
mesh-group LDP-2 {
   neighbor 30.1.1.1;
   neighbor 40.1.1.1;
   neighbor 50.1.1.1;
}
```

NOTE: When you configure BGP signaling to interoperate with LDP signaling in a VPLS network, the following features are not supported:

- Point-to-multipoint VPLS
- Integrated routing and bridging

**Related Documentation**

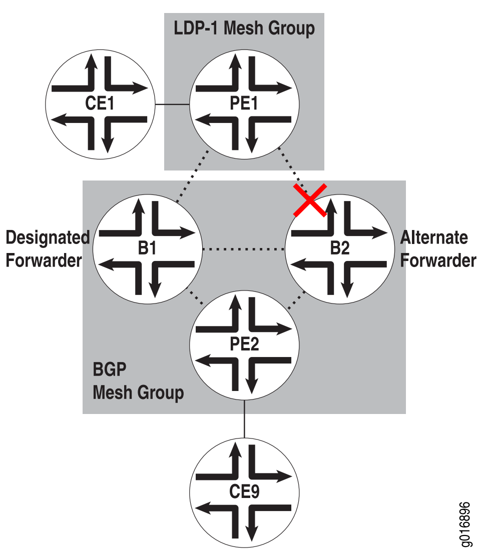
- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71
- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55

## Configuring Multihoming on a VPLS Border Router

Configuring multihoming on VPLS border routers ensures that if one border router is unreachable, BGP/LDP PE connectivity is maintained through the other VPLS border router. With multihoming, one border router is chosen as the designated forwarder for each mesh group. The designated forwarder is chosen through either the BGP or VPLS path-selection procedure. If the designated forwarder loses connectivity with a mesh group, the alternate border router then takes over as designated forwarder for that mesh group. A VPLS instance must be configured with BGP signaling in order for multihoming to work.

Figure 4 on page 18 shows a simplified example of how multihoming works with VPLS border routers. In this example, B1 is the designated forwarder and B2 is the alternate forwarder. If CE1 wanted to send data to CE9, the data would travel from CE1 to PE1, which is part of the LDP-1 mesh group. PE1 would then flood the data to B1 (the designated forwarder), which would forward the data to PE2. It would not send the data to Router B2. PE2 would then send the data to its destination, CE9. If B1 lost connectivity with the LDP-1 mesh group, then B2 would become the designated forwarder. In this case, PE1 would send the data through B2, not through B1.

Figure 4: Multihoming for Border Area Routers




You configure multihoming on border routers by including the **site-identifier** and **multi-homing** statements at the [**edit routing-instances** ***routing-instance-name*** **protocols**] hierarchy level. The designated forwarder and alternate forwarder must be configured with the same site identifier.

**Router B1**

```
[edit routing-instances example protocols]
```

```
vpls {
  site mult-home-ldp-1 {
    site-identifier 1;
    mesh-group ldp-1;
    multi-homing;
  }
```

**Router B2**

```
[edit routing-instances example protocols]
vpls {
  site mult-home-ldp-1 {
    site-identifier 1;
    mesh-group ldp-1;
    multi-homing;
  }
```

For more information on multihoming, see *Option: Configuring VPLS Multihoming with BGP Signaling*.

**Related Documentation**


- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71
- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55


## Option: Selecting an LSP for the VPLS Routing Instance to Traverse

If you have two or more equal-cost-path LSPs between your VPLS PE router sites, you can select an LSP over which the VPLS traffic will travel. To select an LSP for VPLS traffic, assign the VPLS instance to a BGP community, define a policy that directs community traffic over a specified LSP, and then apply the policy to the forwarding table.

To configure a BGP community, include the **community *community-name*** statement at the **[edit policy-options]** hierarchy level. Be sure to specify the **vrf-export** or **vrf-target** values from the VPLS routing instance as community identifiers with the **members *community-ids*** statement at the **[edit policy-options community *community-name*]** hierarchy level.

To create a policy that sends community traffic over a specific LSP, include the **community *community-name*** statement at the **[edit policy-options policy-statement *policy-name* term *term-name* from]** hierarchy level and the **install-nexthop lsp *lsp-name*** statement at the **[edit policy-options policy-statement *policy-name* term *term-name* then]** hierarchy level. To apply the policy to the forwarding table, include the **export *policy-name*** statement at the **[edit routing-options forwarding-table]** hierarchy level.

```
[edit]
routing-options {
  autonomous-system 69;
  forwarding-table {
    export LSP-policy;
  }
  policy-options {
    policy-statement LSP-policy {
      term a {
```

```
                from community gold;
                then {
                    install-nexthop lsp pe1-to-pe2;
                    accept;
                }
            }
        }
        community gold members target:11111:1;
    }
}
```

**Related Documentation**


- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71
- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55


## Option: Configuring VPLS Multihoming with BGP Signaling

With VPLS multihoming, you can connect multiple PE router interfaces to one customer site. This feature provides VPLS redundancy should a PE router or PE router interface fail.

To configure multihoming, you must configure the same site IDs on all PE routers and router interfaces that are connected to the same customer site, You must also specify on each PE router which interfaces are connected to the customer site. We recommend that you configure distinct route distinguishers for each multihomed router. Configuring distinct route distinguishers helps with faster convergence when the connection to a primary router goes down. It also requires that the other PE routers maintain additional state information.

To configure a route distinguisher, include the **route-distinguisher** statement at the **[edit routing-instances *instance-name*]** hierarchy level. To assign a site ID, include the **site-identifier** statement at the **[edit routing-instances *instance-name* protocols vpls site *name*]** hierarchy level. To specify the interfaces associated with a site, include the **interface** statement at the **[edit routing-instances *instance-name* protocols vpls site *name*]** hierarchy level.

To connect multiple PE routers to one customer site, you must configure multihoming on each PE router connected to that site. This will prevent routing loops should BGP connectivity fail. BGP automatically determines the primary and backup routers. Alternatively, you can statically configure a primary PE router and backup PE routers for a customer site by specifying the preference value. BGP uses preference values to determine routing paths.

NOTE: **Multihoming relies on full BGP connectivity to all other PEs. Configure a dual router reflector topology to provide redundant PE-to-PE BGP connectivity.**

To configure multihoming, include the **multi-homing** statement at the **[edit routing-instances *instance-name* protocols vpls site *name*]** hierarchy level. To configure preference value, include the **preference-value** statement at the [**edit routing-instances *instance-name* protocols vpls *site name***] hierarchy level. You can configure the preference value as **primary** or **backup**, or you can specify a preference number. When specifying preference numbers, configure the primary interface with a preference value of 65,535 and any backup interfaces with a number from 1 to 65,534.

When multiple PE router interfaces on a single PE router are connected to one customer site, you must configure an active interface. All traffic will pass through the active interface unless this interface fails, in which case a backup interface will become the active interface.

To specify a multihomed interface as the primary interface for a site, include the **active-interface** statement at the [**edit routing-instances *instance-name* protocols vpls site *name***] hierarchy level. The interface that you specify is called the primary interface. If the primary interface goes down, an alternate interface becomes the active interface. Once the primary interface comes back up, the primary interface becomes the active interface once again and the alternate interface becomes inactive.

If you do not want to specify a primary multihomed interface, you can use the **any** option. With the **any** option, the router dynamically chooses an active interface. If the active interface goes down, an alternate interface becomes the active interface. Once the down interface comes back up, it stays inactive.

If no active interfaces are configured at the site level, it is assumed that all traffic for a VPLS site travels through a single, nonmultihomed PE router.

NOTE: If you add a direct connection between CE devices that are multihomed to the same VPLS site on different PE routers, traffic loops and loss of connectivity might occur. We do not recommend this topology.

The following example shows a multihoming configuration with two PE routers that are connected to a single customer site. Note in the configuration that PE1 is the primary router and PE2 is the backup router.

**Router PE1**

```
[edit]
routing-instances {
  green {
    instance-type vpls;
    interface fe-0/1/3.0;
    route-distinguisher 10.255.14.218:1;
    vrf-target target:11111:1;
    protocols {
      vpls {
        site-range 10;
        site green4 {
          site-identifier 4;
          multi-homing; # Ensures that BGP is established before forwarding on the
            # site member interfaces.
          preference value 65535;
```

```
                interface fe-1/1/3.0;
              }
            }
          }
        }
      }
```

**Router PE2**

```
[edit]
routing-instances {
  green {
    instance-type vpls;
    interface fe-0/1/0.0;
    route-distinguisher 10.255.14.219:1;
    vrf-target target:11111:1;
    protocols {
      vpls {
        site-range 10;
        site green4 {
          site-identifier 4;
          multi-homing;
          preference value 1;
          interface fe-0/1/0.0;
        }
      }
    }
  }
}
```

The following example shows a multihoming configuration with one PE router with multiple interfaces that are connected to a single customer site.

**Router PE3**

```
[edit]
routing-instances {
  green {
    instance-type vpls;
    interface fe-1/1/0.0;
    interface fe-1/2/0.0;
    interface fe-1/3/0.0;
    route-distinguisher 10.255.14.218:1;
    vrf-target target:11111:1;
    protocols {
      vpls {
        site-range 10;
        site green4 {
          site-identifier 4;
          active-interface any;
          interface fe-1/1/0.0;
          interface fe-1/2/0.0;
          interface fe-1/3/0.0;
        }
      }
    }
  }
}
```

For more information on VPLS multihoming, see the *Junos VPNs Configuration Guide*.

**Related Documentation**

- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71
- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55

## Option: Configuring VPLS Traffic Flooding over a Point-to-Multipoint LSP

In each VPLS routing instance, you can configure a dedicated point-to-multipoint LSP to carry all unknown unicast, broadcast, and multicast traffic. Enabling this feature increases the efficiency of your network, because duplicate copies of flooded traffic do not have to be created for each PE router in the VPLS routing instance. Figure 5 on page 23 shows how flooded traffic reaches PE routers in a VPLS routing instance when a point-to-multipoint LSP is not configured for flooding. Figure 6 on page 23 shows an example of a VPLS routing instance configured with point-to-multipoint LSP flooding.

NOTE: You cannot configure point-to-multipoint LSP flooding if your VPLS network is configured for interoperability between BGP and LDP signaling.

Figure 5: Traditional Flooding in a VPLS Routing Instance

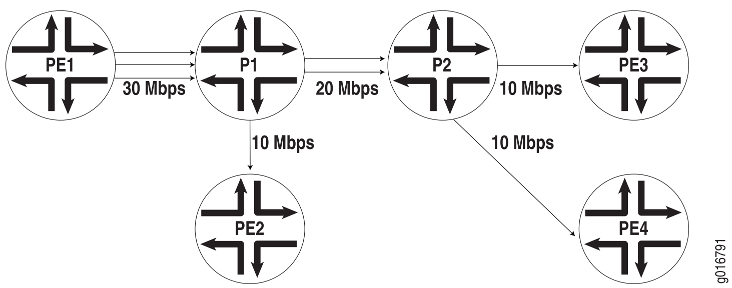
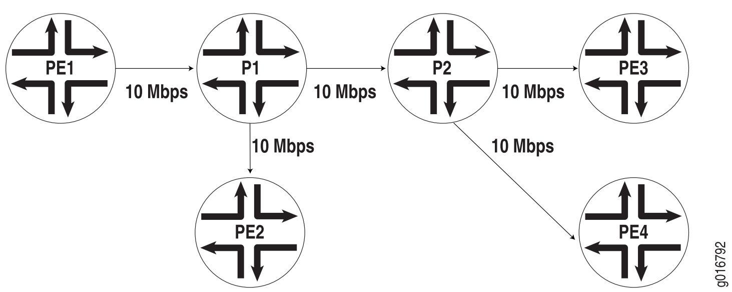



Figure 6: VPLS Routing Instance with Point-to-Multipoint LSP Flooding




You have three options when configuring a point-to-multipoint LSP for flooding:

- Static point-to-multipoint LSP—Configure this option to control which path each PE sub-LSP takes. When using this option, ensure that all PEs within the VPLS routing instance are part of the static point-to-multipoint LSP. When you add PEs to the VPLS routing instance, you must configure a sub-LSP for the new PE and add the sub-LSP to the static point-to-multipoint LSP. To configure a static point-to-multipoint LSP, include the **label-switched-path** ***path-name*** statement at the [**edit protocols mpls**] hierarchy level.

- Dynamic point-to-multipoint LSP with a preconfigured template—Configure this option to create a dynamic point-to-multipoint LSP with specific parameters such as link protection and optimized time. With this option, newly added PEs are automatically added to the point-to-multipoint LSP. To use the preconfigured template, include the **template** statement at the [**edit protocols mpls label-switch-path** ***path-name***] hierarchy level.
- Dynamic point-to-multipoint LSP with a default template—Configure this option to automatically create a dynamic point-to-multipoint LSP with default parameters. With this option, newly added PEs are automatically added to the point-to-multipoint LSP. To use a default template, include the **default-template** statement at the [**edit routing-instances** ***routing-instance-name*** **provider-tunnel rsvp-te label-switched-path-template**] hierarchy level.

To define the parameters for a static point-to-multipoint LSP, include the **label-switched-path** ***path-name*** statement at the [**edit protocols mpls**] hierarchy level:

```
[edit]
protocols {
  mpls {
    label-switched-path vpls-bar-p2mp-s21_lsp_a {
      to 192.168.1.1
      p2mp vpls-bar-p2mp-lsp;
    }
    label-switched-path vpls-bar-p2mp-s21_lsp_b {
      to 192.168.1.2
      p2mp vpls-bar-p2mp-lsp;
    }
  }
}
```

To add a new PE router to the static point-to-multipoint LSP, include the **label-switched-path** ***sub-path-name*** statement at the [**edit protocols mpls**] hierarchy level:

```
[edit]
protocols {
  mpls {
    label-switched-path added-PE3 {
      to 1.1.1.1
      p2mp vpls-bar-p2mp-lsp;
    }
  }
}
```

For more information on configuring static and dynamic point-to-multipoint LSPs, see the *Junos MPLS Applications Configuration Guide*.

To enable this feature, configure either the **static** or **label-switched-path-template** options for the **rsvp-te** statement at the [**edit routing-instance *routing-instance-name* provider-tunnel**] hierarchy level:

```
[edit]
routing-instance foo {
  provider-tunnel {
    rsvp-te {
      static-lsp vpls-bar-p2mp-lsp;
    }
  }
}
```

To verify your work, enter the **show vpls connection extensive** command:

```
Router_1# show vpls connection extensive
....
status-vector: BF
connection-site Type St Time last up # Up trans
2 rmtUpJan 31 10:14:37 2007 1
Local interface: lsi.32768, Status: Up, Encapsulation: VPLS
Description: Intf -vpls VPLS-A local site 1 remote site 2
Remote PE: 10.255.164.2, Negotiated control-word: No
Incoming label: 262153, Outgoing label: 800000
RSVP-TE P2MP lsp:
Ingress branch LSP: 13:vpls:10.255.164.1:BPLS-A, State: Up
Egress branch LSP: 4:vpls:10.255.164.2:VPLS-A, Statue: Up
TimeEventInterface/Lb1/PE
Jan 31 10:14:37 2007 status update timer
Ingress RSVP-TE P2MP LSP: 11:vpls:10.255.164.1:VPLS-A, Flood next-hop ID: 476
```

**Related Documentation**


- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71
- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55


## Option: Configuring Automatic Site Selection

You can configure BGP-signaled VPLS instances to automatically specify the site IDs for the routers participating in the VPLS domain. Site IDs help to minimize label usage in VPLS instances with numerous PE routers.

The **automatic-site-id** statement includes the following options:

- **startup-wait-time**—Time to wait at startup to receive all VPLS information for configured route targets from other PE routers.
- **new-site-wait-time**—Time to wait to receive VPLS information from a newly configured routing instance or a new site. Effectively, it is the time to wait before a site makes an attempt to locate an unused site ID for its claim advertisement.
- **collision-detect-time**—Time to wait after issuing a claim advertisement before the PE router can start using the site ID if it does not receive a competing claim. If the PE router receives a competing claim within this time interval, it runs a collision resolution

procedure. Explicitly configured site IDs always take precedence over automatically generated site IDs.

- **reclaim-wait-time**—Time to wait before attempting to claim a site ID after a collision. There are default values for all of these options, so they do not need to be explicitly configured.

To configure a VPLS automatic site ID, include the **automatic-site-id** statement at the [**edit routing-instances** ***routing-instance-name*** **protocols vpls site** ***site-name***] hierarchy level:

```
[edit]
routing-instances {
  vpls instance 1 {
    protocols {
      vpls {
        site vpls instance 1 {
          automatic-site-id;
        }
      }
    }
  }
}
```

**Related Documentation**

- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71
- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55

## Option: Configuring VPLS to Use LSI Interfaces

On M Series and T Series routers, VPLS uses tunnel-based PICs to create virtual ports on **vt** interfaces. If you do not have a tunnel-based PIC installed on your M Series or T Series router, you can still configure VPLS by using label-switched interfaces (LSIs) to support the virtual ports. Use of LSI interfaces requires the use of Ethernet-based PICs installed in an Enhanced FPC.

NOTE: On MX Series routers, when using VPLS with an LSI interface, you cannot enable **ingress-and-egress** mode CoS queuing using the **traffic-manager** statement. On I-chip ASIC-based DPCs in MX Series routers you can enable EXP classification on traffic entering core facing VPLS LSI interfaces using the **classifiers** statement.

To use LSI interfaces for VPLS instead of **vt** interfaces, include the **no-tunnel-services** statement at the **[edit routing-instances** ***instance-name*** **protocols vpls]** hierarchy level.

```
[edit routing-instances]
instance-name {
  protocols {
    vpls {
```

```
            no-tunnel-services;
        }
    }
}
```

NOTE: The following interface types do not support the use of LSI interfaces with VPLS:

- Aggregated SONET/SDH interfaces (cannot be used as the core-facing interface)
- Channelized interfaces (cannot be used as the core-facing interface)
- ATM1 interfaces

NOTE: When VPLS is configured with the **no-tunnel-services** option to use an LSI interface instead of a Tunnel-PIC, statistics pertaining to VPLS traffic arriving on a PE router from the core-facing interface cannot be obtained. This is because statistics per logical LSI interface is not supported.

**Related Documentation**


- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71
- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55


## Option: Configuring Tunnel Services on MX Series Routers

MX Series routers use Dense Port Concentrators (DPCs) with built-in physical ports, which means that you do not insert PICs on the router. Instead, you configure tunnel interfaces on one of the four Packet Forwarding Engines (PFEs) that are on each DPC.

To create tunnel interfaces on an MX Series router, include the **tunnel-services** statement at the [**edit chassis fpc *slot-number* pic *number***] hierarchy level. To configure the bandwidth for a tunnel interface, include the **bandwidth** statement at the [**edit chassis fpc *slot-number* pic *number***] hierarchy level.

The following example shows a tunnel interface with 1 Gbps of bandwidth configured on PFE 1 of the DPC installed in slot 4 of an MX Series router:

```
[edit chassis]
fpc 4;
  pic 1 {
    tunnel services {
      bandwidth 1g;
    }
  }
}
```

Once you have configured a tunnel interface on a PFE, you can treat this interface as a standard tunnel interface and proceed with a standard VPLS configuration. For more information, see the *Junos OS Administration Library for Routing Devices*.

**Related Documentation**


- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71
- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55


## Configuring Integrated Routing and Bridging in a VPLS Instance (MX Series Routers Only)

Integrated routing and bridging (IRB) over VPLS cannot be used in conjunction with the **vlan-id all** statement. One or more Layer 2 logical interfaces must be configured inside the instance in order for IRB to function properly.

To configure IRB within a VPLS instance, include the **routing-interface** ***irb-interface-name*** statement at the [**edit routing-instances** ***routing-instance-name*** **instance-type vpls**] hierarchy level:

```
[edit]
routing-instances {
  marketing {
    instance-type vpls;
    route-distinguisher 11.11.11.11:10;
    vrf-target target:100:100;
    interface ae0.100;
    interface ae0.200;
    routing-interface irb.1234;
  }
}
```

**Related Documentation**


- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71
- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55


## Configuring VLAN IDs in a VPLS Instance (MX Series Routers Only)

You can configure VLAN identifiers for a VPLS instance in the following ways:

- By using the **input-vlan-map** and the **output-vlan-map** statements at the [**edit interfaces**] hierarchy level. For more information, see the *Junos OS Network Interfaces Library for Routing Devices* and *Junos OS Class of Service Library for Routing Devices*.
- By using the **vlan-id** or **vlan-tags** statements at the [**edit routing-instances** ***routing-instance-name*** **instance-type vpls**] hierarchy level.

The **vlan-id** and **vlan-tags** statements are used to perform the following functions:

- Translate, or normalize, the VLAN tags of received packets received into a learn VLAN identifier.
- Create multiple learning domains that each contain a VLAN identifier. A learning domain is a MAC address database to which MAC addresses are added based on the VLAN identifier.

For more information about how VLAN tags are processed and translated, see the *Junos MX Series Layer 2 Configuration Guide*.

To configure VLAN identifiers for a VPLS instance, include the **vlan-id** or **vlan-tags** statement at the [**edit routing-instances *routing-instance-name* instance-type vpls**] hierarchy level.

NOTE: You cannot configure VLAN mapping using the **input-vlan-map** and **output-vlan-map** statements if you configure a VLAN identifier for a VPLS instance using the **vlan-id** or **vlan-tags** statements.

```
[edit]
routing-instances {
  marketing {
    instance-type vpls;
    vlan-id 401;
    route-distinguisher 11.11.11.11:10;
    vrf-target target:100:100;
    interface ae0.100;
    interface ae0.200;
  }
}
```

**Related Documentation**


- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71
- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55


## Defining a VPLS Firewall Policer

You can configure filters, policers, and broadcast and unknown filters to determine which kind of traffic is allowed into and out of a VPLS domain. You can apply these filters and policers to CE-facing interfaces only.

To process traffic as it enters a VPLS domain, you can define a firewall policer and apply it to the input interface. To define policer characteristics for incoming VPLS traffic, include the **bandwidth-limit** and **burst-size-limit** statements at the **[edit firewall policer *policer-name* if-exceeding]** hierarchy level. Then, specify statements to implement the desired action (for example, **discard**) for the policed traffic at the **[edit firewall policer *policer-name* then]** hierarchy level. To apply the policer to a CE-facing interface, include the **input** or **output** statements and the name of the policer at the **[edit interfaces *interface-name* unit *unit-number* family vpls policer]** hierarchy level.

```
[edit]
interfaces {
    ge-2/1/0 {
        vlan-tagging;
        mtu 1544;
        encapsulation vlan-vpls;
        unit 0 {
            encapsulation vlan-vpls;
            vlan-id 600;
            family vpls {
                policer {
                    input vpls-policer;
                }
            }
        }
    }
}
firewall {
    policer {
        vpls-policer {
            if-exceeding {
                bandwidth-limit 5m;
                burst-size-limit 1m;
            }
            then discard;
        }
    }
}
```

**Related Documentation**

- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71
- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55

## Defining a VPLS Firewall Filter

You can configure filters, policers, and broadcast and unknown filters to determine which kind of traffic is allowed into and out of a VPLS domain. You can apply these filters and policers to CE-facing interfaces only.

To process traffic as it exits a VPLS domain, you can define a firewall filter and apply it to the output interface. To configure match conditions for a firewall filter, include the **interface-group**, **source-mac-address**, **destination-mac-address**, **ethernet-type**, or **vlan-ethernet-type** statements at the **[edit firewall family vpls filter *filter-name* term *term-name* from]** hierarchy level. Then, implement the desired action (for example, **discard**) for the traffic at the **[edit firewall family vpls filter *filter-name* term *term-name* then]** hierarchy level. To apply the filter to a CE-facing interface, include the **input**, **output**, or **group** statements at the **[edit interfaces *interface-name* unit *unit-number* family vpls filter]** hierarchy level.

```
[edit]
interfaces {
  fe-2/1/1 {
    vlan-tagging;
    mtu 1544;
    encapsulation vlan-vpls;
    unit 0 {
      encapsulation vlan-vpls;
      vlan-id 600;
      family vpls {
        filter {
          output vpls-out-filter;
        }
      }
    }
  }
}
firewall {
  family vpls {
    filter vpls-out-filter {
      interface-specific;
      term 1 {
        from {
          source-mac-address {
            00.10.10.10.11.18/48;
          }
        }
        then {
          count count.ce2;
          accept;
        }
      }
      term 2 {
        then accept;
      }
    }
  }
}
```

NOTE:

- Output filters do not work for broadcast, multicast, and unknown unicast traffic.
- If an IRB interface is configured as part of a VPLS routing instance, VPLS filters might not filter packets that are destined to the IRB interface. This can be configured by installing filters that match Layer 3 fields for the the IRB interface.
- If you apply a firewall filter to discard a source MAC address, the MAC address is not deleted from the MAC address table.

**Related Documentation**

- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71

- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55


## Restricting Broadcast Packets in VPLS

You can configure filters, policers, and broadcast and unknown filters to determine which kind of traffic is allowed into and out of a VPLS domain. You can apply these filters and policers to CE-facing interfaces only.

To restrict the flow of broadcast and unknown unicast packets into a VPLS domain, you must create a firewall filter and apply the filter to one of the forwarding tables of the VPLS routing instance. When you apply a filter in this way, the filter processes traffic from all interfaces in the instance, including **vt** interfaces. To configure match conditions for a VPLS-based firewall filter, include the **source-mac-address**, **destination-mac-address**, **interface-group**, **ethernet-type**, or **vlan-ethernet-type** statements at the **[edit firewall family vpls filter *filter-name* term *term-name* from]** hierarchy level. Then, specify statements to activate the desired action (for example, **discard**) for the matched packets at the **[edit firewall family vpls filter *filter-name* term *term-name* then]** hierarchy level.

To apply the filter to the broadcast and unknown unicast table of a VPLS routing instance, include the **input** statement and the name of the filter at the **[edit routing-instances *instance-name* forwarding-options family vpls flood]** hierarchy level. To apply the filter to the destination MAC address table of a VPLS routing instance, include the **input** statement and the name of the filter at the **[edit routing-instances *instance-name* forwarding-options family vpls filter]** hierarchy level.

```
[edit]
firewall {
  family vpls {
    filter vpls-flood {
      term 1 {
        from {
          destination-mac-address {
            00.90.69.dc.95.3b/48;
          }
        }
        then discard;
      }
      term 2 {
        then accept;
      }
    }
  }
}
routing-instances {
  green {
    forwarding-options {
      family vpls {
        (flood | filter) {
          input vpls-flood;
        }
```

```
            }
          }
        }
      }
```

When you configure VPLS, a priority filter for Spanning Tree Protocol (STP) bridge protocol data units (BPDUs) is enabled by default. This BPDU filter matches on the well-known STP MAC address of **01:80:c2:00:00:00/24** and applies high priority to this traffic.

For more information on VPLS policers and filters, see the *Junos Policy Framework Configuration Guide* and the *Junos VPNs Configuration Guide*.

**Related Documentation**


- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71
- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55


## Option: Enabling VPLS Class of Service

For Junos OS Release 6.2 or later, you can configure class of service (CoS) for all interfaces in the VPLS domain. CoS information is sent across the MPLS backbone and is preserved for all VPLS traffic processed by local interfaces, virtual ports, and remote interfaces.

For more information on configuring CoS, see the *Junos Class of Service Configuration Guide*.

**Related Documentation**


- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71
- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55


## Option: Enabling VPLS Graceful Restart

VPLS graceful restart allows you to continue forwarding VPLS traffic across the core MPLS network even if one of the routers in the forwarding path restarts. Graceful restart for VPLS functions the same way as Layer 2 VPN graceful restart. To configure graceful restart for VPLS, include the **graceful-restart** statement at the **[edit routing-options]** hierarchy level on all PE and core routers.

```
[edit]
routing-options {
  graceful-restart;
}
```

For more information on graceful restart, see the *Junos OS High Availability Library for Routing Devices*.

**Related Documentation**


- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71
- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55

## Configuring the VPLS MAC Address Timeout

You can fine-tune your VPLS domain by clearing MAC address entries from the VPLS table or modifying the default timeout interval for the VPLS table.

NOTE: On MX Series routers running Junos OS Release 8.4 and later, you can set the expiration time of entries in the MAC table only for the entire router, not for specific VPLS routing instances. To set the expiration for the entire router, include the **mac-table-aging-time seconds** statement at the **[edit protocols l2-learning]** hierarchy level. Do not include the **mac-table-aging-time** statement at the **[edit routing-instances routing-instance-name protocols vpls]** hierarchy level on MX Series routers running Junos OS Release 8.4 and later.

To clear all MAC address entries from the VPLS table, issue the **clear vpls mac-address** command. Add the **logical-system *logical-system-name*** option to clear entries within a logical system and include the **instance *instance-name*** option to clear entries in a specific VPLS instance. Use the ***mac-address*** option to remove individual MAC addresses.

To configure the VPLS table timeout interval, include the **mac-table-aging-time** statement at the **[edit routing-instances *instance-name* protocols vpls]** hierarchy level. The default interval is 300 seconds, with a minimum of 10 seconds and a maximum of 1 million seconds. As a general rule, you can configure longer values for small, stable VPLS networks and shorter values for large, dynamic VPLS networks. If no traffic is received for a specific MAC address, M Series and T Series routers wait one additional interval before automatically clearing MAC address entries from the VPLS table. MX Series routers do not wait for this interval.

```
[edit]
routing-instances {
  instance-name {
    protocols {
      vpls {
        mac-table-aging-time seconds;
      }
    }
  }
}
```

**Related Documentation**

- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71
- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55

## Option: Configuring VPLS Interinstance Bridging and Routing

To deliver interinstance traffic between two or more VPLS instances, or between a VPLS instance and a Layer 3 VPN routing instance, you must use a logical tunnel interface. Originally designed to interconnect logical systems, the logical tunnel interface acts as a point-to-point connection between instances. A logical tunnel interface can be generated by a Tunnel Services PIC installed on an Enhanced FPC in your routing platform, an integrated Adaptive Services Module installed in an M7i router, or a tunnel services interface configured on MX Series routers. To configure a logical tunnel interface, include the **lt-*fpc/pic/*0** statement at the **[edit interfaces]** hierarchy level. Keep in mind these rules when you connect instances:

- You need to configure both endpoints of the logical tunnel. Configure the first logical tunnel interface in the VPLS instance and the second within the instance you want to interconnect to the VPLS domain.
- Choose one of several interface encapsulation types for your logical tunnel interface peers. Your choices are Ethernet, Ethernet circuit cross-connect (CCC), Ethernet VPLS, Frame Relay, Frame Relay CCC, VLAN, VLAN CCC, and VLAN VPLS. Include one of these choices with the **encapsulation** statement at the **[edit interfaces *lt-fpc/pic/*0 unit *unit-number*]** hierarchy level.
- Depending on the encapsulation type you select, specify a corresponding data-link connection identifier (DLCI) number for Frame Relay or a VLAN identifier for VLAN encapsulations on your logical tunnel interface peers. To configure the DLCI or VLAN identifier, include the **dlci** or **vlan-id** statement at the **[edit interfaces lt-*fpc/pic/*0 unit *unit-number*]** hierarchy level.
- Your choice of protocol family for the logical tunnel interface also is determined by your selection of an encapsulation type. For Ethernet VPLS and VLAN VPLS, family **vpls** is assigned by default. For all other Ethernet and VLAN encapsulation types, include the **mpls** or **inet** statement at the **[edit interfaces lt-*fpc/pic/*0 unit *unit-number* family]** hierarchy level. For Frame Relay encapsulation types, you can configure any of the available protocol families: **ccc**, **inet**, **inet6**, **iso**, **mpls**, or **tcc**.
- Be sure to match the logical interface unit numbers of the peering logical tunnel interfaces. To configure, include the **peer-unit** statement at the **[edit interfaces lt-*fpc/pic/*0 unit *unit-number*]** hierarchy level.

```
[edit]
interfaces {
  lt-fpc/pic/0 {
    unit unit-number {
      encapsulation (ethernet | ethernet-ccc | ethernet-vpls | frame-relay |
        frame-relay-ccc | vlan | vlan-ccc | vlan-vpls);
      peer-unit number; # The logical unit number of the peering lt interface.
      dlci dlci-number;
      vlan-id vlan-number;
      family (ccc | inet | inet6 | iso | mpls | tcc);
    }
  }
}
```

```
routing-instances {
  vpls-instance-name {
    interface ge-fpc/pic/port.unit-number;
    interface lt-0/0/0.1;
    ...
    second-instance-name {
      interface at-fpc pic/port.unit-number;
      interface lt-0/0/0.2;
      ...
    }
  }
}
```

**Related Documentation**

- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71
- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55

## Option: Selecting Interfaces to Process VPLS Traffic

On M Series and T Series routers, the PICs that can create VPLS virtual ports dynamically from **vt** interfaces include the Tunnel Services PIC, the Link Services PIC, and the Adaptive Services PIC. On MX Series routers, logical tunnel interfaces configured by including the **tunnel-services** statement at the [**edit chassis fpc** ***slot-number pic number***] hierarchy level can create VPLS virtual ports dynamically from **vt** interfaces.

By default, the Junos OS automatically and randomly selects **vt** interfaces to act as VPLS virtual ports in a round-robin fashion. However, if your routing platform contains two or more of these tunnel-enabled interfaces, you can manually select which interfaces process traffic for each VPLS domain.

You can select an interface to be the primary device responsible for VPLS traffic processing. You can also select a group of interfaces to share responsibility for VPLS traffic processing. When the primary interface is operating normally, it handles all VPLS-related tasks. If the primary device is not available, any interfaces included in the VPLS interface group assume responsibility.

To select an interface to be the primary device responsible for VPLS traffic processing, include the **primary** statement at the **[edit routing-instances** ***instance-name*** **protocols vpls tunnel-services]** hierarchy level. To select a group of interfaces to share responsibility for VPLS traffic processing, include the **devices** statement at the **[edit routing-instances** ***instance-name*** **protocols vpls tunnel-services]** hierarchy level.

```
[edit]
routing-instances {
  instance-name {
    protocols {
      vpls {
        tunnel-services {
          devices [vt-0/0/0 vt-1/0/0 vt-2/0/0];
          primary vt-0/0/0;
```

```
        }
      }
    }
  }
}
```

**Related Documentation**


- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71
- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55


## Option: Limiting the Number of MAC Addresses Learned on a VPLS Interface

There are three main levels where you can configure MAC address limits:

- **interface-mac-limit**—This statement allows you to specify a limit for MAC addresses at an interface level. For VPLS, you can include the **interface-mac-limit** statement at the [**edit logical-systems** ***logical-system-name*** **routing-instances** ***routing-instance-name*** **protocols vpls**], [**edit logical-systems** ***logical-system-name*** **routing-instances** ***routing-instance-name*** **protocols vpls site** ***site-name*** **interfaces** ***interface-name***], [**edit routing-instances** ***routing-instance-name*** **protocols vpls**], or [**edit routing-instances** ***routing-instance-name*** **protocols vpls site** ***site-name*** **interfaces** ***interface-name***] hierarchy level. For MX Series routers only, you can specify what the router does with additional MAC addresses once the MAC address limit is reached. The default behavior is for the router to flood the packet, but you can alternatively include the **packet-action drop** option to have the router drop the packets. The default MAC address table size for each interface is 1024 addresses.
- **mac-table-size**—This statement allows you to specify a limit for MAC addresses at a domain level. For VPLS, you can include the **mac-table-size** statement at the [**edit logical-systems** ***logical-system-name*** **routing-instances** ***routing-instance-name*** **protocols vpls**] or [**edit routing-instances** ***routing-instance-name*** **protocols vpls**] hierarchy level. The default MAC address table size for each domain is 5120 addresses.
- **global-mac-limit** (MX Series routers only)—This statement allows you to specify a limit for MAC addresses for all interfaces and all domains for the entire router. You can include the **global-mac-limit** statement at the [**edit protocols l2-learning**] hierarchy level. The default MAC address table size for the entire system is 393,215 addresses. Note that the value of **global-mac-limit** must be set lower than the configured value of **interface-mac-limit** .

NOTE: If you manually configure a MAC address limit, you must ensure that values for interface limits (such as the **interface-mac-limit**) are set lower than domain limits (such as **mac-table-size**), and the domain limits are set lower than global limitss (such as **global-mac-limit**). If a value for a more specific limit is set higher than a more global limit, the commit operation fails.

The range of values for the **interface-mac-limit** statement is 16 through 65,536. The output of the **show vpls statistics** command displays the results of configuring interface-level MAC address limitations.

```
[edit]
routing-instances {
  instance-name {
    protocols {
      vpls {
        interface-mac-limit number;
        site site-name {
          interface interface-name {
            interface-mac-limit number;
          }
        }
      }
    }
  }
}
```

**Related Documentation**

- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71
- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55

## Option: Optimizing VPLS Traffic Flows

To improve the performance of VPLS traffic processing in your routing platform, you can implement the following features:

- To optimize VPLS traffic flows across multiple paths, you can enable per-packet load balancing. To enable per-packet load balancing, include the **load-balance per-packet** statement at the **[edit policy-options policy-statement *policy-name* term *term-name* then]** hierarchy level and apply the policy to the forwarding table with the **export *policy-name*** statement at the **[edit routing-options forwarding-table]** hierarchy level.
- To optimize hashing of source and destination MAC addresses within VPLS traffic flows, include the **source-mac** and **destination-mac** statements at the **[edit forwarding-options hash-key family multiservice]** hierarchy level.

For more information about load balancing and hash keys, see the *Junos Policy Framework Configuration Guide*.

**Related Documentation**

- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71
- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55

## Option: Aggregated Interfaces for VPLS

You can configure aggregated Ethernet interfaces between CE devices and PE routers for VPLS routing instances. Traffic is load-balanced across all of the links in the aggregated interface. If one or more links in the aggregated interface fails, the traffic is switched to the remaining links.

In the example below, 0 is the interface instance number that completes the link association. This number can be from 0 through 127, for a total of 128 aggregated interfaces. The VPLS encapsulation types supported on aggregated Ethernet interfaces are **ethernet-vpls**, **vlan-vpls**, or **extended-vlan-vpls**.

```
[edit]
interfaces ae0
vlan-tagging;
encapsulation vlan-vpls;
unit 0 {
   vlan-id 100;
}
```

The aggregated Ethernet interface must also be configured for a VPLS routing instance. Use the standard VPLS routing instance configuration on aggregated Ethernet interfaces.

For more information about how to configure aggregated Ethernet interfaces, see the *Junos Network Interfaces Configuration Guide*.

**Related Documentation**


- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71
- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55


## Synchronizing the Routing Engine Configuration

When you configure nonstop active routing, you must also include the **commit synchronize** statement at the **[edit system]** hierarchy level so that configuration changes are synchronized on both Routing Engines:

```
[edit system]
commit synchronize;
```

If you try to commit the nonstop active routing configuration without including the **commit synchronize** statement, the commit operation fails.

If you issue the **commit synchronize** command at the **[edit]** hierarchy level on the backup Routing Engine, the Junos system software displays a warning and commits the candidate configuration.

NOTE: A newly inserted backup Routing Engine automatically synchronizes its configuration with the master Routing Engine configuration.

When you configure nonstop active routing, you can bring the backup Routing Engine online after the master Routing Engine is already running. There is no requirement to start the two Routing Engines simultaneously.

**Related Documentation**

- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71
- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55

## Verifying VPLS Nonstop Active Routing Operation

To see whether or not nonstop active routing is enabled, issue the **show task replication** command.

NOTE: You must issue the **show task replication** command on the master Routing Engine. This command is not supported on the backup Routing Engine.

For more information on this command, see the CLI Explorer.

**Related Documentation**

- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71
- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55

## Tracing VPLS Nonstop Active Routing Synchronization Events

To trace the label and logical interface association that VPLS receives from the kernel replication state, include the **nsr-synchronization** statement at the **[edit routing-options traceoptions flag]** hierarchy level. This flag also traces the Layer 2 VPN signaling state replicated from routes advertised by BGP.

```
[edit routing-options]
traceoptions {
  flag nsr-synchronization;
}
```

**Related Documentation**

- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71
- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55

## Option: Configuring the Spanning Tree Protocol and VPLS on MX Series Routers

If multiple routers on a customer site are connected to the same PE, you should enable the Spanning Tree Protocol on that PE. To configure RSTP or MSTP and VPLS simultaneously, include the **rstp** or **mstp** statement at the [**edit instance-type layer2-control**] hierarchy level:

```
[edit]
instance-type layer2-control;
protocols {
  rstp {
    interface interface name;
    force-version stp; # To run STP instead of RSTP
  }
}
```

The Per-VLAN Spanning Tree (PVST) protocol maintains a separate spanning-tree instance for each VLAN. To enable PVST for a specific VLAN ID, there should be a VPLS instance with that VLAN ID and all of the logical interfaces assigned to that instance should have the same matching VLAN ID. To configure PVST with VPLS, include the **vstp** statement at the [**edit instance-type layer2-control**] hierarchy level:

```
[edit]
instance-type layer2-control;
protocols {
  vstp {
    interface interface name;
    vlan vlan-id;
  }
}
```

If you want only STP to run on a device, you can configure STP by including the **force-version stp** statement at the [**edit protocols rstp**] or [**edit protocols vstp**] hierarchy level:

```
[edit]
protocols {
  rstp {
    force-version stp;
  }
}
```

For more information about the Spanning Tree Protocol (VSTP, MSTP, RSTP, or STP), see the *MX Series Solutions Guide* and the *Junos OS Routing Protocols Library for Routing Devices*.

**Related Documentation**


- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71
- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55

## Filtering Layer 2 Packets in a VPLS Instance (MX Series Routers Only)

You can match the **learn-vlan-id**, **user-vlan-id**, and **traffic-type** terms for a VPLS instance on the MX Series platform. Packets entering or exiting the VPLS instance have a single VLAN tag. This VLAN tag is the same as what was received from the network. This VLAN tag corresponds to the one VLAN ID on a singly tagged logical interface or inner VLAN tag for the doubly tagged logical interface. The VLAN ID is used to qualify learned MAC addresses.

To configure a firewall filter for a VPLS instance, specify the conditions that the packet must match at the [**edit firewall family vpls filter** ***filter-name*** **term** ***term-name*** **from**] hierarchy level. To apply a firewall filter to a VPLS routing instance, include the **input filter-name** statement at [**edit routing-instances** ***routing-instance-name*** **forwarding-options family vpls filter**] hierarchy level. For more information, see the *Routing Policy Feature Guide for Routing Devices*.

**Related Documentation**


- Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 71
- Example: VPLS Configuration (BGP Signaling) on page 43
- Example: VPLS Configuration (BGP and LDP Interworking) on page 55

CHAPTER 3

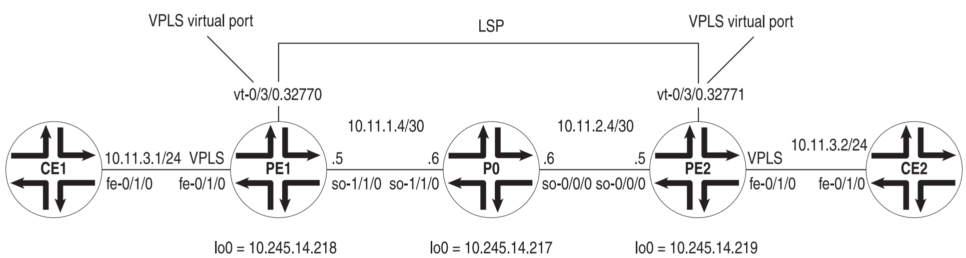
# Virtual Private LAN Service Configuration Example

This section contains configuration examples and commands you can issue to verify your VPLS configuration:



## Example: VPLS Configuration (BGP Signaling)

### Figure 7: VPLS Topology Diagram




**VPLS table for PE1**

| Interface | MAC Address | Outgoing label | Received label |
|---|---|---|---|
| fe-0/1/0 | aaaa.aaaa.aaaa | n/a | n/a |
| vt-0/3/0.32770 | bbbb.bbbb.bbbb | 800000 | 800002 |

g017142

In Figure 7 on page 43, a simple VPLS topology is enabled between routers PE1 and PE2. CE routers CE1 and CE2 use Ethernet-based interfaces to connect VLAN 600 to their local PE router. The PE routers PE1 and PE2 are connected to one another by LSPs enabled across a service provider backbone running MPLS, BGP, RSVP, and OSPF.

In a VPLS routing instance named **green**, PE1 has a local interface **fe-0/1/0** and a virtual port of **vt-0/3/0.32770** (the virtual port is created dynamically on the Tunnel Services PIC when VPLS is configured). PE2 has a local interface **fe-0/1/0** and a virtual port of **vt-0/3/0.32771** in the same **green** instance. As a result, routers CE1 and CE2 send Ethernet traffic to one another as if they were physically connected to each other on a LAN.

On Router CE1, the only item you need to configure is the Fast Ethernet interface that connects to PE1. Be sure to write down the VLAN identifier and IP address, so you can match them later on CE2.

**Router CE1**

```
[edit]
interfaces {
  fe-0/1/0 {
    vlan-tagging; # Configure VLAN tagging for VLAN VPLS or extended VLAN VPLS.
    unit 0 {
      vlan-id 600; # The Ethernet interface on CE2 must use the same VLAN ID.
      family inet {
        address 10.11.3.1/24; # The interface on CE2 must use the same prefix.
      }
    }
  }
}
```

If Router PE1 is an MX Series device, you need to configure a tunnel service interface.

To create tunnel interfaces on an MX Series router, include the **tunnel-services** statement at the [**edit chassis fpc *slot-number* pic *number***] hierarchy level. To configure the bandwidth for a tunnel interface, include the **bandwidth** statement at the [**edit chassis fpc *slot-number* pic *number* tunnel services**] hierarchy level.

The following example shows a tunnel interface with 1 Gbps of bandwidth configured on PFE 3 of the DPC installed in slot 0 of an MX Series router:

```
[edit chassis]
fpc 0 {
  pic 3 {
    tunnel services {
      bandwidth 1g;
    }
  }
}
```

On Router PE1, prepare the router for VPLS by configuring BGP, MPLS, OSPF, and RSVP. (These protocols are the basis for most Layer 2 VPN-related applications, including VPLS.) Include the **signaling** statement at the **[edit protocols bgp group *group-name* family l2vpn]** hierarchy level, because VPLS uses the same infrastructure for internal BGP as Layer 2 VPNs.

NOTE: In Junos OS Release 7.3 and later, the **signaling** statement replaces the **unicast** statement at the **[edit protocols bgp group *group-name* family l2vpn]** hierarchy level. You must use the **signaling** statement if you wish to configure VPLS domains and Layer 2 VPNs simultaneously.

Next, configure VLAN tagging on the Fast Ethernet interface connected to Router CE1. Include VLAN VPLS encapsulation at both the physical and logical interface levels. Be sure to use the same VLAN ID for all Ethernet interfaces that are part of a single VPLS instance. Finally, add the Fast Ethernet interface into a VPLS routing instance and specify the site range, site ID number, and site name.

**Router PE1**

```
[edit]
interfaces {
  fe-0/1/0 {
    vlan-tagging;# Configure VLAN tagging for VLAN VPLS or extended VLAN VPLS.
    encapsulation vlan-vpls; # Configure VPLS encapsulation on both the
    unit 0 { # physical interface and the logical interface.
      encapsulation vlan-vpls;
      vlan-id 600;# The VLAN ID is the same one used by the CE routers.
    }
  }
  so-1/1/0 {
    unit 0 {
      family inet {
        address 10.11.1.5/30;
      }
      family mpls;
    }
  }
  lo0 {
    unit 0 {
      family inet {
        address 10.245.14.218/32;
      }
    }
  }
}
routing-options {
  autonomous-system 69;
  forwarding-table {
    export exp-to-fwd; # Apply a policy that selects an LSP for the VPLS instance.
  }
}
protocols {
  rsvp {
    interface all {
      aggregate;
    }
  }
  mpls {
    label-switched-path pe1-to-pe2 { # Configure an LSP to reach other VPLS PEs.
      to 10.245.14.219;
    }
    interface all;
  }
  bgp {
    group vpls-pe {
      type internal;
      local-address 10.245.14.218;
      family l2vpn { # VPLS uses the same infrastructure as Layer 2 VPNs
        signaling; # for internal BGP.
      }
      neighbor 10.245.14.217;
      neighbor 10.245.14.219;
    }
  }
  ospf {
```

```
        traffic-engineering;
        area 0.0.0.0 {
            interface so-1/1/0.0 {
                metric 11;
            }
            interface lo0.0 {
                passive;
            }
        }
    }
}
policy-options {
    policy-statement exp-to-fwd {
        term a {
            from community grn-com; # Matches the community in the VPLS instance.
            then {
                install-nexthop lsp pe1-to-pe2; # If there are multiple LSPs that exist
                accept; # between VPLS PE routers, this statement sends VPLS traffic
            } # over a specific LSP.
        }
    }
    community grn-com members target:11111:1; # Adds the instance to a BGP
} # community.
routing-instances {
    green {
        instance-type vpls; # Configure a VPLS routing instance.
        interface fe-0/1/0.0;
        route-distinguisher 10.245.14.218:1;
        vrf-target target:11111:1; # This value is important to the BGP community.
        protocols {
            vpls { # Configure a VPLS site range, site name, and site identifier.
                site-range 10;
                site greenPE1 {
                    site-identifier 1;
                }
            }
        }
    }
}
```

On Router P0, configure BGP, MPLS, OSPF, and RSVP to interconnect PE1 and PE2.

**Router P0**

```
[edit]
interfaces {
    so-0/0/0 {
        unit 0 {
            family inet {
                address 10.11.2.6/30;
            }
            family mpls;
        }
    }
    so-1/1/0 {
        unit 0 {
            family inet {
                address 10.11.1.6/30;
```

```
        }
        family mpls;
      }
    }
    lo0 {
      unit 0 {
        family inet {
          address 10.245.14.217/32;
        }
      }
    }
  }
  routing-options {
    autonomous-system 69;
  }
  protocols {
    rsvp {
      interface all {
        aggregate;
      }
    }
    mpls {
      interface all;
    }
    bgp {
      group vpls-pe {
        type internal;
        local-address 10.245.14.217;
        family l2vpn { # VPLS uses the same infrastructure as Layer 2 VPNs
          signaling; # for internal BGP.
        }
        neighbor 10.245.14.218;
        neighbor 10.245.14.219;
      }
    }
    ospf {
      traffic-engineering;
      area 0.0.0.0 {
        interface so-1/1/0.0 {
          metric 11;
        }
        interface so-0/0/0.0 {
          metric 15;
        }
        interface lo0.0 {
          passive;
        }
      }
    }
  }
```

If Router PE2 is an MX Series device, you need to configure a tunnel service interfaces.

To create tunnel interfaces on an MX Series router, include the **tunnel-services** statement at the [**edit chassis fpc *slot-number* pic *number***] hierarchy level. To configure the bandwidth for a tunnel interface, include the **bandwidth** statement at the [**edit chassis fpc *slot-number* pic *number***] hierarchy level.

The following example shows a tunnel interface with 1 Gbps of bandwidth configured on PFE 3 of the DPC installed in slot 0 of an MX Series router:

```
[edit chassis]
fpc 0 {
   pic 3 {
      tunnel services {
         bandwidth 1g;
      }
   }
}
```

On Router PE2, configure BGP, MPLS, OSPF, and RSVP to complement the configuration on PE1. Next, configure VLAN tagging on the Fast Ethernet interface connected to Router CE2. Include VLAN VPLS encapsulation at both the physical and logical interface levels. Be sure to use the same VLAN ID for all Ethernet interfaces that are part of a single VPLS instance. Finally, add the Fast Ethernet interface into a VPLS routing instance and specify the site range, site ID number, and site name.

**Router PE2**

```
[edit]
interfaces {
   fe-0/1/0 {
      vlan-tagging; # Configure VLAN tagging for VLAN VPLS or extended VLAN VPLS.
      encapsulation vlan-vpls; # Configure VPLS encapsulation on both the
      unit 0 { # physical interface and logical interface.
         encapsulation vlan-vpls;
         vlan-id 600;# The VLAN ID is the same one used by the CE routers.
      }
   }
   so-0/0/0 {
      unit 0 {
         family inet {
            address 10.11.2.5/30;
         }
         family mpls;
      }
   }
   lo0 {
      unit 0 {
         family inet {
            address 10.245.14.219/32;
         }
      }
   }
}
routing-options {
   autonomous-system 69;
   forwarding-table {
      export exp-to-fwd; # Apply a policy that selects an LSP for the VPLS instance.
   }
}
protocols {
```

```
  rsvp {
    interface all {
      aggregate;
    }
  }
  mpls {
    label-switched-path pe2-to-pe1 { # Configure an LSP to other VPLS PE routers.
      to 10.245.14.218;
    }
    interface all;
  }
  bgp {
    group vpls-pe {
      type internal;
      local-address 10.245.14.219;
      family l2vpn { # VPLS uses the same infrastructure as Layer 2 VPNs
        signaling; # for internal BGP.
      }
      neighbor 10.245.14.217;
      neighbor 10.245.14.218;
    }
  }
  ospf {
    traffic-engineering;
    area 0.0.0.0 {
      interface so-0/0/0.0 {
        metric 15;
      }
      interface lo0.0 {
        passive;
      }
    }
  }
}
policy-options {
  policy-statement exp-to-fwd {
    term a {
      from community grn-com; # Matches the community with the VPLS instance.
      then {
        install-nexthop lsp pe2-to-pe1; # If there are multiple LSPs that exist
        accept; # between VPLS PE routers, this statement sends VPLS traffic
      } # over a specific LSP.
    }
  }
  community grn-com members target:11111:1; # This adds the instance into a BGP
    community.
}
routing-instances {
  green {
    instance-type vpls; # Configure a VPLS routing instance.
    interface fe-0/1/0.0;
    route-distinguisher 10.245.14.219:1;
    vrf-target target:11111:1; # This value is important for the BGP community.
    protocols {
      vpls { # Configure a VPLS site range, site name, and site identifier.
        site-range 10;
```

```
            site greenPE2 {
               site-identifier 2;
            }
         }
      }
   }
}
```

On Router CE2, complete your VPLS network by configuring the Fast Ethernet interface that connects to PE2. Use the same VLAN identifier and IP address prefix used on Router CE1.

**Router CE2**

```
[edit]
interfaces {
   fe-0/1/0 {
      vlan-tagging; # Configure VLAN tagging for VLAN VPLS or extended VLAN VPLS.
      unit 0 {
         vlan-id 600; # The Ethernet interface on CE1 must use the same VLAN ID.
         family inet {
            address 10.11.3.2/24; # The interface on CE1 must use the same prefix.
         }
      }
   }
}
```

## Verifying Your Work

To verify proper operation of VPLS, use the following commands:

- **clear vpls mac-address instance *instance-name***
- **show interfaces terse**
- **show route forwarding-table family mpls**
- **show route forwarding-table family vpls (destination | extensive | matching | table)**
- **show route instance (detail)**
- **show system statistics vpls**
- **show vpls connections**
- **show vpls statistics**

The following section shows the output of these commands on Router PE1 as a result of the configuration example:

```
user@PE1> show interfaces terse
Interface               Admin Link Proto Local                 Remote
so-1/1/0                up    up
so-1/1/0.0              up    up   inet  10.11.1.5/30
                                   mpls
so-1/1/1                up    up
so-1/1/2                up    up
so-1/1/3                up    up
fe-0/1/0                up    up
fe-0/1/0.0              up    up   vpls   # This is the local Fast Ethernet
# interface.
```

```
fe-0/1/1                up    up
fe-0/1/2                up    up
fe-0/1/3                up    up
gr-0/3/0                up    up
ip-0/3/0                up    up
mt-0/3/0                up    up
pd-0/3/0                up    up
pe-0/3/0                up    up
vt-0/3/0                up    up
vt-0/3/0.32770          up    up  # This is the dynamically generated virtual
port.
dsc                     up    up
fxp0                    up    up
fxp0.0                  up    up   inet  192.186.14.218/24
fxp1                    up    up
fxp1.0                  up    up   tnp   4
gre                     up    up
ipip                    up    up
lo0                     up    up
lo0.0                   up    up   inet  10.245.14.218       --> 0/0
                                         127.0.0.1           --> 0/0
                                   inet6 fe80::2a0:a5ff:fe28:13e0
                                         feee::10:245:14:218
lsi                     up    up
mtun                    up    up
pimd                    up    up
pime                    up    up
tap                     up    up

user@PE1> show system statistics vpls
vpls:
        0 total packets received
        0 with size smaller than minimum
        0 with incorrect version number
        0 packets for this host
        0 packets with no logical interface
        0 packets with no family
        0 packets with no route table
        0 packets with no auxiliary table
        0 packets with no corefacing entry
        0 packets with no CE-facing entry
         6 mac route learning requests # This indicates that VPLS is working.
        6 mac routes learnt
        0 mac routes aged
        0 mac routes moved
```

To display VPLS source and destination MAC address accounting information, use the **destination**, **extensive**, **matching**, or **table** option with the **show route forwarding-table family vpls** command. When you analyze the display output, keep in mind the following:

- VPLS MAC address accounting is handled on a per-MAC address basis for each VPLS instance. All information is retrieved from MAC address entries in the MAC address table. VPLS MAC address accounting is performed only on local CE routers.
- The VPLS counters for source and destination MAC addresses increment continuously until the oldest MAC address entries are removed from the memory buffer, either when the entries time out or if the VPLS instance is restarted.

  ```
  user@PE1> show route forwarding-table family vpls extensive
  ```

```
Routing table: green.vpls [Index 2]
VPLS:

Destination:  default
  Route type: dynamic            Route reference: 0
  Flags: sent to PFE
  Next-hop type: flood                Index: 353      Reference: 1

Destination:  default
  Route type: permanent          Route reference: 0
  Flags: none
  Next-hop type: discard              Index: 298      Reference: 1

Destination:  fe-0/1/0.0
  Route type: dynamic            Route reference: 0
  Flags: sent to PFE
  Next-hop type: flood                Index: 355      Reference: 1

Destination:  bb:bb:bb:bb:bb:bb/48 # This MAC address belongs to remote CE2.
  Route type: dynamic            Route reference: 0
  Flags: sent to PFE, prefix load balance
  Next-hop type: indirect             Index: 351      Reference: 4
  Next-hop type: Push 800000, Push 100002(top)
  Next-hop interface: so-1/1/0.0

Destination:  aa:aa:aa:aa:aa:aa/48 # This MAC address belongs to local CE1.
  Route type: dynamic            Route reference: 0
  Flags: sent to PFE, prefix load balance
  Next-hop type: unicast              Index: 354      Reference: 2
  Next-hop interface: fe-0/1/0.0
```

user@PE1> **show route forwarding-table family vpls**

```
Routing table: green.vpls
VPLS:
Destination        Type RtRef Next hop          Type Index NhRef Netif
default            dynm     0                   flood  353     1
default            perm     0                   dscd   298     1
fe-0/1/0.0         dynm     0                   flood  355     1
bb:bb:bb:bb:bb:bb/48 # This MAC address belongs to remote CE2.
                   dynm     0                   indr   351     4
                                                Push 800000, Push 100002(top)
so-1/1/0.0
aa:aa:aa:aa:aa:aa/48 # This MAC address belongs to local CE1.
                   dynm     0                   ucst   354     2 fe-0/1/0.0
```

user@PE1> **show route forwarding-table family mpls**

```
Routing table: mpls
MPLS:
Destination        Type RtRef Next hop          Type Index NhRef Netif
default            perm     0                   dscd    19     1
0                  user     0                   recv    18     3
1                  user     0                   recv    18     3
2                  user     0                   recv    18     3
100000             user     0 10.11.1.6         swap  100001     so-1/1/0.0
800002            user     0                   Pop               vt-0/3/0.32770
vt-0/3/0.32770 (VPLS)
                   user     0                   indr   351     4
                                                Push 800000, Push 100002(top)
so-1/1/0.0
```

```
user@PE1> show route instance green detail
green:
  Router ID: 0.0.0.0
  Type: vpls             State: Active
  Interfaces:
    fe-0/1/0.0  # This is the local Fast Ethernet interface.
    vt-0/3/0.32770  # This is the dynamically generated VPLS virtual port.
  Route-distinguisher: 10.245.14.218:1
  Vrf-import: [ __vrf-import-green-internal__ ]
  Vrf-export: [ __vrf-export-green-internal__ ]
  Vrf-import-target: [ target:11111:1 ]
  Vrf-export-target: [ target:11111:1 ]
  Tables:
    green.l2vpn.0          : 2 routes (2 active, 0 holddown, 0 hidden)
```

```
user@PE1> show vpls connections
L2VPN Connections:
Legend for connection status (St)
OR -- out of range              WE -- intf encaps != instance encaps
EI -- encapsulation invalid     Dn -- down
EM -- encapsulation mismatch    VC-Dn -- Virtual circuit down
CM -- control-word mismatch     -> -- only outbound conn is up
CN -- circuit not present       <- -- only inbound  conn is up
OL -- no outgoing label         Up -- operational
NC -- intf encaps not CCC/TCC   XX -- unknown
NP -- interface not present
Legend for interface status
Up -- operational
Dn -- down
Instance: green
Local site: greenPE1 (1)
    connection-site           Type  St     Time last up          # Up trans
    2                         rmt   Up     Jan 24 06:26:49 2003           1
      Local interface: vt-0/3/0.32770, Status: Up, Encapsulation: VPLS
      Remote PE: 10.245.14.219, Negotiated control-word: No
      Incoming label: 800002, Outgoing label: 800000
```

```
user@PE1> show system statistics vpls
vpls:
        0 total packets received
        0 with size smaller than minimum
        0 with incorrect version number
        0 packets for this host
        0 packets with no logical interface
        0 packets with no family
        0 packets with no route table
        0 packets with no auxiliary table
        0 packets with no corefacing entry
        0 packets with no CE-facing entry
        7 mac route learning requests
        7 mac routes learnt
        0 mac routes aged
        0 mac routes moved
```

```
user@PE1> show route instance green detail
green:
  Router ID: 0.0.0.0
  Type: vpls             State: Active
   Interfaces:
```

```
    fe-0/1/0.0
    vt-0/3/0.32770
  Route-distinguisher: 10.245.14.218:1
  Vrf-import: [ __vrf-import-green-internal__ ]
  Vrf-export: [ __vrf-export-green-internal__ ]
  Vrf-import-target: [ target:11111:1 ]
  Vrf-export-target: [ target:11111:1 ]
  Tables:
    green.l2vpn.0          : 2 routes (2 active, 0 holddown, 0 hidden)
```

```
user@PE1> show vpls statistics
Layer-2 VPN Statistics:
Instance: green
   Local interface: fe-0/1/0.0, Index: 351
   Remote provider edge router: 10.245.14.219
     Multicast packets:                   363
     Multicast bytes   :                30956
     Flood packets     :                    0
     Flood bytes       :                    0
   Local interface: vt-0/3/0.32770, Index: 354
   Remote provider edge router: 10.245.14.219
     Multicast packets:                   135
     Multicast bytes   :                12014
     Flood packets     :                  135
     Flood bytes       :                12014
```

To clear all MAC address entries for a VPLS instance from the VPLS table, issue the **clear vpls mac-address instance** ***instance-name*** command. Add the **logical-system** ***logical-system-name*** option to clear entries in a VPLS instance within a logical system. Use the ***mac-address*** option to remove individual MAC addresses.

**Related Documentation**


- Virtual Private LAN Service Overview on page 3
- Configuring a VPLS Instance with BGP Signaling on page 14
- Configuring Integrated Routing and Bridging in a VPLS Instance (MX Series Routers Only) on page 28
- Configuring Interworking Between BGP Signaling and LDP Signaling in VPLS Instances on page 15
- Configuring LDP Signaling for VPLS on page 13
- Configuring Multihoming on a VPLS Border Router on page 18
- Configuring Routing Protocols on the PE and Core Routers on page 10
- Configuring the VPLS MAC Address Timeout on page 34
- Configuring VLAN IDs in a VPLS Instance (MX Series Routers Only) on page 28
- Configuring VPLS Encapsulation on CE-Facing Interfaces on page 11
- Defining a VPLS Firewall Filter on page 30
- Defining a VPLS Firewall Policer on page 29
- Filtering Layer 2 Packets in a VPLS Instance (MX Series Routers Only) on page 42
- Option: Aggregated Interfaces for VPLS on page 39
- Option: Configuring Automatic Site Selection on page 25

## Example: VPLS Configuration (BGP and LDP Interworking)

Figure 8: Topology for VPLS Configuration Example

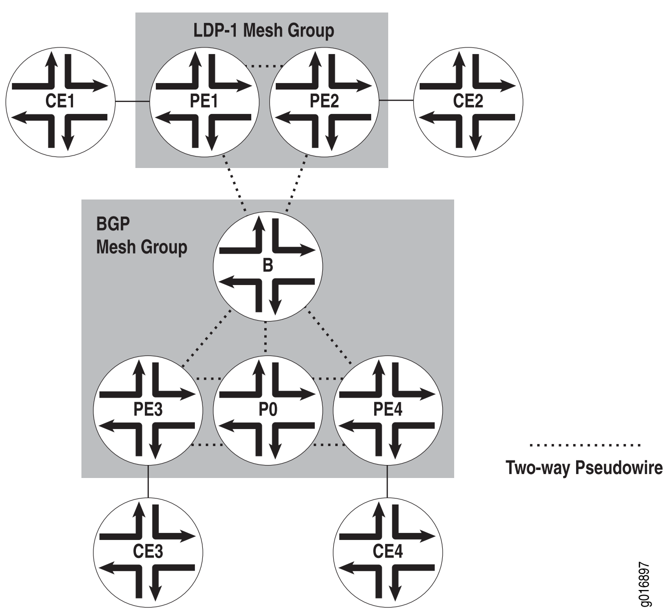


Figure 8 on page 55, shows two VPLS mesh groups: LDP-1 and the default BGP mesh group. The VPLS instance is named **v1** in the configuration. Table 1 on page 56 shows the addresses for the router interfaces in the example topology.

### Table 1: Router Interface Addresses for VPLS Configuration Example

| Router | Interface | Address |
|---|---|---|
| CE1 | fe-0/0/3 (link to Router PE1) | 10.12.31.1 |
| | loopback | 10.12.53.1 |
| CE2 | fe-0/0/1 (link to Router PE2) | 10.12.31.2 |
| | loopback | 10.12.53.2 |
| PE1 | t1-1/1/1 (link to Router PE2) | 10.12.100.17 |
| | t1-0/1/0 (link to Router B) | 10.12.100.2 |
| | loopback | 10.255.170.106 |
| PE2 | t1-0/1/1 (link to Router PE1) | 10.12.100.18 |
| | t1–0/1/3 (link to Router B) | 10.12.100.6 |
| | loopback | 10.255.170.104 |
| B | t1-0/1/2 (link to Router PE1) | 10.12.100.1 |
| | t1-0/1/3 (link to Router PE2) | 10.12.100.5 |
| | so-0/2/2 (link to Router PE3) | 10.12.100.9 |
| | fe-0/0/3 (link to Router PE4) | 10.12.100.13 |
| | loopback | 10.255.170.98 |
| PE3 | s0-0/2/1 (link to Router B) | 10.12.100.10 |
| | so-0/2/2 (link to Router P0) | 10.12.100.21 |
| | loopback | 10.255.170.96 |
| P0 | so-0/2/1 (link to Router PE3) | 10.12.100.22 |
| | t1-0/1/3 (link to Router PE4) | 10.12.100.25 |
| | loopback | 10.255.170.100 |

Table 1: Router Interface Addresses for VPLS Configuration Example *(continued)*

| Router | Interface | Address |
|---|---|---|
| PE4 | fe-0/0/3 (link to Router B) | 10.12.100.14 |
| | t1-0/1/3 (link to Router P0) | 10.12.100.26 |
| | loopback | 10.255.170.102 |
| CE3 | ge-1/2/1 (link to PE3) | 10.12.31.3 |
| | loopback | 10.12.53.3 |
| CE4 | fe-0/0/2 (link to PE4) | 10.12.31.4 |
| | loopback | 10.12.53.4 |

On Router CE3, the only item you need to configure is the Gigabit Ethernet interface that connects to PE3.

**Router CE3**

```
[edit]
interfaces {
  ge-1/2/1 {
    unit 0 {
      family inet {
        address 10.12.31.1/24;
      }
    }
  }
}
```

On Router PE3, prepare the router for VPLS by configuring BGP, MPLS, OSPF, and LDP. (These protocols are the basis for most Layer 2 VPN-related applications, including VPLS.) Include the **signaling** statement at the **[edit protocols bgp group *group-name* family l2vpn]** hierarchy level, because VPLS uses the same infrastructure for internal BGP as Layer 2 VPNs.

NOTE: In Junos OS Release 7.3 and later, the **signaling** statement replaces the **unicast** statement at the **[edit protocols bgp group *group-name* family l2vpn]** hierarchy level. You must use the **signaling** statement if you wish to configure VPLS domains and Layer 2 VPNs simultaneously.

Next, configure VLAN tagging on the Gigabit Ethernet interface connected to Router CE3. Finally, add the Gigabit Ethernet interface into a VPLS routing instance and specify the site range, site ID number, and site name.

**Router PE3**

```
[edit]
interfaces {
  so-0/2/1 {
```

```
        unit 0 {
            family inet {
                address 10.12.100.10/30;
            }
            family mpls;
        }
    so-0/2/2 {
        unit 0 {
            family inet {
                address 10.12.100.21/30;
            }
            family mpls;
        }
    }
        ge-1/3/1 {
            encapsulation ethernet-vpls;
            unit 0 {
                family vpls;
            }
        }
    }
}
protocols {
    mpls {
        interface all;
    }
    bgp {
        log-updown;
        group int {
            type internal;
            local-address 10.255.170.96;
            family l2vpn {
                signaling;
            }
            neighbor 10.255.170.98;
            neighbor 10.255.170.102;
        }
    }
    ospf {
        area 0.0.0.0 {
            interface so-0/2/1.0;
            interface so-0/2/2.0;
            interface lo0.0 {
                passive;
            }
        }
    }
    ldp {
        interface so-0/2/1.0;
        interface so-0/2/2.0;
    }
}
routing-instances {
    v1 {
        instance-type vpls;
        interface ge-1/3/1.0;
```

```
        route-distinguisher 10.255.170.96:1;
        vrf-target target:1:2;
        protocols {
            vpls {
                site-range 10;
                site 1 {
                    site-identifier 3;
                }
            }
        }
    }
```

On Router P0, configure MPLS, OSPF, and LDP to interconnect PE3 and PE4.

**Router P0**

```
[edit]
interfaces {
    t1-0/1/3 {
        unit 0 {
            family inet {
                address 10.12.100.25/30;
            }
            family mpls;
        }
    so-0/2/1 {
        unit 0 {
            family inet {
                address 10.12.100.22/30;
            }
            family mpls;
        }
    }
}
protocols {
    mpls {
        interface all;
    }
    ospf {
        area 0.0.0.0 {
            interface so-0/2/1.0;
            interface t1-0/1/3.0;
            interface lo0.0 {
                passive;
            }
        }
    }
    ldp {
        interface t1-0/1/3.0;
        interface so-0/2/1.0;
    }
}
```

On Router PE4, configure BGP, MPLS, OSPF, and LDP to complement the configuration on PE3. Next, configure VLAN tagging on the Fast Ethernet interface connected to Router CE4. Include VLAN VPLS encapsulation at both the physical and logical interface levels. Finally, add the Fast Ethernet interface into a VPLS routing instance and specify the site range, site ID number, and site name.

**Router PE4**

```
[edit]
interfaces {
   fe-0/0/2 {
   encapsulation ethernet-vpls;
      unit 0 {
         family vpls;
      }
   fe-0/0/3 {
      unit 0 {
         family inet {
            address 10.12.100.14/30;
         }
         family mpls;
      }
   }
   t1-0/1/3 {
      unit 0 {
         family inet {
            address 10.12.100.26/30;
         }
         family mpls;
      }
   }
}
protocols {
   mpls {
      interface all;
   }
   bgp {
      log-updown;
      group int {
         type internal;
         local-address 10.255.170.102;
         family l2vpn {
            signaling;
         }
         neighbor 10.255.170.96;
         neighbor 10.255.170.98;
      }
      }
   }
   ospf {
      area 0.0.0.0 {
         interface fe-0/0/3.0;
         interface t1-0/1/3.0;
         interface lo0.0 {
            passive;
         }
      }
   }
   ldp {
      interface fe-0/0/3.0;
      interface t1-0/1/3.0;
      interface lo0.0;
   }
}
```

On Router CE4, configure the Fast Ethernet interface that connects to PE4.

**Router CE4**

```
[edit]
interfaces {
   fe-0/0/2 {
      unit 0 {
         family inet {
            address 10.12.31.4/24;
         }
      }
   }
}
```

On Router B, the area border router, configure the interfaces. Next, configure BGP, MPLS, OSPF, and LDP. Be sure to include the loopback interface in the LDP configuration by including the **interface lo0.0** statement at the [**edit protocols ldp**] hierarchy level. For BGP, include the **signaling** statement at the [**edit bgp group *group-name* family l2vpn**] hierarchy level. Last, configure the VPLS instance with both BGP and LDP signaling. Configure the LDP-1 mesh group by including the **mesh-group ldp1** statement at the [**edit routing-instances v1 protocols vpls**] hierarchy level.

**Router B**

```
[edit]
interfaces {
   fe-0/0/3 {
      unit 0 {
         family inet {
            address 10.12.100.13/30;
         }
         family mpls;
      }
   }
   t1-0/1/2 {
      unit 0 {
         family inet {
            address 10.12.100.1/30;
         }
         family mpls;
      }
   }
   t1-0/1/3 {
      unit 0 {
         family inet {
            address 10.12.100.5/30;
         }
         family mpls;
      }
   }
   so-0/2/2 {
      unit 0 {
         family inet {
            address 10.12.100.9/30;
         }
         family mpls;
      }
   }
}
```

```
protocols {
  mpls {
    interface all;
  }
  bgp {
    log-updown;
    group int {
      type internal;
      local-address 10.255.170.98;
      family l2vpn {
        signaling;
      }
      neighbor 10.255.170.96;
      neighbor 10.255.170.102;
    }
  }
  ospf {
    area 0.0.0.0 {
      interface t1-0/1/2.0;
      interface t1-0/1/3.0;
      interface so-0/2/2.0;
      interface fe-0/0/3.0;
      interface lo0.0 {
        passive;
      }
    }
  }
  ldp {
    interface fe-0/0/3.0;
    interface t1-0/1/2.0;
    interface t1-0/1/3.0;
    interface so-0/2/2.0;
    interface lo0.0;
  }
}
routing-instances {
  v1 {
    instance-type vpls;
    route-distinguisher 10.255.170.98:1;
    vrf-target target:1:2;
    protocols {
      vpls {
        site-range 10;
        site 1 {
          site-identifier 1;
        }
        vpls-id 101;
        mesh-group ldp-1 {
          neighbor 10.255.170.106;
          neighbor 10.255.170.104;
        }
      }
    }
  }
}
```

Finally, configure the LDP PE routers. On Router PE1, prepare the router for VPLS by configuring LDP, MPLS, and OSPF. Next, configure VPLS encapsulation on the Fast Ethernet interface connected to CE1. Finally, add the Fast Ethernet interface to the routing instance, specifying the VPLS ID and the neighboring routers' loopback addresses.

**Router PE1**

```
[edit]
interfaces {
   fe-0/0/3 {
      encapsulation ethernet-vpls;
      unit 0 {
         family vpls;
      }
   }
   t1-0/1/0 {
      unit 0 {
         family inet {
            address 10.12.100.2/30;
         }
         family mpls;
      }
   }
   t1-1/1/1 {
      unit 0 {
         family inet {
            address 10.12.100.17/30;
         }
         family mpls;
      }
   }
}
protocols {
   mpls {
      interface all;
   }
   ospf {
      area 0.0.0.0 {
         interface t1-0/1/0.0;
         interface t1-1/1/1.0;
         interface lo0.0 {
            passive;
         }
      }
   }
   ldp {
      interface t1-0/1/0.0;
      interface t1-1/1/1.0;
      interface lo0.0;
   }
}
routing-instances {
   v1 {
      instance-type vpls;
      interface fe-0/0/3.0;
      protocols {
         vpls {
            vpls-id 101;
```

```
            neighbor 10.255.170.98;
            neighbor 10.255.170.104;
          }
        }
      }
    }
```

Next, configure the Fast Ethernet interface on Router CE1 that connects to Router PE1.

**Router CE1**

```
[edit]
interfaces {
  fe-0/0/3 {
    unit 0 {
      family inet {
        address 10.12.31.1/24;
      }
    }
  }
}
```

On Router PE2, prepare the router for VPLS by configuring LDP, MPLS, and OSPF. Next, configure VPLS encapsulation on the Fast Ethernet interface connected to Router CE1. Finally, add the Fast Ethernet interface to the routing instance, specifying the VPLS ID and the neighboring routers' loopback addresses.

**Router PE2**

```
[edit]
interfaces {
  t1-0/1/1 {
    unit 0 {
      family inet {
        address 10.12.100.18/30;
      }
      family mpls;
    }
  t1-0/1/3 {
    unit 0 {
      family inet {
        address 10.12.100.6/30;
      }
      family mpls;
    }
  }
  fe-1/0/2 {
    encapsulation ethernet-vpls;
    unit 0 {
      family vpls;
    }
  }
}
protocols {
  mpls {
    interface all;
  }
  ospf {
    area 0.0.0.0 {
      interface t1-0/1/3.0;
```

```
            interface t1-0/1/1.0;
            interface lo0.0 {
                passive;
            }
        }
    }
    ldp {
        interface t1-0/1/1.0;
        interface t1-0/1/3.0;
        interface lo0.0;
    }
}
routing-instances {
    v1 {
        instance-type vpls;
        interface fe-1/0/2.0;
        protocols {
            vpls {
                vpls-id 101;
                neighbor 10.255.170.98;
                neighbor 10.255.170.106;
            }
        }
    }
}
```

Finally, on Router CE2 configure the Fast Ethernet interface connected to PE2:

**Router CE2**

```
[edit]
interfaces {
    fe-0/0/1 {
        unit 0 {
            family inet {
                address 10.12.31.2/24;
            }
        }
    }
}
```

## Verifying Your Work

To verify proper operation of VPLS, use the following commands:

- **show bgp summary**
- **show ldp neighbor**
- **show vpls connections**
- **show route forwarding-table family vpls (destination | extensive | matching | table)**
- **show interfaces vt* terse**
- **show vpls flood extensive**
- **show vpls statistics**

The following section shows the output of some of these commands on Router B as a result of the configuration example.

Use the **show bgp summary** command to verify BGP signaling for VPLS is up.

```
user@B> show bgp summary
Groups: 1 Peers: 2 Down peers: 0
Table          Tot Paths  Act Paths Suppressed    History Damp State    Pending
bgp.l2vpn.0            2          2          0          0          0          0
Peer               AS      InPkt     OutPkt    OutQ   Flaps Last Up/Dwn
State|#Active/Received/Damped...
10.255.170.96   65000        124        125       0       0       54:26 Establ
  bgp.l2vpn.0: 1/1/0
  v1.l2vpn.0: 1/1/0
10.255.170.102  65000        122        124       0       0       54:18 Establ
  bgp.l2vpn.0: 1/1/0
  v1.l2vpn.0: 1/1/0
```

Use the **show ldp neighbors** command to verify that LDP signaling for VPLS is up.

```
user@B> show ldp neighbors
Address            Interface          Label space ID         Hold time
10.255.170.104     lo0.0              10.255.170.104:0         41
10.255.170.106     lo0.0              10.255.170.106:0         38
10.12.100.14       fe-0/0/3.0         10.255.170.102:0         12
10.12.100.10       so-0/2/2.0         10.255.170.96:0          14
10.12.100.2        t1-0/1/2.0         10.255.170.106:0         14
10.12.100.6        t1-0/1/3.0         10.255.170.104:0         13
```

To verify that the VPLS connections are up, use the **show vpls connections** command.

```
user@B>show vpls connections
Layer-2 VPN connections:

Legend for connection status (St)
EI -- encapsulation invalid      NC -- interface encapsulation not CCC/TCC/VPLS
EM -- encapsulation mismatch     WE -- interface and instance encaps not same
VC-Dn -- Virtual circuit down    NP -- interface hardware not present
CM -- control-word mismatch      -> -- only outbound connection is up
CN -- circuit not provisioned    <- -- only inbound connection is up
OR -- out of range               Up -- operational
OL -- no outgoing label          Dn -- down
LD -- local site signaled down   CF -- call admission control failure
RD -- remote site signaled down  SC -- local and remote site ID collision LN --
local site not designated  LM -- local site ID not minimum designated RN -- remote
 site not designated RM -- remote site ID not minimum designated XX -- unknown
connection status  IL -- no incoming label
MM -- MTU mismatch               MI -- Mesh-Group ID not availble

Legend for interface status
Up -- operational
Dn -- down

Instance: v1
BGP-VPLS State
  Local site: 1 (1)
    connection-site           Type  St     Time last up          # Up trans
    3                         rmt   Up     Jan 22 16:38:47 2008           1
      Local interface: vt-0/3/0.1048834, Status: Up, Encapsulation: VPLS
        Description: Intf - vpls v1 local site 1 remote site 3
      Remote PE: 10.255.170.96, Negotiated control-word: No
```

```
      Incoming label: 800258, Outgoing label: 800000
    4                        rmt   Up     Jan 22 16:38:54 2008           1
      Local interface: vt-0/3/0.1048835, Status: Up, Encapsulation: VPLS
        Description: Intf - vpls v1 local site 1 remote site 4
      Remote PE: 10.255.170.102, Negotiated control-word: No
      Incoming label: 800259, Outgoing label: 800000 LDP-VPLS State
VPLS-id: 101
  Mesh-group connections: m1
    Neighbor                 Type  St     Time last up          # Up trans
    10.255.170.104(vpls-id 101) rmt Up     Jan 22 16:38:40 2008           1
      Local interface: vt-0/3/0.1048833, Status: Up, Encapsulation: ETHERNET
        Description: Intf - vpls v1 neighbor 10.255.170.104 vpls-id 101
      Remote PE: 10.255.170.104, Negotiated control-word: No
      Incoming label: 800001, Outgoing label: 800000
    10.255.170.106(vpls-id 101) rmt Up     Jan 22 16:38:39 2008           1
      Local interface: vt-0/3/0.1048832, Status: Up, Encapsulation: ETHERNET
        Description: Intf - vpls v1 neighbor 10.255.170.106 vpls-id 101
      Remote PE: 10.255.170.106, Negotiated control-word: No
      Incoming label: 800000, Outgoing label: 800000
```

To display VPLS routes (MAC addresses) in the vpls forwarding table, use the **show route forwarding-table family vpls** command.

```
user@B> show route forwarding-table family vpls
Routing table: v1.vpls
VPLS:
Destination        Type RtRef Next hop           Type Index NhRef Netif
default            perm     0                    rjct   540     1
vt-0/3/0.1048832   user     0                    comp   587     3
vt-0/3/0.1048833   user     0                    comp   587     3
vt-0/3/0.1048834   user     0                    comp   589     3
vt-0/3/0.1048835   user     0                    comp   589     3
00:17:cb:c2:10:01/48
                   dynm     0                    indr 262143     4
                                                Push 800000   580     2
t1-0/1/3.0
00:17:cb:c2:10:02/48
                   dynm     0                    indr 262145     4
                              10.12.100.14      Push 800000   594     2
fe-0/0/3.0
00:17:cb:c2:10:03/48
                   dynm     0                    indr 262142     4
                                                Push 800000   576     2
t1-0/1/2.0
00:17:cb:c2:10:bd/48
                   dynm     0                    indr 262144     4
                                                Push 800000   585     2
so-0/2/2.0
```

To display VPLS source and destination MAC address accounting information, use the **destination**, **extensive**, **matching**, or **table** option with the **show route forwarding-table family vpls** command. When you analyze the display output, keep in mind the following:

- VPLS MAC address accounting is handled on a per-MAC address basis for each VPLS instance. All information is retrieved from MAC address entries in the MAC address table. VPLS MAC address accounting is performed only on local CE routers.
- The VPLS counters for source and destination MAC addresses increment continuously until the oldest MAC address entries are removed from the memory buffer, either when the entries time out or if the VPLS instance is restarted.

To display status information about Virtual Loopback Tunnel interfaces in the VPLS instance, use the **show interfaces vt* terse** command.

```
user@B> show interfaces vt* terse
Interface               Admin Link Proto    Local                 Remote
vt-0/3/0                up    up
vt-0/3/0.1048832        up    up   vpls
vt-0/3/0.1048833        up    up   vpls
vt-0/3/0.1048834        up    up   vpls
vt-0/3/0.1048835        up    up   vpls
```

To display VPLS route information related to the flood process, use the **show vpls flood extensive** command.

```
user@B> show vpls flood extensive
Name: v1
CEs: 0
VEs: 4
  Flood route prefix: 0x4a/32
  Flood route type: IFF_FLOOD
  Flood route owner: vt-0/3/0.1048834
  Flood group name: __ves__
  Flood group index: 0
  Nexthop type: comp
  Nexthop index: 589
    Flooding to:
    Name             Type          NhType          Index
    m1               Group          comp            588
        Composition: flood-to-all
        Flooding to:
        Name             Type          NhType          Index
        vt-0/3/0.1048832 VE             indr            262142
        vt-0/3/0.1048833 VE             indr            262143

  Flood route prefix: 0x4b/32
  Flood route type: IFF_FLOOD
  Flood route owner: vt-0/3/0.1048835
  Flood group name: __ves__
  Flood group index: 0
  Nexthop type: comp
  Nexthop index: 589
    Flooding to:
    Name             Type          NhType          Index
    m1               Group          comp            588
        Composition: flood-to-all
        Flooding to:
        Name             Type          NhType          Index
        vt-0/3/0.1048832 VE             indr            262142
        vt-0/3/0.1048833 VE             indr            262143

  Flood route prefix: 0x48/32
  Flood route type: IFF_FLOOD
  Flood route owner: vt-0/3/0.1048832
  Flood group name: m1
  Flood group index: 2
  Nexthop type: comp
  Nexthop index: 587
    Flooding to:
    Name             Type          NhType          Index
    __ves__          Group          comp            586
        Composition: flood-to-all
```

```
        Flooding to:
        Name              Type          NhType          Index
        vt-0/3/0.1048834 VE             indr             262144
        vt-0/3/0.1048835 VE             indr             262145

  Flood route prefix: 0x49/32
  Flood route type: IFF_FLOOD
  Flood route owner: vt-0/3/0.1048833
  Flood group name: m1
  Flood group index: 2
  Nexthop type: comp
  Nexthop index: 587
    Flooding to:
    Name              Type          NhType          Index
    __ves__           Group          comp             586
        Composition: flood-to-all
        Flooding to:
        Name              Type          NhType          Index
        vt-0/3/0.1048834 VE             indr             262144
        vt-0/3/0.1048835 VE             indr             262145
```

To view packet flow statistics for the VPLS instance, use the **show vpls statistics** command:

```
user@B> show vpls statistics
Instance: v1
   Local interface: vt-0/3/0.1048832, Index: 72
   Remote PE: 10.255.170.106
     Multicast packets:                    6
     Multicast bytes   :                 360
     Flooded packets   :                  16
     Flooded bytes     :                1188
     Current MAC count:                    1
   Local interface: vt-0/3/0.1048833, Index: 73
   Remote PE: 10.255.170.104
     Multicast packets:                    4
     Multicast bytes   :                 240
     Flooded packets   :                   6
     Flooded bytes     :                 398
     Current MAC count:                    1
   Local interface: vt-0/3/0.1048834, Index: 74
   Remote PE: 10.255.170.96
     Multicast packets:                    2
     Multicast bytes   :                 120
     Flooded packets   :                   4
     Flooded bytes     :                 278
     Current MAC count:                    1
   Local interface: vt-0/3/0.1048835, Index: 75
   Remote PE: 10.255.170.102
     Multicast packets:                    1
     Multicast bytes   :                  60
     Flooded packets   :                   2
     Flooded bytes     :                 158
     Current MAC count:                    1
```

**Related Documentation**

- Virtual Private LAN Service Overview on page 3
- Configuring a VPLS Instance with BGP Signaling on page 14

- Configuring Integrated Routing and Bridging in a VPLS Instance (MX Series Routers Only) on page 28
- Configuring Interworking Between BGP Signaling and LDP Signaling in VPLS Instances on page 15
- Configuring LDP Signaling for VPLS on page 13
- Configuring Multihoming on a VPLS Border Router on page 18
- Configuring Routing Protocols on the PE and Core Routers on page 10
- Configuring the VPLS MAC Address Timeout on page 34
- Configuring VLAN IDs in a VPLS Instance (MX Series Routers Only) on page 28
- Configuring VPLS Encapsulation on CE-Facing Interfaces on page 11
- Defining a VPLS Firewall Filter on page 30
- Defining a VPLS Firewall Policer on page 29
- Filtering Layer 2 Packets in a VPLS Instance (MX Series Routers Only) on page 42
- Option: Aggregated Interfaces for VPLS on page 39
- Option: Configuring Automatic Site Selection on page 25
- Option: Configuring the Spanning Tree Protocol and VPLS on MX Series Routers on page 41
- Option: Configuring Tunnel Services on MX Series Routers on page 27
- Option: Configuring VPLS Interinstance Bridging and Routing on page 35
- Option: Configuring VPLS Multihoming with BGP Signaling on page 20
- Option: Configuring VPLS Traffic Flooding over a Point-to-Multipoint LSP on page 23
- Option: Configuring VPLS to Use LSI Interfaces on page 26
- Option: Enabling VPLS Class of Service on page 33
- Option: Enabling VPLS Graceful Restart on page 33
- Option: Limiting the Number of MAC Addresses Learned on a VPLS Interface on page 37
- Option: Optimizing VPLS Traffic Flows on page 38
- Option: Selecting an LSP for the VPLS Routing Instance to Traverse on page 19
- Option: Selecting Interfaces to Process VPLS Traffic on page 36
- Restricting Broadcast Packets in VPLS on page 32
- Synchronizing the Routing Engine Configuration on page 39
- Tracing VPLS Nonstop Active Routing Synchronization Events on page 40
- Verifying VPLS Nonstop Active Routing Operation on page 40

# Example: Configuring Inter-AS VPLS with MAC Processing at the ASBR

This example describes how to configure inter-AS Virtual Private LAN Service (VPLS) with MAC processing between BGP-signaled VPLS and LDP-signaled VPLS. This feature is described in RFC 4761 as multi-AS VPLS option E or method E.

This example is organized in the following sections:



## Requirements

To support inter-AS VPLS between BGP-signaled VPLS and LDP-signaled VPLS, your network must meet the following hardware and software requirements:

- MX Series or M320 routers for the ASBRs.
- Junos OS Release 9.3 or higher.
- Gigabit Ethernet or 10-Gigabit Ethernet interfaces.

NOTE: **This configuration example has been tested using the software release listed and is assumed to work on all later releases.**

## Overview and Topology

VPLS is a key enabler for delivering multipoint Ethernet service. Major service providers have implemented IP and MPLS backbones and offer VPLS services to large enterprises. Growing demand requires the VPLS network to scale to support many VPLS customers with multiple sites spread across geographically dispersed regions. BGP-signaled VPLS signaling offers scaling advantages over LDP-signaled VPLS. In some environments there is a need for BGP-signaled VPLS to interoperate with existing LDP-signaled VPLS.

This example shows one way to configure BGP-signaled VPLS interworking with an existing LDP-signaled VPLS network.

The advantages of the configuration are:

- You can interconnect customer sites that are spread across different autonomous systems (ASs).
- LDP-signaled VPLS and BGP-signaled VPLS interworking is supported.
- Because the ASBR supports MAC operations, customer sites can be connected directly to the ASBR.
- The inter-AS link is not restricted to Ethernet interfaces.
- Additional configuration for multihoming is relatively straightforward.

Traffic from the interworking virtual private LAN services is switched at the ASBR. The ASBR does all the data plane operations: flooding, MAC learning, aging, and MAC forwarding for each AS to switch traffic among any customer facing interfaces and between the fully meshed pseudowires in the AS. A single pseudowire is created between the ASBRs across the inter-AS link and the ASBRs forward traffic from the pseudowires in each AS to the peer ASBR.

Each ASBR performs VPLS operations within its own AS and performs VPLS operations with the ASBR in the other AS. The ASBR treats the other AS as a BGP-signaled VPLS site. To establish VPLS pseudowires, VPLS NLRI messages are exchanged across the EBGP sessions on the inter-AS links between the ASBRs.

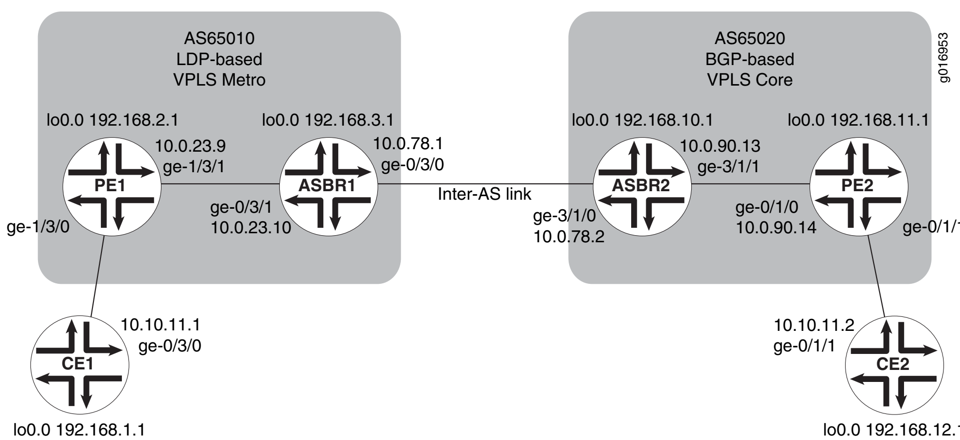
The sample metro network is configured for LDP-signaled VPLS. The core network is configured for BGP-signaled VPLS.

The first part of the example shows the basic configuration steps to configure the logical interfaces, OSPF, internal BGP, LDP, and MPLS. This part of the configuration is the same as other VPLS configurations for LDP-signaled VPLS and BGP-signaled VPLS.

The unique part of the example is configured in the VPLS routing instances, external BGP, and the policy that populates the BGP route table with routes learned from direct routes and OSPF routes. Additional details about the configuration statements are included in the step-by-step procedure.

Figure 9 on page 72 shows the topology used in this example.

### Figure 9: Inter-AS VPLS with MAC Operations Example Topology




## Configuration

To configure inter-AS VPLS between BGP-signaled VPLS and LDP-signaled VPLS, perform these tasks.

NOTE: In any configuration session it is a good practice to periodically use the commit check command to verify that the configuration can be committed.



## Configuring Interfaces

**Step-by-Step Procedure**

To configure interfaces:

1. On each router, configure an IP address on the loopback logical interface 0 (lo0.0):

   user@CE1# **set interfaces lo0 unit 0 family inet address 192.168.1.1/32 primary**

   user@PE1# **set interfaces lo0 unit 0 family inet address 192.168.2.1/32 primary**

   user@ASBR1# **set interfaces lo0 unit 0 family inet address 192.168.3.1/32 primary**

   user@ASBR2# **set interfaces lo0 unit 0 family inet address 192.168.10.1/32 primary**

   user@PE2# **set interfaces lo0 unit 0 family inet address 192.168.11.1/32 primary**

   user@CE2# **set interfaces lo0 unit 0 family inet address 192.168.12.1/32 primary**

2. On each router, commit the configuration:

```
user@host> commit check
configuration check succeeds
user@host> commit
commit complete
```

3. On each router, display the interface information for **lo0** and verify that the correct IP address is configured:

```
user@host> show interfaces lo0

Physical interface: lo0, Enabled, Physical link is Up
  Interface index: 6, SNMP ifIndex: 6
  Type: Loopback, MTU: Unlimited
  Device flags   : Present Running Loopback
  Interface flags: SNMP-Traps
  Link flags     : None
  Last flapped   : Never
```

```
    Input packets : 0
    Output packets: 0

  Logical interface lo0.0 (Index 75) (SNMP ifIndex 16)
    Flags: SNMP-Traps Encapsulation: Unspecified
    Input packets : 0
    Output packets: 0
    Protocol inet, MTU: Unlimited
      Flags: None
      Addresses
        Local: 127.0.0.1
      Addresses, Flags: Primary Is-Default Is-Primary
        Local: 192.168.3.1
Logical interface lo0.16384 (Index 64) (SNMP ifIndex 21)
    Flags: SNMP-Traps Encapsulation: Unspecified
    Input packets : 0
    Output packets: 0
    Protocol inet, MTU: Unlimited
      Flags: None
      Addresses
        Local: 127.0.0.1

  Logical interface lo0.16385 (Index 65) (SNMP ifIndex 22)
    Flags: SNMP-Traps Encapsulation: Unspecified
    Input packets : 0
    Output packets: 0
    Protocol inet, MTU: Unlimited
      Flags: None
```

In the example above notice that the primary **lo0** local address for the **inet** protocol family on Router ASBR1 is **192:168:3:1**.

4. On each router, configure an IP address and protocol family on the Gigabit Ethernet interfaces. Specify the **inet** protocol family.

   user@CE1# **set interfaces ge-0/3/0 unit 0 family inet address 10.10.11.1/24**

   user@PE1# **set interfaces ge-1/3/1 unit 0 family inet address 10.0.23.9/30**

   user@ASBR1# **set interfaces ge-0/3/1 unit 0 family inet address 10.0.23.10/30**
   user@ASBR1# **set interfaces ge-0/3/0 unit 0 family inet address 10.0.78.1/30**

   user@ASBR2# **set interfaces ge-3/1/0 unit 0 family inet address 10.0.78.2/30**
   user@ASBR2# **set interfaces ge-3/1/1 unit 0 family inet address 10.0.90.13/30**

   user@PE2# **set interfaces ge-0/1/0 unit 0 family inet address 10.0.90.14/30**

   user@CE2# **set interfaces ge-0/1/1 unit 0 family inet address 10.10.11.2/24**

5. On each router, commit the configuration:

   ```
   user@host> commit check
   configuration check succeeds
   user@host> commit
   commit complete
   ```

6. Display information for Gigabit Ethernet interfaces and verify that the IP address and protocol family are configured correctly.

```
user@ASBR2> show interfaces ge-* terse
Interface               Admin Link Proto    Local                 Remote
ge-3/1/0                up    up
ge-3/1/0.0              up    up   inet   10.0.78.2/30
                                    multiservice
ge-3/1/1                up    up
ge-3/1/1.0              up    up   inet   10.0.90.13/30
                                    multiservice
ge-3/1/2                up    down
ge-3/1/3                up    down
```

## Configuring OSPF

**Step-by-Step Procedure**

To configure OSPF:

1. On the PE and ASBR routers, configure the provider instance of OSPF. Configure OSPF traffic engineering support. Specify area 0.0.0.1 in the LDP-signaled VPLS network and area 0.0.0.0 in the BGP-signaled network. Specify the Gigabit Ethernet logical interfaces between the PE and ASBR routers. Specify **lo0.0** as a passive interface.

```
user@PE1# set protocols ospf traffic-engineering
user@PE1# set protocols ospf area 0.0.0.1 interface ge-1/3/1.0
user@PE1# set protocols ospf area 0.0.0.1 interface lo0.0 passive

user@ASBR1# set protocols ospf traffic-engineering
user@ASBR1# set protocols ospf area 0.0.0.1 interface ge-0/3/1.0
user@ASBR1# set protocols ospf area 0.0.0.1 interface lo0.0 passive

user@ASBR2# set protocols ospf traffic-engineering
user@ASBR2# set protocols ospf area 0.0.0.0 interface ge-3/1/1.0
user@ASBR2# set protocols ospf area 0.0.0.0 interface lo0.0 passive

user@PE2# set protocols ospf traffic-engineering
user@PE2# set protocols ospf area 0.0.0.0 interface ge-0/1/0.0
user@PE2# set protocols ospf area 0.0.0.0 interface lo0.0 passive
```

2. On each router, commit the configuration:

```
user@host> commit check
configuration check succeeds
user@host> commit
commit complete
```

3. Display OSPF neighbor information and verify that the PE routers form adjacencies with the ASBR router in the same area. Verify that the neighbor state is **Full**.

```
user@host> show ospf neighbor
Address          Interface         State      ID            Pri  Dead
10.0.23.10       ge-1/3/1.0        Full       192.168.3.1   128   31
```

## Configuring the Internal BGP Peer Group

**Step-by-Step Procedure**

The purpose of configuring an internal BGP peer group is to create a full mesh of BGP LSPs among the PE routers in the BGP-signaled AS, including the ASBR routers.

To configure the internal BGP peer group:

1. The purpose of this step is to create a full mesh of IBGP peers between the PE routers, including the ASBR routers, within the BGP-signaled AS.

   On Router ASBR2, configure internal BGP. Specify the BGP type as **internal**. Specify the local address as the local **lo0** IP address.

   Specify the **inet** protocol family. Specify the **labeled-unicast** statement and the **resolve-vpn** option. The **labeled-unicast** statement causes the router to advertise labeled routes out of the IPv4 inet.0 route table and places labeled routes into the inet.0 route table. The **resolve-vpn** option puts labeled routes in the MPLS inet.3 route table The inet.3 route table is used to resolve routes for the PE router located in the other AS.

   Specify the **l2vpn** family to indicate to the router that this is a VPLS. Specify the **signaling** option to configure BGP as the signaling protocol. This enables BGP to carry Layer 2 VPLS NLRI messages for this peer group.

   Specify the **lo0** interface IP address of the PE as the neighbor. Configure an autonomous system identifier.

   ```
   user@ASBR2# set protocols bgp group core-ibgp type internal
   user@ASBR2# set protocols bgp group core-ibgp local-address 192.168.10.1
   user@ASBR2# set protocols bgp group core-ibgp family inet labeled-unicast
     resolve-vpn
   user@ASBR2# set protocols bgp group core-ibgp family l2vpn signaling
   user@ASBR2# set protocols bgp group core-ibgp neighbor 192.168.11.1
   user@ASBR2# set routing-options autonomous-system 0.65020
   ```

2. On Router PE2, configure internal BGP. Specify the BGP type as **internal**. Specify the local address as the local **lo0** IP address.

   Specify the **l2vpn** family to indicate this is a VPLS. Specify the **signaling** option to configure BGP as the signaling protocol. This enables BGP to carry Layer 2 VPLS NLRI messages.

   Specify the **lo0** interface IP address of Router ASBR2 as the neighbor. Configure an autonomous system identifier.

   ```
   user@PE2# set protocols bgp group core-ibgp type internal
   user@PE2# set protocols bgp group core-ibgp local-address 192.168.11.1
   user@PE2# set protocols bgp group core-ibgp family l2vpn signaling
   user@PE2# set protocols bgp group core-ibgp neighbor 192.168.10.1
   user@PE2# set routing-options autonomous-system 0.65020
   ```

3. On each router, commit the configuration:

   ```
   user@host> commit check
   configuration check succeeds
   user@host> commit
   ```

```
commit complete
```

4. On Router PE2 and Router ASBR2, display BGP neighbor information and verify that the peer connection state is **Established**.

```
user@ASBR2> show bgp neighbor
Peer: 192.168.11.1+49443 AS 65020 Local: 192.168.10.1+179 AS 65020
  Type: Internal    State: Established    Flags: ImportEval Sync
  Last State: OpenConfirm   Last Event: RecvKeepAlive
  Last Error: None
  Options: Preference LocalAddress AddressFamily Rib-group Refresh
  Address families configured: l2vpn-signaling inet-labeled-unicast
  Local Address: 192.168.10.1 Holdtime: 90 Preference: 170
  Number of flaps: 0
  Peer ID: 192.168.11.1     Local ID: 192.168.10.1     Active Holdtime: 90
  Keepalive Interval: 30         Peer index: 0

...
```

## Configuring LDP

**Step-by-Step Procedure**

To configure LDP:

1. On the PE and ASBR routers, configure LDP with the Gigabit Ethernet interfaces between the PE and ASBR routers, and between the two ASBR routers. To support LDP-signaled VPLS, additionally configure LDP with the **lo0.0** interface on Router PE1 and Router ASBR1:

```
user@PE1# set protocols ldp interface ge-1/3/1.0
user@PE1# set protocols ldp interface lo0.0

user@ASBR1# set protocols ldp interface ge-0/3/1.0
user@ASBR1# set protocols ldp interface ge-0/3/0.0
user@ASBR1# set protocols ldp interface lo0.0

user@ASBR2# set protocols ldp interface ge-3/1/0.0
user@ASBR2# set protocols ldp interface ge-3/1/1.0

user@PE2# set protocols ldp interface ge-0/1/0.0
```

NOTE: The configuration of LDP signaling between the ASBR routers is not required for Inter-AS VPLS. It is included here for reference only and might be used in LDP environments.

2. On each router, commit the configuration:

```
user@host> commit check
configuration check succeeds
user@host> commit
commit complete
```

3. Display LDP configuration information and verify that the correct interfaces are configured. LDP operation can be verified after MPLS is configured.

```
user@ASBR1> show configuration protocols ldp
```

```
interface ge-0/3/0.0;
interface ge-0/3/1.0;
interface lo0.0;
```

The preceding example is from ASBR1.

## Configuring MPLS

**Step-by-Step Procedure**

To configure MPLS:

1. On the PE and ASBR routers, configure MPLS. Enable MPLS on the logical interfaces. Add the Gigabit Ethernet interfaces to the MPLS protocol. This adds entries to the MPLS forwarding table.

   ```
   user@pe1# set protocols mpls interface ge-1/3/1.0
   user@pe1# set interfaces ge-1/3/1 unit 0 family mpls

   user@ASBR1# set protocols mpls interface ge-0/3/1.0
   user@ASBR1# set protocols mpls interface ge-0/3/0.0
   user@ASBR1# set interfaces ge-0/3/1 unit 0 family mpls
   user@ASBR1# set interfaces ge-0/3/0 unit 0 family mpls

   user@ASBR2# set protocols mpls interface ge-3/1/0.0
   user@ASBR2# set protocols mpls interface ge-3/1/1.0
   user@ASBR2# set interfaces ge-3/1/0 unit 0 family mpls
   user@ASBR2# set interfaces ge-3/1/1 unit 0 family mpls

   user@pe2# set protocols mpls interface ge-0/1/0.0
   user@pe2# set interfaces ge-0/1/0 unit 0 family mpls
   ```

2. On each router, commit the configuration:

   ```
   user@host> commit check
   configuration check succeeds
   user@host> commit
   commit complete
   ```

3. On the PE and ASBR routers, display LDP neighbor information and verify that the directly connected LDP neighbors are listed:

   ```
   user@ASBR1> show ldp neighbor
   Address            Interface          Label space ID         Hold time
   192.168.2.1        lo0.0              192.168.2.1:0            44
   10.0.78.2          ge-0/3/0.0         192.168.10.1:0           13
   10.0.23.9          ge-0/3/1.0         192.168.2.1:0            11
   ```

   The preceding example is from ASBR1.

## Configuring the External BGP Peer Group Between the Loopback Interfaces

**Step-by-Step Procedure**

To configure the external BGP (EBGP) peer group between the loopback interfaces:

1. On Router ASBR1 and Router PE1, configure an autonomous system identifier:

   ```
   user@PE1# set routing-options autonomous-system 0.65010

   user@ASBR1# set routing-options autonomous-system 0.65010
   ```

2. On Router ASBR1, configure an external BGP peer group for the loopback interfaces. Specify the **external** BGP group type. Include the **multihop** statement. Specify the local address as the local **lo0** IP address. Configure the **l2vpn** family for BGP signaling. Configure the peer AS as the core AS number. Specify the **lo0** IP address of Router ASBR2 as the neighbor.

   ```
   user@ASBR1# set protocols bgp group vpls-core type external
   user@ASBR1# set protocols bgp group vpls-core multihop
   user@ASBR1# set protocols bgp group vpls-core local-address 192.168.3.1
   user@ASBR1# set protocols bgp group vpls-core family l2vpn signaling
   user@ASBR1# set protocols bgp group vpls-core peer-as 65020
   user@ASBR1# set protocols bgp group vpls-core neighbor 192.168.10.1
   ```

3. On Router ASBR2, configure an external BGP peer group for the loopback interfaces. Specify the **external** BGP group type. Include the **multihop** statement. The **multihop** statement is needed because the EBGP neighbors are in different ASs. Specify the local address as the local **lo0** IP address. Configure the **l2vpn** family for BGP signaling. Configure the peer AS as the metro AS number. Specify the **lo0** IP address of Router ASBR1 as the neighbor.

   ```
   user@ASBR2# set protocols bgp group vpls-metro type external
   user@ASBR2# set protocols bgp group vpls-metro multihop
   user@ASBR2# set protocols bgp group vpls-metro local-address 192.168.10.1
   user@ASBR2# set protocols bgp group vpls-metro family l2vpn signaling
   user@ASBR2# set protocols bgp group vpls-metro peer-as 65010
   user@ASBR2# set protocols bgp group vpls-metro neighbor 192.168.3.1
   ```

4. On each router, commit the configuration:

   ```
   user@host> commit
   ```

## Configuring the External BGP Peer Group Between the Inter-AS Link Interfaces

**Step-by-Step Procedure**

The purpose of configuring external BGP peer groups between the inter-AS link interfaces is to create a full mesh of BGP LSPs among the ASBR routers. To configure the external BGP peer group between the inter-AS link interfaces:

1. On Router ASBR1, configure a policy to export OSPF and direct routes, including the **lo0** address of the PE routers, into BGP for the establishment of label-switched paths (LSPs):

   ```
   user@ASBR1# set policy-options policy-statement loopback term term1 from
     protocol ospf
   user@ASBR1# set policy-options policy-statement loopback term term1 from
     protocol direct
   user@ASBR1# set policy-options policy-statement loopback term term1 from
     route-filter 192.168.0.0/16 longer
   user@ASBR1# set policy-options policy-statement loopback term term1 then accept
   ```

2. On Router ASBR1, configure an external BGP peer group for the inter-AS link. Specify the **external** BGP group type. Specify the local inter-AS link IP address as the local address. Configure the **inet** family and include the **labeled-unicast** and **resolve-vpn** statements. The **labeled-unicast** statement advertises labeled routes out of the IPv4 inet.0 route table and places labeled routes into the inet.0 route table. The **resolve-vpn** option stores labeled routes in the MPLS **inet.3** route table.

Include the **export** statement and specify the policy you created. Configure the peer AS as the core AS number. Specify the inter-AS link IP address of Router ASBR2 as the neighbor.

```
user@ASBR1# set protocols bgp group metro-core type external
user@ASBR1# set protocols bgp group metro-core local-address 10.0.78.1
user@ASBR1# set protocols bgp group metro-core family inet labeled-unicast
  resolve-vpn
user@ASBR1# set protocols bgp group metro-core export loopback
user@ASBR1# set protocols bgp group metro-core peer-as 65020
user@ASBR1# set protocols bgp group metro-core neighbor 10.0.78.2
```

3. On Router ASBR2, configure a policy to export OSPF and direct routes, including the **lo0** address, into BGP for the establishment of LSPs:

```
user@ASBR2# set policy-options policy-statement loopback term term1 from
  protocol ospf
user@ASBR2# set policy-options policy-statement loopback term term1 from
  protocol direct
user@ASBR2# set policy-options policy-statement loopback term term1 from
  route-filter 192.168.0.0/16 longer
user@ASBR2# set policy-options policy-statement loopback term term1 then accept
```

4. On Router ASBR2, configure an external BGP peer group for the inter-AS link. Specify the **external** BGP group type. Specify the local inter-AS link IP address as the local address. Configure the **inet** family and include the **labeled-unicast** and **resolve-vpn** statements. Include the **export** statement and specify the policy you created. Configure the peer AS as the core AS number. Specify the inter-AS link IP address of Router ASBR1 as the neighbor.

```
user@ASBR2# set protocols bgp group core-metro type external
user@ASBR2# set protocols bgp group core-metro local-address 10.0.78.2
user@ASBR2# set protocols bgp group core-metro family inet labeled-unicast
  resolve-vpn
user@ASBR2# set protocols bgp group core-metro export loopback
user@ASBR2# set protocols bgp group core-metro peer-as 65010
user@ASBR2# set protocols bgp group core-metro neighbor 10.0.78.1
```

5. On each router, commit the configuration:

```
user@host> commit check
configuration check succeeds
user@host> commit
commit complete
```

6. On Router ASBR1, display the BGP neighbors. Verify that the first peer is the IP address of the Gigabit Ethernet interface of Router ASBR2. Verify that the second peer is the IP address of the **lo0** interface of Router ASBR2. Also verify that the state of each peer is **Established**. Notice that on Router ASBR1 the NLRI advertised by Router ASBR2 the inter-AS link peer is **inet-labeled-unicast** and the NLRI advertised by Router ASBR2 the loopback interface peer is **l2vpn-signaling**.

```
user@ASBR1> show bgp neighbor
Peer: 10.0.78.2+65473 AS 65020 Local: 10.0.78.1+179 AS 65010
  Type: External    State: Established    Flags: Sync
  Last State: OpenConfirm   Last Event: RecvKeepAlive
  Last Error: Cease
  Export: [ loopback ]
  Options: Preference LocalAddress AddressFamily PeerAS Rib-group Refresh
```

```
  Address families configured: inet-labeled-unicast
  Local Address: 10.0.78.1 Holdtime: 90 Preference: 170
  Number of flaps: 3
  Last flap event: Stop
  Error: 'Cease' Sent: 1 Recv: 2
  Peer ID: 192.168.10.1     Local ID: 192.168.3.1      Active Holdtime: 90
  Keepalive Interval: 30         Peer index: 0
  BFD: disabled, down
  Local Interface: ge-0/3/0.0
  NLRI for restart configured on peer: inet-labeled-unicast
  NLRI advertised by peer: inet-labeled-unicast
  NLRI for this session: inet-labeled-unicast
  Peer supports Refresh capability (2)
  Restart time configured on the peer: 120
  Stale routes from peer are kept for: 300
  Restart time requested by this peer: 120
  NLRI that peer supports restart for: inet-labeled-unicast
  NLRI that restart is negotiated for: inet-labeled-unicast
  NLRI of received end-of-rib markers: inet-labeled-unicast
  NLRI of all end-of-rib markers sent: inet-labeled-unicast
  Peer supports 4 byte AS extension (peer-as 65020)
  Table inet.0 Bit: 10000
    RIB State: BGP restart is complete
    Send state: in sync
    Active prefixes:              2
    Received prefixes:            3
    Accepted prefixes:            3
    Suppressed due to damping:    0
    Advertised prefixes:          3
  Last traffic (seconds): Received 8    Sent 3    Checked 60
  Input messages:  Total 8713   Updates 3      Refreshes 0    Octets 165688

  Output messages: Total 8745   Updates 2      Refreshes 0    Octets 166315

  Output Queue[0]: 0

Peer: 192.168.10.1+51234 AS 65020 Local: 192.168.3.1+179 AS 65010
  Type: External    State: Established    Flags: Sync
  Last State: OpenConfirm   Last Event: RecvKeepAlive
  Last Error: Cease
  Options: Multihop Preference LocalAddress AddressFamily PeerAS Rib-group
Refresh
  Address families configured: l2vpn-signaling
  Local Address: 192.168.3.1 Holdtime: 90 Preference: 170
  Number of flaps: 3
  Last flap event: Stop
  Error: 'Cease' Sent: 1 Recv: 2
  Peer ID: 192.168.10.1     Local ID: 192.168.3.1      Active Holdtime: 90
  Keepalive Interval: 30         Peer index: 0
  BFD: disabled, down
  NLRI for restart configured on peer: l2vpn-signaling
  NLRI advertised by peer: l2vpn-signaling
  NLRI for this session: l2vpn-signaling
  Peer supports Refresh capability (2)
  Restart time configured on the peer: 120
  Stale routes from peer are kept for: 300
  Restart time requested by this peer: 120
  NLRI that peer supports restart for: l2vpn-signaling
  NLRI that restart is negotiated for: l2vpn-signaling
  NLRI of received end-of-rib markers: l2vpn-signaling
  NLRI of all end-of-rib markers sent: l2vpn-signaling
```

```
  Peer supports 4 byte AS extension (peer-as 65020)
  Table bgp.l2vpn.0 Bit: 20000
    RIB State: BGP restart is complete
    RIB State: VPN restart is complete
    Send state: in sync
    Active prefixes:              1
    Received prefixes:            1
    Accepted prefixes:            1
    Suppressed due to damping:    0
    Advertised prefixes:          1
  Table inter-as.l2vpn.0
    RIB State: BGP restart is complete
    RIB State: VPN restart is complete
    Send state: not advertising
    Active prefixes:              1
    Received prefixes:            1
    Accepted prefixes:            1
    Suppressed due to damping:    0
  Last traffic (seconds): Received 19   Sent 18   Checked 42
  Input messages:  Total 8712   Updates 3      Refreshes 0    Octets 165715

  Output messages: Total 8744   Updates 2      Refreshes 0    Octets 166342

  Output Queue[1]: 0
  Output Queue[2]: 0
```

7. On Router ASBR2, display the BGP summary. Notice that the first peer is the IP address of the Gigabit Ethernet interface of Router ASBR1, the second peer is the IP address of the **lo0** interface of Router ASBR1, and the third peer is the **lo0** interface of Router PE2. Verify that the state of each peer is **Established**.

```
user@ASBR2> show bgp summary
Groups: 3 Peers: 3 Down peers: 0
Table          Tot Paths  Act Paths Suppressed    History Damp State
Pending
inet.0                 3          2          0          0          0
   0
bgp.l2vpn.0            2          2          0          0          0
   0
Peer                     AS      InPkt     OutPkt    OutQ   Flaps Last Up/Dwn
 State|#Active/Received/Accepted/Damped...
10.0.78.1             65010       8781       8748       0       2 2d 17:54:56
 Establ
  inet.0: 2/3/3/0
192.168.3.1           65010       8780       8747       0       2 2d 17:54:54
 Establ
  bgp.l2vpn.0: 1/1/1/0
  inter-as.l2vpn.0: 1/1/1/0
192.168.11.1          65020       8809       8763       0       1 2d 17:59:22
Establ
  bgp.l2vpn.0: 1/1/1/0
  inter-as.l2vpn.0: 1/1/1/0
```

8. On Router PE2, display the BGP group. Verify that the peer is the IP address of the **lo0** interface of Router ASBR2. Verify that the number of established peer sessions is 1.

```
user@PE1> show bgp group
Group Type: Internal    AS: 65020                  Local AS: 65020
  Name: core-ibgp       Index: 1                   Flags: Export Eval
```

```
  Holdtime: 0
  Total peers: 1        Established: 1
  192.168.10.1+179
  bgp.l2vpn.0: 1/1/1/0
  inter-as.l2vpn.0: 1/1/1/0

Groups: 1  Peers: 1    External: 0    Internal: 1    Down peers: 0   Flaps:
 7
Table          Tot Paths  Act Paths Suppressed    History Damp State
Pending
bgp.l2vpn.0            1          1          0          0          0
   0
inte.l2vpn.0           1          1          0          0          0
   0
```

## Configuring the VPLS Routing Instances

**Step-by-Step Procedure**

To configure the VPLS routing instances:

1. On Router PE1, configure the VPLS routing instance. To enable a VPLS instance, specify the **vpls** instance type. Configure VPLS on the CE-facing Gigabit Ethernet interface. Configure the CE-facing interface to use **ethernet-vpls** encapsulation.

   user@PE1# **set routing-instances metro instance-type vpls**
   user@PE1# **set routing-instances metro interface ge-1/3/0.0**

2. On Router PE1, configure the VPLS protocol within the routing instance. To uniquely identify the virtual circuit, configure the VPLS identifier. The VPLS identifier uniquely identifies each VPLS in the router. Configure the same VPLS ID on all the routers for a given VPLS.

   Specify the IP address of the **lo0** interface on Router ASBR2 as the neighbor.

   Configure the CE-facing interface to use **ethernet-vpls** encapsulation and the **vpls** protocol family.

   user@PE1# **set routing-instances metro protocols vpls vpls-id 101**
   user@PE1# **set routing-instances metro protocols vpls neighbor 192.168.3.1**
   user@PE1# **set interfaces ge-1/3/0 encapsulation ethernet-vpls**
   user@PE1# **set interfaces ge-1/3/0 unit 0 family vpls**

3. On Router ASBR1, configure the VPLS routing instance. To enable a VPLS instance, specify the **vpls** instance type. Configure a route distinguisher and a VRF target. The **vrf-target** statement causes default VRF import and export policies to be generated that accept and tag routes with the specified target community.

   NOTE: A route distinguisher allows the router to distinguish between two identical IP prefixes used as VPN routes. Configure a different route distinguisher on each ASBR router.

   NOTE: You must configure the same VRF target on both ASBR routers.

```
user@ASBR1# set routing-instances inter-as instance-type vpls
user@ASBR1# set routing-instances inter-as route-distinguisher 65010:1
user@ASBR1# set routing-instances inter-as vrf-target target:2:1
```

4. On Router ASBR1, configure the VPLS protocol within the routing instance.

   Configure the VPLS identifier. Specify the IP address of the **lo0** interface on Router PE1 as the neighbor.

```
user@ASBR1# set routing-instances inter-as protocols vpls vpls-id 101
user@ASBR1# set routing-instances inter-as protocols vpls neighbor 192.168.2.1
```

   NOTE: The VPLS identifier uniquely identifies each LDP-signaled VPLS in the router. Configure the same VPLS ID on Router PE1 and Router ASBR1.

5. On Router ASBR1, configure the VPLS site within the routing instance. Configure the site identifier as required by the protocol to establish the EBGP pseudowire. As a best practice for more complex topologies involving multihoming, configure a site preference.

```
user@ASBR1# set routing-instances inter-as protocols vpls site ASBR-metro
  site-identifier 1
user@ASBR1# set routing-instances inter-as protocols vpls site ASBR-metro
  site-preference 10000
```

6. On Router ASBR1, configure the VPLS mesh group **peer-as** statement within the routing instance to specify which ASs belong to this AS mesh group. Configure the peer AS for the mesh group as **all**.

   This statement enables the router to establish a single pseudowire between the ASBR routers. VPLS NLRI messages are exchanged across the EBGP sessions on the inter-AS links between the ASBR routers. All autonomous systems are in one mesh group.

```
user@ASBR1# set routing-instances inter-as protocols vpls mesh-group metro
  peer-as all
```

7. On ASBR2, configure the VPLS routing instance. To enable a VPLS instance, specify the **vpls** instance type. Configure a route distinguisher and a VRF target. The **vrf-target** statement causes default VRF import and export policies to be generated that accept and tag routes with the specified target community.

   NOTE: A route distinguisher allows the router to distinguish between two identical IP prefixes used as VPN routes. Configure a different route distinguisher on each ASBR router.

   NOTE: You must configure the same VRF target community on both ASBR routers.

user@ASBR2# **set routing-instances inter-as instance-type vpls**
user@ASBR2# **set routing-instances inter-as route-distinguisher 65020:1**
user@ASBR2# **set routing-instances inter-as vrf-target target:2:1**

8. On Router ASBR2, configure the VPLS site within the routing instance. Configure the site identifier as required by the protocol.

   user@ASBR2# **set routing-instances inter-as protocols vpls site ASBR-core site-identifier 2**

9. On Router ASBR2, configure the VPLS mesh group within the routing instance to specify which VPLS PEs belong to this AS mesh group. Configure the peer AS for the mesh group as **all**.

   This statement enables the router to establish a single pseudowire between the ASBR routers. VPLS NLRI messages are exchanged across the EBGP sessions on the inter-AS links between the ASBR routers. All autonomous systems are in one mesh group.

   user@ASBR1# **set routing-instances inter-as protocols vpls mesh-group core peer-as all**

10. On Router PE2, configure the VPLS routing instance. To enable a VPLS instance, specify the **vpls** instance type. Configure VPLS on the CE-facing Gigabit Ethernet interface. Configure a route distinguisher and a VRF target.

    user@PE2# **set routing-instances inter-as instance-type vpls**
    user@PE2# **set routing-instances inter-as interface ge-0/1/1.0**
    user@PE2# **set routing-instances inter-as route-distinguisher 65020:1**
    user@PE2# **set routing-instances inter-as vrf-target target:2:1**

11. On Router PE2, configure the VPLS site within the routing instance. Configure the site identifier as required by the protocol.

    Configure the CE-facing interface to use **ethernet-vpls** encapsulation and the **vpls** protocol family.

    user@PE2# **set routing-instances inter-as protocols vpls site PE2 site-identifier 3**
    user@PE2# **set interfaces ge-0/1/1 encapsulation ethernet-vpls**
    user@PE2# **set interfaces ge-0/1/1 unit 0 family vpls**

12. On each router, commit the configuration:

```
user@host> commit check
configuration check succeeds
user@host> commit
commit complete
```

13. On the PE routers, display the CE-facing Gigabit Ethernet interface information and verify that the encapsulation is configured correctly:

```
user@host> show interfaces ge-1/3/0
Address            Interface          Label space ID        Hold time
10.0.23.10         ge-1/3/1.0         192.168.3.1:0           11

Physical interface: ge-1/3/0, Enabled, Physical link is Up
  Interface index: 147, SNMP ifIndex: 145
  Link-level type: Ethernet, MTU: 1514, Speed: 1000mbps, MAC-REWRITE Error:
 None,
  Loopback: Disabled, Source filtering: Disabled, Flow control: Enabled,
  Auto-negotiation: Enabled, Remote fault: Online
```

```
Device flags   : Present Running
Interface flags: SNMP-Traps Internal: 0x4000
Link flags     : None
CoS queues     : 4 supported, 4 maximum usable queues
Schedulers     : 256
Current address: 00:12:1e:ee:34:db, Hardware address: 00:12:1e:ee:34:db
Last flapped   : 2008-08-27 19:02:52 PDT (5d 22:32 ago)
Input rate     : 0 bps (0 pps)
Output rate    : 0 bps (0 pps)
Ingress rate at Packet Forwarding Engine      : 0 bps (0 pps)
Ingress drop rate at Packet Forwarding Engine : 0 bps (0 pps)
Active alarms  : None
Active defects : None

Logical interface ge-1/3/0.0 (Index 84) (SNMP ifIndex 146)
  Flags: SNMP-Traps Encapsulation: ENET2
  Input packets : 0
  Output packets: 1
  Protocol inet, MTU: 1500
    Flags: None
    Addresses, Flags: Is-Preferred Is-Primary
     Destination: 10.10.11/24, Local: 10.10.11.11, Broadcast: 10.10.11.255
```

## Results

This section describes commands you can use to test the operation of the VPLS.

1. To verify the VPLS connections have been established, enter the **show vpls connections** command on Router PE 1.

```
user@PE1> show vpls connections
Layer-2 VPN connections:

Legend for connection status (St)
EI -- encapsulation invalid      NC -- interface encapsulation not CCC/TCC/VPLS
EM -- encapsulation mismatch      WE -- interface and instance encaps not same
VC-Dn -- Virtual circuit down     NP -- interface hardware not present
CM -- control-word mismatch       -> -- only outbound connection is up
CN -- circuit not provisioned     <- -- only inbound connection is up
OR -- out of range                Up -- operational
OL -- no outgoing label           Dn -- down
LD -- local site signaled down    CF -- call admission control failure
RD -- remote site signaled down   SC -- local and remote site ID collision
LN -- local site not designated   LM -- local site ID not minimum designated
RN -- remote site not designated RM -- remote site ID not minimum designated
XX -- unknown connection status   IL -- no incoming label
MM -- MTU mismatch                MI -- Mesh-Group ID not availble
BK -- Backup connection           ST -- Standby connection

Legend for interface status
Up -- operational
Dn -- down

Instance: metro
  VPLS-id: 101
    Neighbor                  Type  St     Time last up          # Up trans
    192.168.3.1(vpls-id 101)  rmt   Up     Sep  9 14:05:18 2008           1
      Remote PE: 192.168.3.1, Negotiated control-word: No
      Incoming label: 800001, Outgoing label: 800000
      Local interface: vt-1/2/0.1048576, Status: Up, Encapsulation: ETHERNET
        Description: Intf - vpls metro neighbor 192.168.3.1 vpls-id 101
```

In the display from Router PE1, verify that the neighbor is the **lo0** address of Router ASBR1 and that the status is **Up**.

2. To verify the VPLS connections have been established, enter the **show vpls connections** command on Router ASBR 1.

```
user@ASBR1> show vpls connections
...
Instance: inter-as
  BGP-VPLS State
  Mesh-group connections: metro
    Neighbor         Local-site   Remote-site   St      Time last up

    192.168.10.1     1            2             Up      Sep  8 20:16:28 2008
      Incoming label: 800257, Outgoing label: 800000
      Local interface: vt-1/2/0.1049088, Status: Up, Encapsulation: VPLS
  LDP-VPLS State
  VPLS-id: 101
  Mesh-group connections: __ves__
    Neighbor                  Type  St     Time last up          # Up trans
    192.168.2.1(vpls-id 101)  rmt   Up     Sep  9 14:05:22 2008           1
```

```
      Remote PE: 192.168.2.1, Negotiated control-word: No
      Incoming label: 800000, Outgoing label: 800001
      Local interface: vt-0/1/0.1049089, Status: Up, Encapsulation: ETHERNET
        Description: Intf - vpls inter-as neighbor 192.168.2.1 vpls-id 101
```

In the display from Router ASBR1, verify that the neighbor is the **lo0** address of Router PE1 and that the status is **Up**.

3. To verify the VPLS connections have been established, enter the **show vpls connections** command on Router ASBR2.

```
user@ASBR2> show vpls connections
...
Instance: inter-as
  BGP-VPLS State
  Mesh-group connections: __ves__
    Neighbor         Local-site   Remote-site   St      Time last up

    192.168.11.1     2            3             Up      Sep 11 15:18:23 2008
      Incoming label: 800002, Outgoing label: 800001
      Local interface: vt-4/0/0.1048839, Status: Up, Encapsulation: VPLS
  Mesh-group connections: core
    Neighbor         Local-site   Remote-site   St      Time last up

    192.168.3.1      2            1             Up      Sep  8 20:16:28 2008
      Incoming label: 800000, Outgoing label: 800257
      Local interface: vt-4/0/0.1048834, Status: Up, Encapsulation: VPLS
```

In the display from Router ASBR2, verify that the neighbor is the **lo0** address of Router PE2 and that the status is **Up**.

4. To verify the VPLS connections have been established, enter the **show vpls connections** command on Router PE2.

```
user@PE2> show vpls connections
...
Instance: inter-as
  Local site: PE2 (3)
    connection-site           Type  St     Time last up          # Up trans
    2                         rmt   Up     Sep  8 20:16:28 2008           1
      Remote PE: 192.168.10.1, Negotiated control-word: No
      Incoming label: 800001, Outgoing label: 800002
      Local interface: vt-0/3/0.1048832, Status: Up, Encapsulation: VPLS
        Description: Intf - vpls inter-as local site 3 remote site 2
```

In the display from Router PE2, verify that the remote PE is the **lo0** address of Router ASBR2 and that the status is **Up**.

5. To verify that the CE routers can send and receive traffic across the VPLS, use the **ping** command.

```
user@CE1> ping 10.10.11.2
PING 10.10.11.2 (10.10.11.2): 56 data bytes
64 bytes from 10.10.11.2: icmp_seq=0 ttl=64 time=1.369 ms
64 bytes from 10.10.11.2: icmp_seq=1 ttl=64 time=1.360 ms
64 bytes from 10.10.11.2: icmp_seq=2 ttl=64 time=1.333 ms
^C

user@CE2> ping 10.10.11.1
PING 10.10.11.1 (10.10.11.1): 56 data bytes
64 bytes from 10.10.11.1: icmp_seq=0 ttl=64 time=6.209 ms
64 bytes from 10.10.11.1: icmp_seq=1 ttl=64 time=1.347 ms
```

```
64 bytes from 10.10.11.1: icmp_seq=2 ttl=64 time=1.324 ms
^C
```

If Router CE1 can send traffic to and receive traffic from Router CE2 and Router CE2 can send traffic to and receive traffic from Router CE1, the VPLS is performing correctly.

6. To display the configuration for Router CE1, use the **show configuration** command.

   For your reference, the relevant sample configuration for Router CE1 follows.

```
interfaces {
  lo0 {
    unit 0 {
      family inet {
        address 192.168.1.1/32 {
          primary;
        }
        address 127.0.0.1/32;
      }
    }
  }
  ge-0/3/0 {
    unit 0 {
      family inet {
        address 10.10.11.1/24;
      }
    }
  }
}
```

7. To display the configuration for Router PE1, use the **show configuration** command.

   For your reference, the relevant sample configuration for Router PE1 follows.

```
interfaces {
  lo0 {
    unit 0 {
      family inet {
        address 192.168.2.1/32 {
          primary;
        }
        address 127.0.0.1/32;
      }
    }
  }
  ge-1/3/0 {
    encapsulation ethernet-vpls;
    unit 0 {
      family vpls;
    }
  }
  ge-1/3/1 {
    unit 0 {
      family inet {
        address 10.0.23.9/30;
      }
      family mpls;
    }
```

```
    }
  }
  routing-options {
    autonomous-system 0.65010;
  }
  protocols {
    mpls {
      interface ge-1/3/1.0;
    }
    ospf {
      traffic-engineering;
      area 0.0.0.1 {
        interface ge-1/3/1.0;
        interface lo0.0 {
          passive;
        }
      }
    }
    ldp {
      interface ge-1/3/1.0;
      interface lo0.0;
    }
  }
  routing-instances {
    metro {
      instance-type vpls;
      interface ge-1/3/0.0;
      protocols {
        vpls {
          vpls-id 101;
          neighbor 192.168.3.1;
        }
      }
    }
  }
```

8. To display the configuration for Router ASBR1, use the **show configuration** command.

   For your reference, the relevant sample configuration for Router ASBR1 follows.

```
  interfaces {
    lo0 {
      unit 0 {
        family inet {
          address 192.168.3.1/32 {
            primary;
          }
          address 127.0.0.1/32;
        }
      }
    }
    ge-0/3/0 {
      unit 0 {
        family inet {
          address 10.0.78.1/30;
        }
        family mpls;
```

```
      }
    }
    ge-0/3/1 {
      unit 0 {
        family inet {
          address 10.0.23.10/30;
        }
        family mpls;
      }
    }
  }
  routing-options {
    autonomous-system 0.65010;
  }
  protocols {
    mpls {
      interface ge-0/3/1.0;
      interface ge-0/3/0.0;
    }
    bgp {
      group vpls-core {
        type external;
        multihop;
        local-address 192.168.3.1;
        family l2vpn {
          signaling;
        }
        peer-as 65020;
        neighbor 192.168.10.1;
      }
      group metro-core {
        type external;
        local-address 10.0.78.1;
        family inet {
          labeled-unicast {
            resolve-vpn;
          }
        }
        export loopback;
        peer-as 65020;
        neighbor 10.0.78.2;
      }
    }
    ospf {
      traffic-engineering;
      area 0.0.0.1 {
        interface ge-0/3/1.0;
        interface lo0.0 {
          passive;
        }
      }
    }
    ldp {
      interface ge-0/3/0.0;
      interface ge-0/3/1.0;
      interface lo0.0;
```

```
    }
}
policy-options {
    policy-statement loopback {
        term term1 {
            from {
                protocol [ ospf direct ];
                route-filter 192.168.0.0/16 longer;
            }
            then accept;
        }
    }
}
routing-instances {
    inter-as {
        instance-type vpls;
        route-distinguisher 65010:1;
        vrf-target target:2:1;
        protocols {
            vpls {
                site ASBR-metro {
                    site-identifier 1;
                    site-preference 10000;
                }
                vpls-id 101;
                neighbor 192.168.2.1;
                mesh-group metro {
                    peer-as {
                        all;
                    }
                }
            }
        }
    }
}
```

9. To display the configuration for Router ASBR2, use the **show configuration** command.

   For your reference, the relevant sample configuration for Router ASBR2 follows.

```
interfaces {
    lo0 {
        unit 0 {
            family inet {
                address 192.168.10.1/32 {
                    primary;
                }
                address 127.0.0.1/32;
            }
        }
    }
    ge-3/1/0 {
        unit 0 {
            family inet {
                address 10.0.78.2/30;
            }
            family mpls;
```

```
        }
    }
    ge-3/1/1 {
        unit 0 {
            family inet {
                address 10.0.90.13/30;
            }
            family mpls;
        }
    }
}
routing-options {
    autonomous-system 0.65020;
}
protocols {
    mpls {
        interface ge-3/1/0.0;
        interface ge-3/1/1.0;
    }
    bgp {
        group core-ibgp {
            type internal;
            local-address 192.168.10.1;
            family inet {
                labeled-unicast {
                    resolve-vpn;
                }
            }
            family l2vpn {
                signaling;
            }
            neighbor 192.168.11.1;
        }
        group vpls-metro {
            type external;
            multihop;
            local-address 192.168.10.1;
            family l2vpn {
                signaling;
            }
            peer-as 65010;
            neighbor 192.168.3.1;
        }
        group core-metro {
            type external;
            local-address 10.0.78.2;
            family inet {
                labeled-unicast {
                    resolve-vpn;
                }
            }
            export loopback;
            peer-as 65010;
            neighbor 10.0.78.1;
        }
    }
```

```
  ospf {
    traffic-engineering;
    area 0.0.0.0 {
      interface ge-3/1/1.0;
      interface lo0.0 {
        passive;
      }
    }
  }
  ldp {
    interface ge-3/1/0.0;
    interface ge-3/1/1.0;
  }
}
policy-options {
  policy-statement loopback {
    term term1 {
      from {
        protocol [ ospf direct ];
        route-filter 192.168.0.0/16 longer;
      }
      then accept;
    }
  }
}
routing-instances {
  inter-as {
    instance-type vpls;
    route-distinguisher 65020:1;
    vrf-target target:2:1;
    protocols {
      vpls {
        site ASBR-core {
          site-identifier 2;
        }
        mesh-group core {
          peer-as {
            all;
          }
        }
      }
    }
  }
}
```

10. To display the configuration for Router PE2, use the **show configuration** command.

    For your reference, the relevant sample configuration for Router PE2 follows.

```
interfaces {
  lo0 {
    unit 0 {
      family inet {
        address 192.168.11.1/32 {
          primary;
        }
        address 127.0.0.1/32;
```

```
            }
        }
    }
    ge-0/1/0 {
        unit 0 {
            family inet {
                address 10.0.90.14/30;
            }
            family mpls;
        }
    }
    ge-0/1/1 {
        encapsulation ethernet-vpls;
        unit 0 {
            family vpls;
        }
    }
}
routing-options {
    autonomous-system 0.65020;
}
protocols {
    mpls {
        interface ge-0/1/0.0;
    }
    bgp {
        group core-ibgp {
            type internal;
            local-address 192.168.11.1;
            family l2vpn {
                signaling;
            }
            neighbor 192.168.10.1;
        }
    }
    ospf {
        traffic-engineering;
        area 0.0.0.0 {
            interface ge-0/1/0.0;
            interface lo0.0 {
                passive;
            }
        }
    }
    ldp {
        interface ge-0/1/0.0;
    }
}
routing-instances {
    inter-as {
        instance-type vpls;
        interface ge-0/1/1.0;
        route-distinguisher 65020:1;
        vrf-target target:2:1;
        protocols {
            vpls {
```

```
                site PE2 {
                    site-identifier 3;
                }
            }
        }
    }
}
```

11. To display the configuration for Router CE2, use the **show configuration** command.

    For your reference, the relevant sample configuration for Router CE2 follows.

```
interfaces {
    lo0 {
        unit 0 {
            family inet {
                address 192.168.12.1/32 {
                    primary;
                }
                address 127.0.0.1/32;
            }
        }
    }
    ge-0/1/1 {
        unit 0 {
            family inet {
                address 10.10.11.2/24;
            }
        }
    }
}
```

**Related Documentation**

- *Introduction to Inter-AS VPLS with MAC Processing at the ASBR*

## For More Information

For additional information about VPLS, see the following:

- *Junos VPNs Configuration Guide*
- *Junos Network Interfaces Configuration Guide*
- *Junos Class of Service Configuration Guide*
- *Junos Routing Protocols Configuration Guide*
- CLI Explorer
- CLI Explorer
- RFC 2684, *Multiprotocol Encapsulation over ATM Adaptation Layer 5*
- RFC 4762, *Virtual Private LAN Service (VPLS) Using Label Distribution Protocol (LDP) Signaling*
- RFC 4761, *Virtual Private LAN Service (VPLS) Using BGP for Auto-Discovery and Signaling*

PART 2

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