JUNIPER NETWORKS

Junos® OS

VPLS Configuration Guide

Release
12.1

Published: 2012-03-13

Juniper Networks, Inc.
1194 North Mathilda Avenue
Sunnyvale, California 94089
USA
408-745-2000
www.juniper.net

Junos® OS VPLS Configuration Guide
12.1

The information in this document is current as of the date on the title page.

YEAR 2000 NOTICE

Juniper Networks hardware and software products are Year 2000 compliant. Junos OS has no known time-related limitations through the year 2038. However, the NTP application is known to have some difficulty in the year 2036.

END USER LICENSE AGREEMENT

The Juniper Networks product that is the subject of this technical documentation consists of (or is intended for use with) Juniper Networks software. Use of such software is subject to the terms and conditions of the End User License Agreement ("EULA") posted at http://www.juniper.net/support/eula.html. By downloading, installing or using such software, you agree to the terms and conditions of that EULA.

Table of Contents

List of Figures

List of Tables

About the Documentation

Documentation and Release Notes

To obtain the most current version of all Juniper Networks® technical documentation, see the product documentation page on the Juniper Networks website at http://www.juniper.net/techpubs/.

If the information in the latest release notes differs from the information in the documentation, follow the product Release Notes.

Juniper Networks Books publishes books by Juniper Networks engineers and subject matter experts. These books go beyond the technical documentation to explore the nuances of network architecture, deployment, and administration. The current list can be viewed at http://www.juniper.net/books.

Using the Examples in This Manual

If you want to use the examples in this manual, you can use the **load merge** or the **load merge relative** command. These commands cause the software to merge the incoming configuration into the current candidate configuration. The example does not become active until you commit the candidate configuration.

If the example configuration contains the top level of the hierarchy (or multiple hierarchies), the example is a *full example*. In this case, use the **load merge** command.

If the example configuration does not start at the top level of the hierarchy, the example is a *snippet*. In this case, use the **load merge relative** command. These procedures are described in the following sections.

Merging a Full Example

To merge a full example, follow these steps:

1. From the HTML or PDF version of the manual, copy a configuration example into a text file, save the file with a name, and copy the file to a directory on your routing platform.

   For example, copy the following configuration to a file and name the file **ex-script.conf**. Copy the **ex-script.conf** file to the **/var/tmp** directory on your routing platform.

   ```
   system {
     scripts {
       commit {
         file ex-script.xsl;
       }
     }
   }
   interfaces {
     fxp0 {
       disable;
       unit 0 {
         family inet {
           address 10.0.0.1/24;
         }
       }
     }
   }
   ```

2. Merge the contents of the file into your routing platform configuration by issuing the **load merge** configuration mode command:

   ```
   [edit]
   user@host# load merge /var/tmp/ex-script.conf
   load complete
   ```

Merging a Snippet

To merge a snippet, follow these steps:

1. From the HTML or PDF version of the manual, copy a configuration snippet into a text file, save the file with a name, and copy the file to a directory on your routing platform.

   For example, copy the following snippet to a file and name the file **ex-script-snippet.conf**. Copy the **ex-script-snippet.conf** file to the **/var/tmp** directory on your routing platform.

   ```
   commit {
     file ex-script-snippet.xsl; }
   ```

2. Move to the hierarchy level that is relevant for this snippet by issuing the following configuration mode command:

   ```
   [edit]
   user@host# edit system scripts
   [edit system scripts]
   ```

3. Merge the contents of the file into your routing platform configuration by issuing the **load merge relative** configuration mode command:

```
[edit system scripts]
user@host# load merge relative /var/tmp/ex-script-snippet.conf
load complete
```

For more information about the **load** command, see the *Junos OS CLI User Guide*.

Documentation Conventions

Table 1 on page xv defines notice icons used in this guide.

Table 1: Notice Icons

Icon	Meaning	Description
	Informational note	Indicates important features or instructions.
	Caution	Indicates a situation that might result in loss of data or hardware damage.
	Warning	Alerts you to the risk of personal injury or death.
	Laser warning	Alerts you to the risk of personal injury from a laser.

Table 2 on page xv defines the text and syntax conventions used in this guide.

Table 2: Text and Syntax Conventions

Convention	Description	Examples
Bold text like this	Represents text that you type.	To enter configuration mode, type the **configure** command: user@host> **configure**
`Fixed-width text like this`	Represents output that appears on the terminal screen.	`user@host>` **show chassis alarms** `No alarms currently active`
Italic text like this	• Introduces important new terms. • Identifies book names. • Identifies RFC and Internet draft titles.	• A policy *term* is a named structure that defines match conditions and actions. • *Junos OS System Basics Configuration Guide* • RFC 1997, *BGP Communities Attribute*

Table 2: Text and Syntax Conventions *(continued)*

Convention	Description	Examples
Italic text like this	Represents variables (options for which you substitute a value) in commands or configuration statements.	Configure the machine's domain name: [edit] root@# **set system domain-name** *domain-name*
Text like this	Represents names of configuration statements, commands, files, and directories; interface names; configuration hierarchy levels; or labels on routing platform components.	• To configure a stub area, include the **stub** statement at the **[edit protocols ospf area area-id]** hierarchy level. • The console port is labeled **CONSOLE**.
< > (angle brackets)	Enclose optional keywords or variables.	**stub** <**default-metric** *metric*>**;**
| (pipe symbol)	Indicates a choice between the mutually exclusive keywords or variables on either side of the symbol. The set of choices is often enclosed in parentheses for clarity.	**broadcast | multicast** (***string1*** **|** ***string2*** **|** ***string3***)
# (pound sign)	Indicates a comment specified on the same line as the configuration statement to which it applies.	**rsvp { # Required for dynamic MPLS only**
[ ] (square brackets)	Enclose a variable for which you can substitute one or more values.	**community name members [** *community-ids* **]**

Indention and braces ({ })	Identify a level in the configuration hierarchy.	[edit]
		routing-options {
		  static {
		  route default {
		  nexthop *address*;
		  retain;
		  }
		  }
		}

; (semicolon)	Identifies a leaf statement at a configuration hierarchy level.	
J-Web GUI Conventions		
Bold text like this	Represents J-Web graphical user interface (GUI) items you click or select.	• In the Logical Interfaces box, select **All Interfaces**. • To cancel the configuration, click **Cancel**.
> (bold right angle bracket)	Separates levels in a hierarchy of J-Web selections.	In the configuration editor hierarchy, select **Protocols>Ospf**.

Documentation Feedback

We encourage you to provide feedback, comments, and suggestions so that we can improve the documentation. You can send your comments to **techpubs-comments@juniper.net**, or fill out the documentation feedback form at

https://www.juniper.net/cgi-bin/docbugreport/ . If you are using e-mail, be sure to include the following information with your comments:

- Document or topic name
- URL or page number
- Software release version (if applicable)

Requesting Technical Support

Technical product support is available through the Juniper Networks Technical Assistance Center (JTAC). If you are a customer with an active J-Care or JNASC support contract, or are covered under warranty, and need post-sales technical support, you can access our tools and resources online or open a case with JTAC.

- JTAC policies—For a complete understanding of our JTAC procedures and policies, review the *JTAC User Guide* located at http://www.juniper.net/us/en/local/pdf/resource-guides/7100059-en.pdf .
- Product warranties—For product warranty information, visit http://www.juniper.net/support/warranty/ .
- JTAC hours of operation—The JTAC centers have resources available 24 hours a day, 7 days a week, 365 days a year.

Self-Help Online Tools and Resources

For quick and easy problem resolution, Juniper Networks has designed an online self-service portal called the Customer Support Center (CSC) that provides you with the following features:

- Find CSC offerings: http://www.juniper.net/customers/support/
- Search for known bugs: http://www2.juniper.net/kb/
- Find product documentation: http://www.juniper.net/techpubs/
- Find solutions and answer questions using our Knowledge Base: http://kb.juniper.net/
- Download the latest versions of software and review release notes: http://www.juniper.net/customers/csc/software/
- Search technical bulletins for relevant hardware and software notifications: https://www.juniper.net/alerts/
- Join and participate in the Juniper Networks Community Forum: http://www.juniper.net/company/communities/
- Open a case online in the CSC Case Management tool: http://www.juniper.net/cm/

To verify service entitlement by product serial number, use our Serial Number Entitlement (SNE) Tool: https://tools.juniper.net/SerialNumberEntitlementSearch/

Opening a Case with JTAC

You can open a case with JTAC on the Web or by telephone.

- Use the Case Management tool in the CSC at http://www.juniper.net/cm/ .
- Call 1-888-314-JTAC (1-888-314-5822 toll-free in the USA, Canada, and Mexico).

For international or direct-dial options in countries without toll-free numbers, see http://www.juniper.net/support/requesting-support.html .

PART 1

Overview

CHAPTER 1

Introduction to VPLS

Introduction to VPLS

VPLS is an Ethernet-based point-to-multipoint Layer 2 VPN. It allows you to connect geographically dispersed Ethernet local area networks (LAN) sites to each other across an MPLS backbone. For customers who implement VPLS, all sites appear to be in the same Ethernet LAN even though traffic travels across the service provider's network.

VPLS, in its implementation and configuration, has much in common with a Layer 2 VPN. In VPLS, a packet originating within a service provider customer's network is sent first to a customer edge (CE) device (for example, a router or Ethernet switch). It is then sent to a provider edge (PE) router within the service provider's network. The packet traverses the service provider's network over a MPLS label-switched path (LSP). It arrives at the egress PE router, which then forwards the traffic to the CE device at the destination customer site.

The difference is that for VPLS, packets can traverse the service provider's network in point-to-multipoint fashion, meaning that a packet originating from a CE device can be broadcast to all the PE routers participating in a VPLS routing instance. In contrast, a Layer 2 VPN forwards packets in point-to-point fashion only.

The paths carrying VPLS traffic between each PE router participating in a routing instance are called pseudowires. The pseudowires are signaled using either BGP or LDP.

VPLS Routing and Virtual Ports

Because VPLS carries Ethernet traffic across a service provider network, it must mimic an Ethernet network in some ways. When a PE router configured with a VPLS routing instance receives a packet from a CE device, it first determines whether it has the destination of the VPLS packet in the appropriate routing table. If it does, it forwards the packet to the appropriate PE router or CE device. If it does not, it broadcasts the packet to all other PE routers and CE devices that are members of that VPLS routing instance. In both cases, the CE device receiving the packet must be different from the one sending the packet.

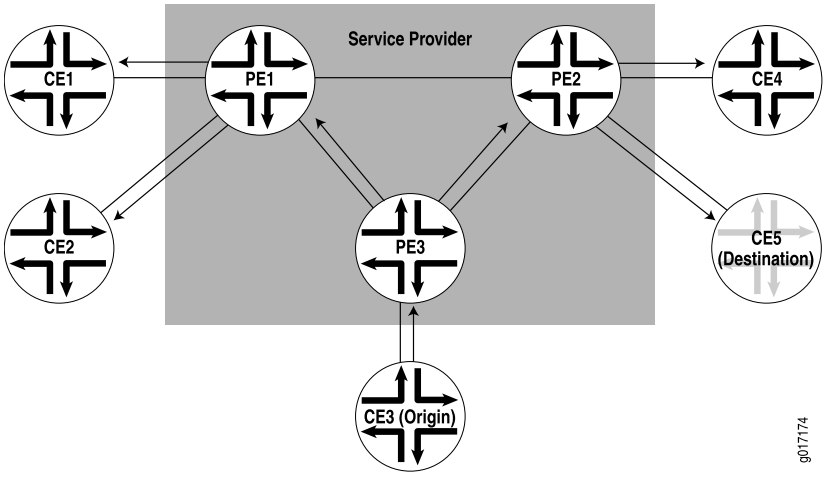
When a PE router receives a packet from another PE router, it first determines whether it has the destination of the VPLS packet in the appropriate routing table. If it does, the PE router either forwards the packet or drops it depending on whether the destination is a local or remote CE device:

- If the destination is a local CE device, the PE router forwards the packet to it.
- If the destination is a remote CE device (connected to another PE router), the PE router discards the packet.

If the PE router cannot determine the destination of the VPLS packet, it floods the packet to all attached CE devices.

This process is illustrated in Figure 1 on page 4.

Figure 1: Flooding a Packet with an Unknown Destination to All PE Routers in the VPLS Instance



VPLS can be directly connected to an Ethernet switch. Layer 2 information gathered by an Ethernet switch (for example, media access control [MAC] addresses and interface ports) is included in the VPLS routing instance table. However, instead of all VPLS interfaces being physical switch ports, the router allows remote traffic for a VPLS instance to be delivered across an MPLS 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 in almost the same way as traffic is sent to a local port.

The VPLS routing table learns MAC address and interface information for both physical and virtual ports. The main difference between a physical port and a virtual port is that the router captures additional information from the 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. The virtual port is generated dynamically on a Tunnel Services Physical Interface Card (PIC) when you configure VPLS on the router.

You can also configure VPLS without a Tunnel Services PIC. To do so, you use a label-switched interface (LSI) to provide VPLS functionality. An LSI MPLS label is used as the inner label for VPLS. This label maps to a VPLS routing instance. On the PE router, the LSI label is stripped and then mapped to a logical LSI interface. The Layer 2 Ethernet frame is then forwarded using the LSI interface to the correct VPLS routing instance.

One restriction on 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. However, if a CE Ethernet switch has two or more connections to the same PE router, you must enable the Spanning Tree Protocol (STP) on the CE switch to prevent loops. STP is supported on MX Series routers only.

The Junos OS allows standard Bridge Protocol Data Unit (BPDU) frames to pass through emulated Layer 2 connections, such as those configured with Layer 2 VPNs, Layer 2 circuits, and VPLS routing instances. However, CE Ethernet switches that generate proprietary BPDU frames might not be able to run STP across Juniper Networks routing platforms configured for these emulated Layer 2 connections.

NOTE: Under certain circumstances, VPLS provider routers might duplicate an Internet Control Message Protocol (ICMP) reply from a CE router when a PE router has to flood an ICMP request because the destination MAC address has not yet been learned. The duplicate ICMP reply can be triggered when a CE router with promiscuous mode enabled is connected to a PE router. The PE router automatically floods the promiscuous mode–enabled CE router, which then returns the ICMP request to the VPLS provider routers. The VPLS provider routers consider the ICMP request to be new and flood the request again, creating a duplicate ping reply.

VPLS and Aggregated Ethernet Interfaces

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.

Forwarding is based on a lookup of the DA MAC address. For the remote site, if a packet needs to be forwarded over an LSP, the packet is encapsulated and forwarded through the LSP. If the packet destination is a local site, it is forwarded over appropriate local site

interface. For an aggregated Ethernet interface on the local site, packets are sent out of the load-balanced child interface. The Packet Forwarding Engine acquires the child link to transmit the data.

When a received packet does not have a match to a MAC address in the forwarding database, the packet is forwarded over a set of interfaces determined from a lookup in the flooding database based on the incoming interface. This is denoted by a flood next hop. The flood next hop can include the aggregated Ethernet interface as the set of interfaces to flood the packet.

Each VPLS routing instance configured on a PE router has its own forwarding database entries that associate all of the MAC addresses the VPLS routing instance acquires with each corresponding port. A route is added to the kernel with a MAC address as the prefix and the next hop used to reach the destination. The route is an interface if the destination is local. For a remote destination, the route is a next hop for the remote site.

For local aggregated Ethernet interfaces on M Series and T Series routers, learning is based on the parent aggregated Ethernet logical interface. To age out MAC addresses for aggregated Ethernet interfaces, each Packet Forwarding Engine is queried to determine where the individual child interfaces are located. MAC addresses are aged out based on the age of the original interface.

For MX Series routers, when a Dense Port Concentrator (DPC) learns a MAC address it causes the Routing Engine to age out the entry. This behavior applies to all logical interfaces. For an aggregated Ethernet logical interface, once all the member DPCs have aged out the entry, the entry is deleted from the Routing Engine.

For information about how to configure aggregated Ethernet interfaces for VPLS routing instances, see "Configuring Aggregated Ethernet Interfaces for VPLS" on page 45.

BGP Signaling for VPLS PE Routers Overview

BGP can autonomously signal pseudowires between the PE routers participating in the same virtual private LAN service (VPLS) network. As PE routers are added to and removed from the VPLS network, BGP can signal pseudowires to new PE routers and tear down old pseudowires to old PE routers. Each PE router only needs to be configured with the identity of the VPLS routing instance. Each PE router does not need to be configured with the identities of all of the PE routers that are or might become a part of the VPLS network.

When you configure BGP for signaling in a VPLS network, customer sites can be either single-homed to a single PE router or multihomed to two or more PE routers. Multihoming provides redundancy for the connection between the customer site and the service provider's network.

You can either configure all of the PE routers in the VPLS network as a full mesh or you can use BGP route reflectors. For full mesh configurations, each PE router needs to be able to create a bidirectional pseudowire to each of the other PE routers participating in the VPLS network.

Related Documentation

- VPLS Multihoming Overview on page 7
- VPLS Path Selection Process for PE Routers on page 9

BGP Route Reflectors for VPLS

In large networks, it might be necessary to configure BGP route reflectors to reduce the control plane workload for the routers participating in the VPLS network. BGP route reflectors can help to reduce the workload of the network control plane in the following ways.

- Making it unnecessary to configure all of the VPLS PE routers in a full mesh.
- Limiting the total volume of BGP VPLS messages exchanged within the network by transmitting messages to interested routers only (instead of all of the BGP routers in the network)
- Reducing the network signaling load whenever another BGP router is added to or removed from the network

The basic solution to these problems is to deploy a small group of BGP route reflectors that are in a full mesh with one another. Each of the VPLS PE routers is configured to have a BGP session with one or more of the route reflectors, making it unnecessary to maintain a full mesh of BGP sessions between all of the PE routers.

This type of configuration only affects the control plane of the VPLS network (how routers signal and tear down pseudowires to one another in the network). The actual data plane state and forwarding paths for the VPLS traffic are not modified by the route reflectors. Effectively, the VPLS pseudowires should take the same paths across the network whether or not you have configured route reflectors. For a description of how VPLS selects the best path to a PE router, see "VPLS Path Selection Process for PE Routers" on page 9.

The MAC addresses themselves are not exchanged or processed in any way by BGP. Each VPLS PE router performs all MAC address learning and aging individually. BGP's only function relative to VPLS is to exchange messages related to automatic discovery of PE routers being added to and removed from the VPLS network and the MPLS label exchange needed to signal a pseudowire from one PE router to another.

Related Documentation

- VPLS Path Selection Process for PE Routers on page 9
- Example: Configuring a Route Reflector
- Example: NG-VPLS Using Point-to-Multipoint LSPs on page 152
- Example: Next-Generation VPLS for Multicast with Multihoming on page 191

VPLS Multihoming Overview

VPLS multihoming enables you to connect a customer site to two or more PE routers to provide redundant connectivity. A redundant PE router can provide network service to the customer site as soon as a failure is detected. VPLS multihoming helps to maintain VPLS service and traffic forwarding to and from the multihomed site in the event of the following types of network failures:

- PE router to CE device link failure

- PE router failure
- MPLS-reachability failure between the local PE router and a remote PE router

Figure 2: CE Device Multihomed to Two PE Routers

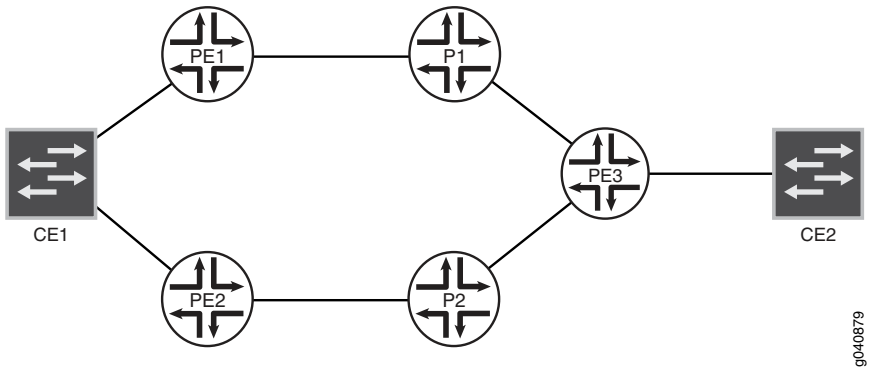


Figure 2 on page 8 illustrates how a CE device could be multihomed to two PE routers. Device CE1 is multihomed to Routers PE1 and PE2. Device CE2 has two potential paths to reach Device CE1, but only one path is active at any one time. If Router PE1 were the designated VPLS edge (VE) device, BGP would signal a pseudowire from Router PE3 to Router PE1. If a failure occurred over this path, Router PE2 would be made the designated VE device and BGP would re-signal the pseudowire from Router PE3 to Router PE2.

Multihomed PE routers advertise network layer reachability information (NLRI) for the multihomed site to the other PE routers in the VPLS network. The NLRI includes the site ID for the multihomed PE routers. For all of the PE routers multihomed to the same CE device, you need to configure the same site ID. The remote VPLS PE routers use the site ID to determine where to forward traffic addressed to the customer site. To avoid route collisions, the site ID shared by the multihomed PE routers must be different than the site IDs configured on the remote PE routers in the VPLS network.

Although you configure the same site ID for each of the PE routers multihomed to the same CE device, you can configure unique values for the block offset, the label range, and the route distinguisher. These values help to determine which multihomed PE router is selected as the designated VE device to be used to reach the customer site.

BEST PRACTICE: **We recommend that you configure unique route distinguishers for each multihomed PE router. Configuring unique route distinguishers helps with faster convergence when the connection to a primary multihomed PE router goes down. If you configure unique route distinguishers, the other PE routers in the VPLS network must maintain additional state for the multihomed PE routers.**

Remote PE routers in the VPLS network need to determine which of the multihomed PE routers should forward traffic to reach the CE device. To make this determination, remote PE routers use the VPLS path-selection process to select one of the multihomed PE routers based on its NLRI advertisement. Because remote PE routers pick only one of the NLRI advertisements, it establishes a pseudowire to only one of the multihomed PE

routers, the PE router that originated the winning advertisement. This prevents multiple paths from being created between sites in the network, preventing the formation of Layer 2 loops. If the selected PE router fails, all PE routers in the network automatically switch to the backup PE router and establish new pseudowires to it.

BEST PRACTICE: To prevent the formation of Layer 2 loops between the CE devices and the multihomed PE routers, we recommend that you employ the Spanning Tree Protocol (STP) on your CE devices. Layer 2 loops can form due to incorrect configuration. Temporary Layer 2 loops can also form during convergence after a change in the network topology.

The PE routers run the BGP path selection procedure on locally originated and received Layer 2 route advertisements to establish that the routes are suitable for advertisement to other peers, such as BGP route reflectors. If a PE router in a VPLS network is also a route reflector, the path selection process for the multihomed site has no effect on the path selection process performed by this PE router for the purpose of reflecting Layer 2 routes. Layer 2 prefixes that have different route distinguishers are considered to have different NLRIs for route reflection. The VPLS path selection process enables the route reflector to reflect all routes that have different route distinguishers to the route reflector clients, even though only one of these routes is used to create the VPLS pseudowire to the multihomed site.

VPLS Path Selection Process for PE Routers

The VPLS path selection process is used to select the best path between a remote PE router and a local PE router in a VPLS network. This path selection process is applied to routes received from both single-homed and multi-homed PE routers.

When the VPLS path selection process is complete, a PE router is made the designated VPLS edge (VE) device. The designated VE device effectively acts as the endpoint for the VPLS pseudowire that is signaled from the remote PE router. Once a PE router is made the designated VE device, a pseudowire can be signaled between the remote PE router and the local PE router and then VPLS packets can begin to flow between the PE routers.

Routes from multihomed PE routers connected to the same customer site share the same site ID, but can have different route distinguishers and block offsets. You can alter the configurations of the route distinguishers and block offsets to make a router more likely or less likely to be selected as the designated VE device.

On each PE router in the VPLS network, the best path to the CE device is determined by completing the following VPLS path selection process on each route advertisement received:

1. If the advertisement has the down bit set to 0, the advertisement is discarded.
2. Select the path with a higher preference. The preference attribute is obtained from the site-preference configured using the **site-preference** statement at the **[edit**

routing-instances *routing-instance-name* **protocols vpls site** *site-name***]** hierarchy level. If the site preference is 0, the preference attribute is obtained from the local preference.

3. If the preference values are the same, select the path with the lower router ID.
4. If the router IDs are the same, the routes are from the same PE router and the advertisement is considered to be an update. The router ID corresponds to the value of the originator ID for the BGP attribute (if present). Otherwise, the IP address for the remote BGP peer is used.
5. If the block offset values are the same, the advertisement is considered to be an update.

Once the VPLS path selection process has been completed and the designated VE device has been selected, a pseudowire is signaled between the remote PE router and the local PE router.

NOTE: **The VPLS path selection process works the same whether or not the route has been received from another PE router, a route reflector, or an autonomous system border router (ASBR).**

When the remote PE router establishes or refreshes a pseudowire to the local PE router, it verifies that the prefix is in the range required for the site ID based on the block offset and label range advertised by the designated VE device. If the prefix is out of range, the pseudowire status is set to out of range.

The following cases outline the potential decisions that could be made when a PE router completes the VPLS path selection process for a Layer 2 advertisement in the VPLS network:

- The PE router originated one of the advertisements and selected its own advertisement as the best path.

  This PE router has been selected as the designated VE device. Selection as the designated VE device triggers the creation of pseudowires to and from the other PE routers in the VPLS network. If the remote customer site is multihomed, the designated VE device triggers the creation of pseudowires to and from only the designated VE device for the remote site.

- The PE router originated one of the advertisements but did not select its own advertisement as the best path.

  This PE router is a redundant PE router for a multihomed site, but it was not selected as the designated VE device. However, if this PE router has just transitioned from being the designated VE device (meaning it was receiving traffic from the remote PE routers addressed to the mulithomed customer site), the PE router tears down all the pseudowires that it had to and from the other PE routers in the VPLS network.

- The PE router received the route advertisements and selected a best path. It did not originate any of these advertisements because it was not connected to the customer site.

If the best path to the customer site (the designated VE device) has not changed, nothing happens. If the best path has changed, this PE router brings up pseudowires to and from the newly designated VE device and tears down the pseudowires to and from the previously designated VE device.

If this PE router does not select a best path after running the VPLS path selection process, then the local PE router does not consider the remote site to exist.

When a VE device receives an advertisement for a Layer 2 NLRI that matches its own site ID but the site is not multihomed, the pseudowire between the VE device and the transmitting PE router transitions to a site collision state and is not considered to be up.

Related Documentation

- BGP Route Reflectors for VPLS on page 7

BGP and VPLS Path Selection for Multihomed PE Routers

The BGP and VPLS path selection procedures are used to select the best path between the remote PE router and one of the multihomed PE routers. As part of these path selection procedures, one of the multihomed PE routers is made the designated VE device. The designated VE device effectively acts as the endpoint for the VPLS pseudowire from the remote PE router. Once a multihomed PE router is made the designated VE device, a pseudowire can be created between the remote PE router and the multihomed PE router.

Routes from multihomed PE routers connected to the same customer site share the same site ID, but can have different route distinguishers and block offsets. On each PE router in the VPLS network, the best path to the multihomed PE router is determined by completing the following VE device-selection procedures on each route advertisement received from a multihomed PE router:

1. BGP designated VE device-selection procedure—Runs before the VPLS designated VE device-selection procedure. However, the BGP designated VE device-selection procedure is used only when the route distinguishers for the multihomed PE routers are identical. If the route distinguishers are unique, only the VPLS designated VE device-selection procedure is run.
2. VPLS designated VE device-selection procedure—Runs after the BGP designated VE device-selection procedure. However, if the route distinguishers for each multihomed PE router are unique, the advertisements are not considered relevant to the BGP designated VE device-selection procedure. As a consequence, only the VPLS designated VE device-selection procedure is used.

The BGP designated VE device-selection procedure is as follows:

1. If the advertisement has the down bit set to 0, the advertisement is discarded.
2. Select the path with a higher preference. The preference attribute is obtained from the site-preference configured using the **site-preference** statement at the [edit routing-instances *routing-instance-name* protocols vpls site *site-name*] hierarchy level. If the site-preference is 0, the preference attribute is obtained from the local-preference.

3. If the preference values are the same, select the path with the lower router-id.
4. If the router-ids are the same, the routes are from the same PE router and the advertisement is considered to be an update.

Once the BGP designated VE device-selection procedure is complete, the VPLS designated VE device-selection procedure begins. This procedure is carried out regardless of the outcome of the BGP designated VE device-selection procedure:

1. If the advertisement has the down bit set to 0, the advertisement is discarded.
2. Select the path with a higher preference. The preference attribute is obtained from the site-preference configured using the **site-preference** statement at the [edit routing-instances *routing-instance-name* protocols vpls site *site-name*] hierarchy level. If the site-preference is 0, the preference attribute is obtained from the local-preference.
3. If the preference values are the same, select the path with the lower router-id.
4. If the router-ids are the same, select the path with a lower route distinguisher.
5. If the route distinguishers are the same, select the path with the lower block offset value.
6. If the block offset values are the same, the advertisement is considered to be an update.

Once the BGP and VPLS path selection procedures have been completed and the designated VE devices have been selected, a pseudowire can be created between the remote PE router and the multihomed PE router.

When the remote PE router establishes or refreshes a pseudowire to the local PE router, it verifies that the prefix is in the range required for the site ID based on the block offset and label range advertised by the designated VE device. If the prefix is out of range, the pseudowire status is set to out of range.

The following cases outline the potential decisions that could be made when a PE router completes the BGP and VPLS path selection procedures for a Layer 2 advertisement in the VPLS network:

- The PE router originated one of the multihomed advertisements and selected its own advertisement as the best path.

  This PE router has been selected as the designated VE device. Selection as the designated VE device triggers the creation of pseudowires to and from the other PE routers in the VPLS network. When the remote customer site is also multihomed, the designated VE device triggers the creation of pseudowires to and from only the designated VE device for the remote site.

- The PE router originated one of the multihomed advertisements but did not select its own advertisement as the best path.

  This PE router is one of the redundant PE routers for the multihomed site; it was not selected as the designated VE device. However, if this PE router has just transitioned from being the designated VE device (meaning it was receiving traffic from the remote

PE routers addressed to the mulithomed customer site), the PE router tears down all the pseudowires that it had to and from the other PE routers in the VPLS network.

- The PE router receives the multihomed advertisements and selects a best path; it does not originate any of these advertisements because it is not connected to the multihomed customer site.

  If the preferred path to the customer site (the designated VE device) has not changed, nothing happens. If the preferred path has changed, this PE router brings up pseudowires to and from the newly designated VE device and tears down the pseudowires to and from the previously designated VE device.

  If this PE router does not select a best path after running the BGP and VPLS path selection process, then the local PE router does not consider the remote site to exist.

When a VE device receives an advertisement for a Layer 2 NLRI which matches its own site ID but the site is not multihomed, the pseudowire between it and the transmitting PE router transitions to a site collision state and is not considered to be up.

VPLS Multihoming Reactions to Network Failures

VPLS multihoming is designed to protect customer sites from a loss of network connectivity in the event of the following types of network failures:

- Link failure between the CE device and the PE router—BGP on the PE router is notified when the link goes down. BGP sets the circuit status vector bit in the MP_REACH_NLRI to indicate that the circuit is down.

  If all of the VPLS local attachment circuits are down, then BGP modifies the down bit in the VPLS advertisement Layer2-Extended-Community to indicate that the customer site is down. When the bit is modified, BGP advertises the route to all of the remote PE routers to notify them that the circuit (and site) is down. Each of the remote PE routers run the BGP and VPLS path selection procedures again and reroute the VPLS pseudowires as needed.

- MPLS connectivity failure to the remote PE router—On the multihomed PE router, BGP discovers that MPLS cannot connect to the BGP next hop in the service provider's network. BGP modifies the circuit status vector bit in the MP_REACH_NLRI to indicate that the LSP is down. Once the bit is modified, BGP readvertises the route to all of the remote PE routers to notify them that connectivity from the local site to the remote site is down.

  The remote PE routers each run the BGP and VPLS path selection procedures again. With the LSP to the original multihomed PE router down, the remote PE routers designate the backup multihomed PE router as the VE device for the multihomed customer site. The pseudowires to and from the remote PE routers are then rerouted to the backup multihomed PE router.

- PE router failure—When either the multihomed PE router or the BGP process running on it fails, the remote PE routers detect the expiration of the holdtimer, bring down their peering sessions, and delete the Layer 2 advertisements from that multihomed PE router. The remote PE routers each run the BGP and VPLS path selection procedures again and reroute their pseudowires to the backup multihomed PE router.

Alternatively, the remote PE routers could discover that the BGP next hop, represented by the failed multihomed PE router, is unreachable. For this case, the remote PE routers mark the Layer 2 routes advertised by the multihomed PE router as unreachable. The remote PE routers each run the BGP and VPLS path selection procedures again and reroute their pseudowires to the backup multihomed PE router.

The remote PE routers behave in the same manner if you reconfigure the local preference attribute of the primary multihomed PE router (effectively performing an administrative failover to the backup multihomed PE router). On the primary multihomed PE router, BGP advertises a Layer 2 update with the new local preference attribute to all of the remote PE routers. The remote PE routers each run the BGP and VPLS path selection procedures again and reroute their pseudowires to the backup multihomed PE router.

Interoperability between BGP Signaling and LDP Signaling in VPLS

You can configure a VPLS routing instance where some of the PE routers use BGP for signaling and some use LDP for signaling.

The following concepts form the basis of the configuration needed to include both BGP-signaled and LDP-signaled PE routers in a VPLS routing instance:

- PE router mesh group—Consists of a set of routers participating in a VPLS routing instance that share the same signaling protocol, either BGP or LDP, and are also fully meshed. Each VPLS routing instance can have just one BGP mesh group. However, you can configure multiple LDP mesh groups for each routing instance.
- Border router—A PE router that must be reachable by all of the other PE routers participating in a VPLS routing instance, whether they are LDP-signaled or BGP-signaled. Bidirectional pseudowires are created between the border router and all of these PE routers. The border router is aware of the composition of each PE mesh group configured as a part of the VPLS routing instance. It can also have direct connections to local CE routers, allowing it to act as a typical PE router in a VPLS routing instance.

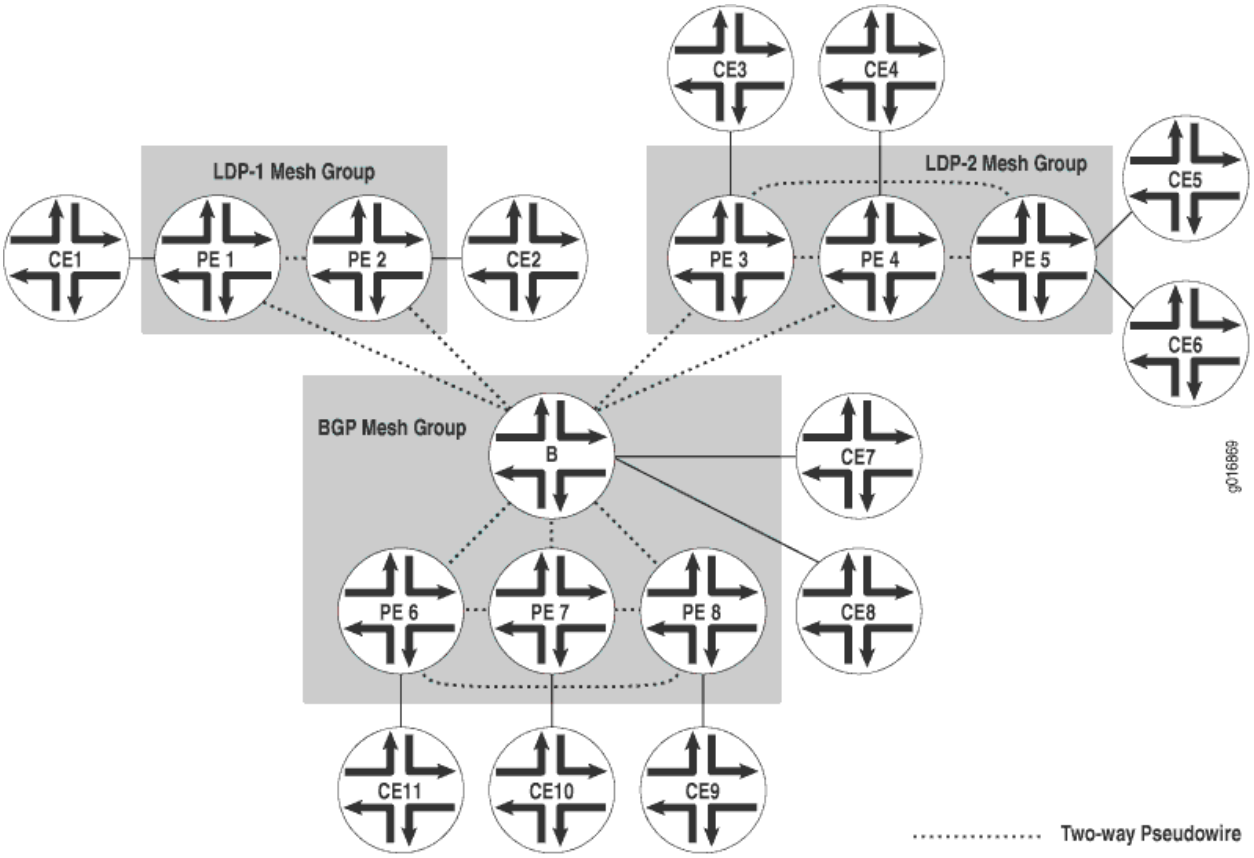
The following sections describe how the LDP-signaled and BGP-signaled PE routers function when configured to interoperate within a VPLS routing instance:

- LDP-Signaled and BGP-Signaled PE Router Topology on page 14
- Flooding Unknown Packets Across Mesh Groups on page 16
- Unicast Packet Forwarding on page 16

LDP-Signaled and BGP-Signaled PE Router Topology

Figure 3 on page 15 illustrates a topology for a VPLS routing instance configured to support both BGP and LDP signaling. Router B is the border router. 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, PE8, and router B (the border router) are in the BGP-signaled mesh group. The border router also acts as a standard VPLS PE router (having local connections to CE routers). All of the PE routers shown are within the same VPLS routing instance.

Figure 3: BGP and LDP Signaling for a VPLS Routing Instance



Two-way pseudowires are established between the PE routers in each mesh group and between each PE router in the VPLS routing instance and the border router. In Figure 3 on page 15, two-way pseudowires are established between routers PE1 and PE2 in mesh group LDP-1, routers PE3, PE4, and PE5 in mesh group LDP-2, and routers PE6, PE7, and PE8 in the BGP mesh group. Routers PE1 through PE8 also all have two-way pseudowires to the Border router. Based on this topology, the LDP-signaled routers are able to interoperate with the BGP-signaled routers. Both the LDP-signaled and BGP-signaled PE routers can logically function within a single VPLS routing instance.

NOTE: The following features are not supported for VPLS routing instances configured with both BGP and LDP signaling:

- Point-to-multipoint LSPs
- Integrated routing and bridging
- IGMP snooping

Flooding Unknown Packets Across Mesh Groups

Broadcast, multicast, and unicast packets of unknown origin received from a PE router are flooded to all local CE routers. They are also flooded to all of the PE routers in the VPLS routing instance except the PE routers that are a part of the originating PE router mesh group.

For example, if a multicast packet is received by the border router in Figure 3 on page 15, it is flooded to the two local CE routers. It is also flooded to routers PE1 and PE2 in the LDP-1 mesh group and to routers PE3, PE4, and PE5 in the LDP-2 mesh group. However, the packet is not flooded to routers PE6, PE7, and PE8 in the BGP mesh group.

Unicast Packet Forwarding

The PE border router is made aware of the composition of each PE router mesh group. From the data plane, each PE router mesh group is viewed as a virtual pseudowire LAN. The border router is configured to interconnect all of the PE router mesh groups belonging to a single VPLS routing instance. To interconnect the mesh groups, a common MAC table is created on the border router.

Unicast packets originating within a mesh group are dropped if the destination is another PE router within the same mesh group. However, if the destination MAC address of the unicast packet is a PE router located in a different mesh group, the packet is forwarded to that PE router.

VPLS Label Blocks Operation

A virtual private LAN service (VPLS) is a Layer 2 (L2) service that emulates a local area network (LAN) across a wide area network (WAN). VPLS labels are defined and exchanged in the Border Gateway Protocol (BGP) control plane. In the Junos OS implementation, label blocks are allocated and used in the VPLS control plane for two primary functions: autodiscovery and signaling.

- Autodiscovery—A method for automatically recognizing each provider edge (PE) router in a particular VPLS domain, using BGP update messages.
- Signaling—Each pair of PE routers in a VPLS domain sends and withdraws VPN labels to each other. The labels are used to establish and dismantle pseudowires between the routers. Signaling is also used to transmit certain characteristics of a pseudowire.

The PE router uses BGP extended communities to identify the members of its VPLS. Once the PE router discovers its members, it is able to establish and tear down pseudowires between members by exchanging and withdrawing labels and transmitting certain characteristics of the pseudowires.

The PE router sends common update messages to all remote PE routers, using a distinct BGP update message, thereby reducing the control plane load. This is achieved by using VPLS label blocks.

Elements of Network Layer Reachability Information

VPLS BGP network layer reachability information (NLRI) is used to exchange VPLS membership and parameters. The elements of a VPLS BGP NLRI are defined in Table 3 on page 17.

Table 3: NLRI Elements

Element	Acronym	Description	Default Size (Octets)
Length		Total length of the NLRI size represented in bytes.	2
Route Distinguisher	RD	Unique identifier for each routing instance configured on a PE.	8
VPLS Edge ID	VE ID	Unique number to identify the edge site.	2
VE Block Offset	VBO	Value used to identify a label block from which a label value is selected to set up pseudowires for a remote site.	2
VE Block Size	VBS	Indicates the number of pseudowires that peers can have in a single block.	2
Label Base	LB	Starting value of the label in the advertised label block.	3

Requirements for NLRI Elements

Junos OS requires a unique route distinguisher (RD) for each routing instance configured on a PE router. A PE router might use the same RD across a VPLS (or VPN) domain or it might use different RDs. Using different RDs helps identify the originator of the VPLS NLRI.

The VPLS edge (VE) ID can be a unique VE ID, site ID, or customer edge (CE) ID. The VE ID is used by a VPLS PE router to index into label blocks used to derive the transmit and receive VPN labels needed for transport of VPLS traffic. The VE ID identifies a particular site, so it needs to be unique within the VPLS domain, except for some scenarios such as multihoming.

All PE routers have full mesh connectivity with each other to exchange labels and set up pseudowires. The VE block size (VBS) is a configurable value that represents the number of label blocks required to cover all the pseudowires for the remote peer.

A single label block contains 8 labels (1 octet) by default. The default VBS in Junos OS is 2 blocks (2 octets) for a total of 16 labels.

How Labels are Used in Label Blocks

Each PE router creates a mapping of the labels in the label block to the sites in a VPLS domain. A PE router advertising a label block with a block offset indicates which sites

can use the labels to reach it. When a PE router is ready to advertise its membership to a VPLS domain, it allocates a label block and advertises the VPLS NLRI. In this way, other PE routers in the same VPLS domain can learn of the existence of the VPLS and set up pseudowires to it if needed. The VPLS NLRI advertised for this purpose is referred to as the *default VPLS NLRI*. The label block in the default VPLS NLRI is referred to as the *default label block*.

Label Block Composition

A label block (set of labels) is used to reach a given site ID. A single label block contains 8 labels (1 octet) by default. The VBS is 2 octets by default in Junos OS.

The label block advertised is defined as a label base (LB) and a VE block size (VBS). It is a contiguous set of labels (LB, LB+1,...LB+VBS-1). For example, when Router PE-A sends a VPLS update, it sends the same label block information to all other PE routers. Each PE router that receives the LB advertisement infers the label intended for Router PE-A by adding its own site ID to the label base.

In this manner, each receiving PE gets a unique label for PE-A for that VPLS. This simple method is enhanced by using a VE block offset (VBO).

A label block is defined as: <Label Base (LB), VE block offset (VBO), VE block size (VBS)> is the set {LB+VBO, LB+VBO+1,...,LB+VBO+VBS-1}.

Label Blocks in Junos OS

Instead of a single large label block to cover all VE IDs in a VPLS, the Junos OS implementation contains several label blocks, each with a different label base. This makes label block management easier, and also allows Router PE-A to seemlessly integrate a PE router joining a VPLS with a site ID not covered by the set of label blocks that Router PE-A has already advertised.

VPLS Label Block Structure

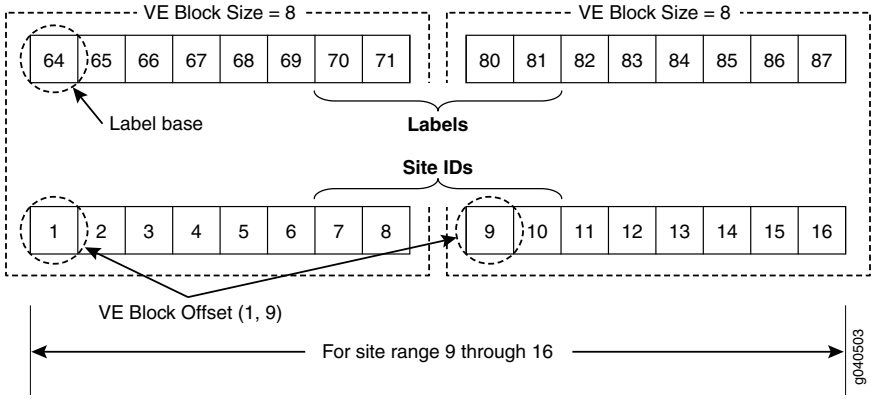
This section illustrates how a label block is uniquely identified.

A VPLS BGP NLRI with site ID V, VE block offset VBO, VE block size VBS, and label base LB communicates the following to its peers:

- Label block for V: Labels from LB to (LB + VBS -1).
- Remote VE set for V: from VBO to (VBO + VBS -1).

The label block advertised is a set of labels used to reach a given site ID. If there are several label blocks, the remote VE set helps to identify which label block to use. The example in Figure 4 on page 19 illustrates label blocks. There are two blocks and each block has eight labels. In this example, the label values are 64 to 71 and 80 to 87.

Figure 4: VPLS Label Block Structure



To create a one-to-one mapping of these 16 labels to 16 sites, assume the site IDs are the numbers 1 to 16, as shown in the illustration. The site block indicates which site ID can use which label in the label block. So, in the first block, site ID 1 uses 64, site ID 2 uses 65, and so forth. Finally, site ID 8 uses 71. The 9th site ID will use the second block instead of the first block.

The labels are calculated by comparing the values of VBO < = Local site ID < (VBO +VBS). Consequently, site ID 9 uses 80, site ID 10 uses 81, and so on.

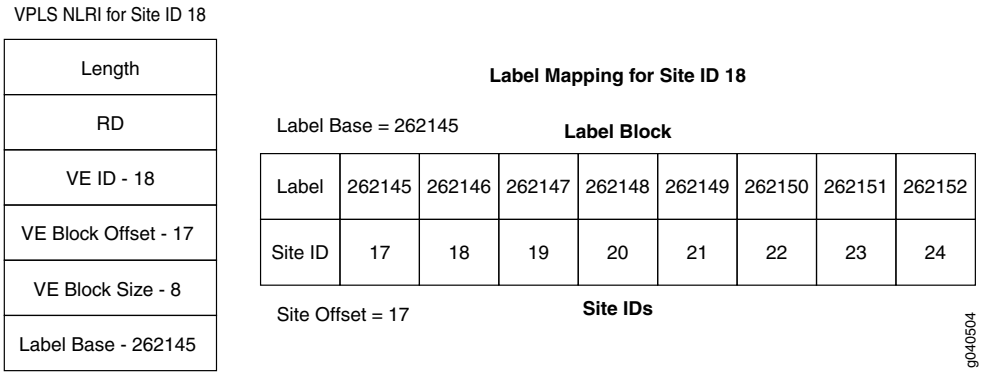
To further illustrate the one-to-one mapping of labels to sites, assume a label block with site offset of 1 and a label base of 10. The combination of label base and block offset contained in the VPLS NLRI provides the mapping of labels to site IDs. The block offset is the starting site ID that can use the label block as advertised in the VPLS NLRI.

To advertise the default VPLS NLRI, a PE router picks a starting block offset that fits its own site ID and is such that the end block offset is a multiple of a single label block. In Junos OS a single label block is eight labels by default.

The end block offset is the last site ID that maps to the last label in the label block. The end offset for the first block is 8 which maps to label 17 and the second block is 16. For example, a site with ID 3 picks a block offset of 1 and advertises a label block of size 8 to cover sites with IDs 1 to 8. A site with ID 10 picks a block offset of 9 to cover sites with IDs 9 to 16.

The VPLS NLRI shown in Figure 5 on page 20 is for site ID 18. The label base contains value 262145. The block offset contains value 17. The illustration shows which site IDs correspond to which labels.

Figure 5: Label Mapping Example



If a PE router configured with site ID 17 is in the same VPLS domain as a PE router configured with site ID 18, it receives the VPLS NLRI as shown in Figure 3. So it uses label 262145 to send traffic to site 18. Similarly, a PE router configured with site ID 19 uses label 262147 to send traffic to a PE router configured with site ID 18. However, only PE routers configured with site IDs 17 to 24 can use the label block shown to set up pseudowires.

Related Documentation

- Example: Building a VPLS From Router 1 to Router 3 to Validate Label Blocks on page 83

PE Router Mesh Groups for VPLS Routing Instances

A PE router mesh group consists of a set of routers participating in a VPLS routing instance that share the same signaling protocol, either BGP or LDP. Each VPLS routing instance can have just one BGP mesh group. However, you can configure multiple LDP mesh groups for each routing instance.

The Junos OS can support up to 16 mesh groups on MX Series routers and up to 128 on M Series and T Series routers. However, two mesh groups are created by default, one for the CE routers and one for the PE routers. Therefore, the maximum number of user-defined mesh groups is 14 for MX Series routers and 126 for M Series and T Series routers. PE router mesh groups are not supported on J Series routers.

The Junos OS supports both forwarding equivalency class (FEC) 128 and FEC 129. FEC 129 uses VPLS autodiscovery to convey endpoint information. FEC 128 requires manually configured pseudowires.

The following describes the behavior of mesh groups in regards to BGP-signaled PE routers and LDP-signaled PE routers:

- BGP-signaled PE routers—Automatically discovered PE routers that use BGP for signaling are associated with the default VE mesh group. You cannot configure the Junos OS to associate these routers with a user-defined VE mesh group.
- LDP-signaled PE routers (FEC 128)—PE routers statically configured using FEC-128 LDP signaling are placed in a default mesh group. However, you can configure a VE mesh group and associate each LDP FEC-128 neighbor with it. Each configured VE mesh group contains a set of VEs that are in the same interior gateway protocol (IGP) routing instance and are fully meshed with each other in the control and data planes.

- LDP-signaled PE routers (FEC 129)—Configuration for a mesh group for FEC 129 is very similiar to the configuration for FEC 128.

  Note the following differences for FEC 129:

  - Each user-defined mesh group must have a unique route distinguisher. Do not use the route distinguisher that is defined for the default mesh group at the **[edit routing-intances]** hierarchy level.
  - Each user-defined mesh group must have its own import and export route target.
  - Each user-defined mesh group can have a unique Layer 2 VPN ID. By default, all the mesh groups that are configured for the a VPLS routing-instance use the same Layer 2 VPN ID, the one that you configure at the **[edit routing-instances]** hierarchy level.

Related Documentation

- Example: Configuring BGP Autodiscovery for LDP VPLS on page 89

CHAPTER 2

Introduction to Configuring VPLS

Configuring an Ethernet Switch as the CE Device

For VPLS configurations, the CE device does not necessarily need to be a router. You can link the PE routers directly to Ethernet switches. However, there are a few configuration issues to be aware of:

- When you configure VPLS routing instances and establish two or more connections between a CE Ethernet switch and a PE router, you must enable the Spanning Tree Protocol (STP) on the switch to prevent loops.
- The Junos OS allows standard Bridge Protocol Data Unit (BPDU) frames to pass through emulated Layer 2 connections, such as those configured with Layer 2 VPNs, Layer 2 circuits, and VPLS instances. However, CE Ethernet switches that generate proprietary BPDU frames might not be able to run STP across Juniper Networks routing platforms configured for these emulated Layer 2 connections.

PART 2

Configuration

CHAPTER 3

Configuring VPLS

Introduction to Configuring VPLS

Virtual private LAN service (VPLS) allows you to provide a point-to-multipoint LAN between a set of sites in a virtual private network (VPN).

To configure VPLS functionality, you must enable VPLS support on the provider edge (PE) router. You must also configure PE routers to distribute routing information to the

other PE routers in the VPLS and configure the circuits between the PE routers and the customer edge (CE) routers.

Each VPLS is configured under a routing instance of type **vpls**. A **vpls** routing instance can transparently carry Ethernet traffic across the service provider's network. As with other routing instances, all logical interfaces belonging to a VPLS routing instance are listed under that instance.

In addition to VPLS routing instance configuration, you must configure MPLS label-switched paths (LSPs) between the PE routers, IBGP sessions between the PE routers, and an interior gateway protocol (IGP) on the PE and provider (P) routers.

By default, VPLS is disabled.

Many configuration procedures for VPLS are identical to the procedures for Layer 2 VPNs and Layer 3 VPNs.

Configuring VPLS Routing Instances

To configure a VPLS routing instance, include the **vpls** statement:

```
vpls {
  active-interface {
    any;
    primary interface-name;
  }
  connectivity-type (ce | irb | permanent);
  encapsulation-type encapsulation-type;
  interface-mac-limit limit;
  label-block-size size;
  mac-table-aging-time time;
  mac-table-size size;
  neighbor neighbor-id;
  no-tunnel-services;
  site site-name {
    active-interface {
      any;
      primary interface-name;
    }
    interface interface-name {
      interface-mac-limit limit;
    }
    multi-homing;
    site-identifier identifier;
    site-preference preference-value;
  }
  site-range number;
  traceoptions {
    file filename <files number> <size size> <world-readable | no-world-readable>;
    flag flag <flag-modifier> <disable>;
  }
  tunnel-services {
    devices device-names;
    primary primary-device-name;
```

```
    }
    vpls-id vpls-id;
}
```

You can include this statement at the following hierarchy levels:

- **[edit routing-instances *routing-instance-name* protocols]**
- **[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols]**

NOTE: **You cannot configure a routing protocol (OSPF, RIP, IS-IS or BGP) inside a VPLS routing instance (instance-type vpls). The Junos CLI disallows this configuration.**

The configuration for the VPLS routing instance statements is explained in the following sections:

- Configuring BGP Signaling for VPLS on page 29
- Configuring LDP Signaling for VPLS on page 34
- Configuring VPLS Routing Instance and VPLS Interface Connectivity on page 36
- Configuring the VPLS Encapsulation Type on page 36
- Configuring the VPLS MAC Table Timeout Interval on page 37
- Configuring the Size of the VPLS MAC Address Table on page 37
- Limiting the Number of MAC Addresses Learned from an Interface on page 38
- Removing Addresses from the MAC Address Database on page 39

Configuring BGP Signaling for VPLS

You can configure BGP signaling for the VPLS routing instance. BGP is used to signal the pseudowires linking each of the PE routers participating in the VPLS routing instance. The pseudowires carry VPLS traffic across the service provider's network between the VPLS sites.

NOTE: **You cannot configure both BGP signaling and LDP signaling for the same VPLS routing instance. If you attempt to configure the statements that enable BGP signaling for the VPLS routing instance (the site, site-identifier, and site-range statements) and the statements that enable LDP signaling for the same instance (the neighbor and vpls-id statements), the commit operation fails.**

Configure BGP signaling for the VPLS routing instance by completing the steps in the following sections:

- Configuring the VPLS Site Name and Site Identifier on page 30
- Configuring Automatic Site Identifiers for VPLS on page 30

Configuring the VPLS Site Name and Site Identifier

When you configure BGP signaling for the VPLS routing instance, on each PE router you must configure each VPLS site that has a connection to the PE router. All the Layer 2 circuits provisioned for a VPLS site are listed as the set of logical interfaces (using the **interface** statement) within the **site** statement.

You must configure a site name and site identifier for each VPLS site.

To configure the site name and the site identifier, include the **site** and the **site-identifier** statements:

```
site site-name {
    interface interface-name {
        interface-mac-limit limit;
    }
    site-identifier identifier;
}
```

The numerical identifier can be any number from 1 through 65,534 that uniquely identifies the local VPLS site.

You can include these statements at the following hierarchy levels:

- **[edit routing-instances *routing-instance-name* protocols vpls]**
- **[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls]**

Configuring Automatic Site Identifiers for VPLS

When you enable automatic site identifiers, the Junos OS automatically assigns site identifiers to VPLS sites. To configure automatic site identifiers for a VPLS routing instance, include the **automatic-site-id** statement:

```
automatic-site-id {
    collision-detect-time seconds;
    new-site-wait-time seconds;
    reclaim-wait-time minimum seconds maximum seconds;
    startup-wait-time seconds;
}
```

You can include this statement at the following hierarchy levels:

- **[edit routing-instances *routing-instance-name* protocols vpls site *site-name*]**
- **[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls site *site-name*]**

The **automatic-site-id** statement includes a number of options that control different delays in network layer reachability information (NLRI) advertisements. All of these options are configured with default values. See the statement summary for the **automatic-site-id** statement for more information.

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

- **collision-detect-time**—The time in seconds to wait after a claim advertisement is sent to the other routers in a VPLS instance before a PE router can begin using a site identifier. If the PE router receives a competing claim advertisement for the same site identifier during this time period, it initiates the collision resolution procedure for site identifiers.
- **new-site-wait-time**—The time in seconds to wait to receive VPLS information for a newly configured routing instance or a new site. This time interval is also applied whenever the automatic site identifier feature is activated on a VPLS routing instance other than at startup. Effectively, this timer indicates how long to wait before an attempt is made to allocate a site identifier. This timer is also triggered whenever a VPLS routing instance is enabled.
- **reclaim-wait-time**—The time to wait before attempting to claim a site identifier after a collision. A collision occurs whenever an attempt is made to claim a site identifier by two separate VPLS sites.
- **startup-wait-time**—The time in seconds to wait at startup to receive all the VPLS information for the route targets configured on the other PE routers included in the VPLS routing instance.

Configuring the Site Range

When you enable BGP signaling for each VPLS routing instance, you can optionally configure the site range. The site range specifies an upper limit on the maximum site identifier that can be accepted to allow a pseudowire to be brought up. You must specify a value from 1 through 65,534. The default value is **65,534**. We recommend using the default. Pseudowires cannot be established to sites with site identifiers greater than the configured site range. If you issue the **show vpls connections** command, such sites are displayed as OR (out of range).

To configure the site range, include the **site-range** statement:

```
site-range number;
```

You can include this statement at the following hierarchy levels:

- **[edit routing-instances *routing-instance-name* protocols vpls]**
- **[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls]**

There are networks that require that the site range be configured using a value smaller than the local site identifier, for example, a hub-and-spoke VPLS with multihomed sites. For this type of network, you need to allow pseudowires to be established between the spoke routers and the hub router. However, you also need to prevent pseudowires from being established between spoke routers directly. Due to the multihoming requirement

of spoke sites, Layer 2 VPN NRLIs need to be accepted from other spoke routers (at least from spokes with the same site identifier as the locally configured sites) to determine the status of local spoke routers (active or not active) based on the local preference included in the NRLIs received from the other spoke routers.

This type of VPLS network can be implemented by, for example, numbering hub sites with identifiers 1 through 8 and spoke sites with identifiers 9 and larger. You can then configure a site range of 8 on each of the spoke sites. Although the spoke sites accept NRLIs and install them in the Layer 2 VPN routing tables (allowing the multihomed sites to determine the status of the local site), the spoke sites cannot establish pseudowires directly to the other spoke sites due to the configured site range.

The following configurations illustrate this concept. The configurations are for the VPLS routing instances on three routers, two spoke routers and one hub router:

Router 1—spoke:

```
routing-instance hub-and-spoke {
    no-local-switching;
    protocols {
        vpls {
            site-range 8;
            no-tunnel-services;
            site spoke-9 {
                site-identifier 9 {
                    multi-homing;
                    site-preference primary;
                }
            }
            site spoke-10 {
                site-identifier 10 {
                    multi-homing;
                    site-preference backup;
                }
            }
        }
    }
}
```

Router 2—spoke:

```
routing-instance hub-and-spoke {
    no-local-switching;
    protocols {
        vpls {
            site-range 8;
            no-tunnel-services;
            site spoke-9 {
                site-identifier 9 {
                    multi-homing;
                    site-preference backup;
                }
            }
            site spoke-10 {
                site-identifier 10 {
```



```
            multi-homing;
            site-preference primary;
          }
        }
      }
    }
  }
```

Hub—router 3:

```
routing-instance hub-and-spoke {
  no-local-switching;
  protocols {
    vpls {
      no-tunnel-services;
      site hub {
        site-identifier 1;
      }
    }
  }
}
```

Configuring the VPLS Site Interfaces

All the Layer 2 circuits you configure for a VPLS site are listed as a set of logical interfaces within the VPLS site configuration.

To configure a logical interface for the VPLS site, include the **interface** statement:

```
interface interface-name {
  interface-mac-limit limit;
}
```

You can include these statements at the following hierarchy levels:

- **[edit routing-instances *routing-instance-name* protocols vpls site *site-name*]**
- **[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls]**

You can also configure a limit on the number of MAC addresses that can be learned from the specified interface. For more information, see "Limiting the Number of MAC Addresses Learned from an Interface" on page 38.

Configuring the VPLS Site Preference

You can specify the preference value advertised for a particular VPLS site. The site preference value is encoded in the BGP local preference attribute. When a PE router receives multiple advertisements with the same VPLS edge (VE) device identifier, the advertisement with the highest local preference value is preferred.

To configure the VPLS site preference, include the **site-preference** statement:

```
site-preference preference-value;
```

You can also specify either the **backup** option or the **primary** option for the **site-preference** statement. The backup option specifies the preference value as 1, the lowest possible

value, ensuring that the VPLS site is the least likely to be selected. The primary option specifies the preference value as 65,535, the highest possible value, ensuring that the VPLS site is the most likely to be selected.

For a list of hierarchy levels at which you can include the **site-preference** statement, see the statement summary section for this statement.

Configuring LDP Signaling for VPLS

You can configure LDP as the signaling protocol for a VPLS routing instance. This functionality is described in RFC 4762, *Virtual Private LAN Service (VPLS) Using Label Distribution Protocol (LDP) Signaling*.

The Junos OS does not support all of RFC 4762. When enabling LDP signaling for a VPLS routing instance, network engineers should be aware that only the following values are supported:

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

To enable LDP signaling for the set of PE routers participating in the same VPLS routing instance, you need to use the **vpls-id** statement configured at the **[edit routing-instances *routing-instance-name* protocols vpls]** hierarchy level to configure the same VPLS identifier on each of the PE routers. The VPLS identifier must be globally unique. When each VPLS routing instance (domain) has a unique VPLS identifier, it is possible to configure multiple VPLS routing instances between a given pair of PE routers.

LDP signaling requires that you configure a full-mesh LDP session between the PE routers in the same VPLS routing instance. Neighboring PE routers are statically configured. Tunnels are created between the neighboring PE routers to aggregate traffic from one PE router to another. Pseudowires are then signaled to demultiplex traffic between VPLS routing instances. These PE routers exchange the pseudowire label, the MPLS label that acts as the VPLS pseudowire demultiplexer field, by using LDP forwarding equivalence classes (FECs). Tunnels based on both MPLS and generic routing encapsulation (GRE) are supported.

NOTE: You cannot configure both BGP signaling and LDP signaling for the same VPLS routing instance. If you attempt to configure the statements that enable BGP signaling for the VPLS routing instance (the **site**, **site-identifier**, and **site-range** statements), and the statements that enable LDP signaling for the same instance, **neighbor** and **vpls-id**, the commit operation fails.

To enable LDP signaling for the VPLS routing instance, complete the steps in the following sections:

- Configuring LDP Signaling for the VPLS Routing Instance on page 35
- Configuring LDP Signaling on the Router on page 35

Configuring LDP Signaling for the VPLS Routing Instance

To configure the VPLS routing instance to use LDP signaling, you must configure the same VPLS identifier on each PE router participating in the instance. Specify the VPLS identifier with the **vpls-id** statement:

```
vpls-id vpls-id;
```

You can include this statement at the following hierarchy levels:

- **[edit routing-instances *routing-instance-name* protocols vpls]**
- **[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls]**

To configure the VPLS routing instance to use LDP signaling, you also must include the **neighbor** statement to specify each of the neighboring PE routers that are a part of this VPLS domain:

```
neighbor neighbor-id;
```

You can include this statement at the following hierarchy levels:

- **[edit routing-instances *routing-instance-name* protocols vpls]**
- **[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls]**

Configuring LDP Signaling on the Router

To enable LDP signaling, you need to configure LDP on each PE router participating in the VPLS routing instance. A minimal configuration is to enable LDP on the loopback interface, which includes the router identifier (**router-id**), on the PE router using the **interface** statement:

```
interface interface-name;
```

You can include this statement at the following hierarchy levels:

- **[edit protocols ldp]**
- **[edit logical-systems *logical-system-name* protocols ldp]**

You can enable LDP on all the interfaces on the router using the **all** option for the **interfaces** statement. For more information about how to configure LDP, see the *Junos OS MPLS Applications Configuration Guide*.

Configuring VPLS Routing Instance and VPLS Interface Connectivity

You can configure the VPLS routing instance to take down or maintain its VPLS connections depending on the status of the interfaces configured for the VPLS routing instance. By default, the VPLS connection is taken down whenever a customer-facing interface configured for the VPLS routing instance fails. This behavior can be explicitly configured by specifying the **ce** option for the **connectivity-type** statement:

```
connectivity-type ce;
```

You can alternatively specify that the VPLS connection remain up so long as an Integrated Routing and Bridging (IRB) interface is configured for the VPLS routing instance by specifying the **irb** option for the **connectivity-type** statement:

```
connectivity-type irb;
```

To ensure that the VPLS connection remain up until explicitly taken down, specify the **permanent** option for the **connectivity-type** statement:

```
connectivity-type permanent;
```

This option is reserved for use in configuring Layer 2 Wholesale subscriber networks. See the *Broadband Subscriber Management Solutions Guide* for details about configuring a Layer 2 Wholesale network.

You can include this statement at the following hierarchy levels:

- **[edit routing-instances *routing-instance-name* protocols vpls]**
- **[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls]**

Configuring the VPLS Encapsulation Type

You can specify a VPLS encapsulation type for the pseudowires established between VPLS neighbors. The encapsulation type is carried in the LDP-signaling messages exchanged between VPLS neighbors when pseudowires are created. You might need to alter the encapsulation type depending on what other vendors' equipment is deployed within your network.

VPLS effectively provides a bridge between Ethernet networks. As a consequence, only two encapsulation types are available:

- **ethernet**—Ethernet
- **ethernet-vlan**—Ethernet virtual LAN (VLAN)

If you do not specify an encapsulation type for the VPLS routing instance or the VPLS neighbor, **ethernet** is used.

To specify an encapsulation type for the VPLS routing instance, include the **encapsulation-type** statement:

```
encapsulation-type (ethernet | ethernet-vlan);
```

You can include this statement at the following hierarchy levels:

- **[edit routing-instances *routing-instance-name* protocols vpls]**
- **[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls]**

You can also specify an encapsulation type for a specific VPLS neighbor by including the **encapsulation-type** statement at the following hierarchy levels:

- **[edit routing-instances *routing-instance-name* protocols vpls neighbor *address*]**
- **[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls neighbor *address*]**

Configuring the VPLS MAC Table Timeout Interval

You can modify the timeout interval for the VPLS table. We recommend you that configure longer values for small, stable VPLS networks and shorter values for large, dynamic VPLS networks. If the VPLS table does not receive any updates during the timeout interval, the router waits one additional interval before automatically clearing the MAC address entries from the VPLS table.

To modify the timeout interval for the VPLS table, include the **mac-table-aging-time** statement:

```
mac-table-aging-time seconds;
```

You can include this statement at the following hierarchy levels:

- **[edit routing-instances *routing-instance-name* protocols vpls]**
- **[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls]**

NOTE: The **mac-table-aging-time** statement is not available on MX Series routers.

Configuring the Size of the VPLS MAC Address Table

You can modify the size of the VPLS media access control (MAC) address table. The default table size is 512 MAC addresses, the minimum is 16 addresses, and the maximum is 65,536 addresses.

If the MAC table limit is reached, new MAC addresses can no longer be added to the table. Eventually the oldest MAC addresses are removed from the MAC address table automatically. This frees space in the table, allowing new entries to be added. However, as long as the table is full, new MAC addresses are dropped.

To change the VPLS MAC table size for each VPLS or VPN routing instance, include the **mac-table-size** statement:

mac-table-size *size*;

You can include this statement at the following hierarchy levels:

- **[edit routing-instances *routing-instance-name* protocols vpls]**
- **[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls]**

When you include the **mac-table-size** statement, the affected interfaces include all interfaces within the VPLS routing instance, including the local interfaces, the LSI interfaces, and the VT interfaces.

Limiting the Number of MAC Addresses Learned from an Interface

You can configure a limit on the number of MAC addresses learned by a VPLS routing instance using the **mac-table-size** statement. If the MAC table limit is reached, new MAC addresses can no longer be added to the table. Eventually the oldest MAC addresses are removed from the MAC address table automatically. This frees space in the table, allowing new entries to be added. However, as long as the table is full, new MAC addresses are dropped.

Because this limit applies to each VPLS routing instance, the MAC addresses of a single interface can consume all the available space in the table, preventing the routing instance from acquiring addresses from other interfaces.

You can limit the number of MAC addresses learned from each interface configured for a VPLS routing instance. To do so, include the **interface-mac-limit** statement:

interface-mac-limit *limit*;

You can include this statement at the following hierarchy levels:

- **[edit routing-instances *routing-instance-name* protocols vpls]**
- **[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls]**

The **interface-mac-limit** statement affects the local interfaces only (the interfaces facing CE devices).

Configuring the **interface-mac-limit** statement at the **[edit routing-instances *routing-instance-name* protocols vpls]** hierarchy level causes the same limit to be applied to all of the interfaces configured for that specific routing instance.

You can also limit the number of MAC addresses learned by a specific interface configured for a VPLS routing instance. This gives you the ability to limit particular interfaces that you expect might generate a lot of MAC addresses.

To limit the number of MAC addresses learned by a specific interface, include the **interface-mac-limit** statement at the following hierarchy levels:

- **[edit routing-instances *routing-instance-name* protocols vpls site *site-name* interfaces *interface-name*]**

- **[edit logical-systems** *logical-system-name* **routing-instances** *routing-instance-name* **protocols vpls site** *site-name* **interfaces** *interface-name***]**

The MAC limit configured for an individual interface at this hierarchy level overrides any value configured at the **[edit routing-instances** *routing-instance-name* **protocols vpls]** hierarchy level. Also, the MAC limit configured using the **mac-table-size** statement can override the limit configured using the **interface-mac-limit** statement.

The MAC address limit applies to customer-facing interfaces only.

Removing Addresses from the MAC Address Database

You can enable MAC flush processing for the VPLS routing instance or for the mesh group under a VPLS routing instance. MAC flush processing removes MAC addresses from the MAC address database that have been learned dynamically. With the dynamically learned MAC addresses removed, MAC address convergence requires less time to complete.

You can clear dynamically learned MAC addresses from the MAC address database by including the **mac-flush** statement:

```
mac-flush [ explicit-mac-flush-message-options ];
```

To clear dynamically learned MAC addresses globally across all devices participating in the routing instance, you can include the statement at the following hierarchy levels:

- **[edit logical-systems** *logical-system-name* **routing-instances** *routing-instance-name* **protocols vpls]**
- **[edit routing-instances** *routing-instance-name* **protocols vpls]**

To clear the MAC addresses on the routers in a specific mesh group, you can include the statement at the following hierarchy levels:

- **[edit logical-systems** *logical-system-name* **routing-instances** *routing-instance-name* **protocols vpls mesh-group** *mesh-group-name***]**
- **[edit routing-instances** *routing-instance-name* **protocols vpls mesh-group** *mesh-group-name***]**

For certain cases where MAC flush processing is not initiated by default, you can also specify ***explicit-mac-flush-message-options*** to additionally configure the router to send explicit MAC flush messages under specific conditions. For a list of the explicit MAC flush message options you can include with this statement, see the summary section for this statement.

Configuring Static Pseudowires for VPLS

You can configure a VPLS domain using static pseudowires. A VPLS domain consists of a set of PE routers that act as a single virtual Ethernet bridge for the customer sites connected to these routers. By configuring static pseudowires for the VPLS domain, you do not need to configure the LDP or BGP protocols that would normally be used for signaling. However, if you configure static pseudowires, any changes to the VPLS network topology have to be managed manually.

Static pseudowires require that you configure a set of in and out labels for each pseudowire configured for the VPLS domain. You still need to configure a VPLS identifier and neighbor identifiers for a static VPLS domain. You can configure both static and dynamic neighbors within the same VPLS routing instance.

To configure a static pseudowire for a VPLS neighbor, include the **static** statement:

```
static {
    incoming-label label;
    outgoing-label label;
}
```

You must configure an incoming and outgoing label for the static pseudowire using the **incoming-label** and **outgoing-label** statements. These statements identify the static pseudowire's incoming traffic and destination.

To configure a static pseudowire for a VPLS neighbor, include the **static** statement at the **[edit routing-instances *routing-instance-name* protocols vpls neighbor *address*]** hierarchy level.

You can also configure the **static** statement for a backup neighbor (if you configure the neighbor as static the backup must also be static) by including it at the **[edit routing-instances *routing-instance-name* protocols vpls neighbor *address* backup-neighbor *address*]** hierarchy level and for a mesh group by including it at the **[edit routing-instances *routing-instance-name* protocols vpls mesh-group *mesh-group-name* neighbor *address*]** hierarchy level.

For a list of hierarchy levels at which you can include the **static** statement, see the statement summary section for this statement.

To enable static VPLS on a router, you need to either configure a virtual tunnel interface (requires the router to have a tunnel services PIC) or you can configure a label switching interface (LSI). To configure an LSI, include the **no-tunnel-services** statement at the **[edit protocols vpls static-vpls]** hierarchy level. For more information, see "Configuring VPLS Without a Tunnel Services PIC" on page 49.

NOTE: Static pseudowires for VPLS using an LSI is supported on MX series routers only. For M series and T series routers, a tunnel services PIC is required.

If you issue a **show vpls connections** command, static neighbors are displayed with **"SN"** next to their addresses in the command output.

Related Documentation

- Configuring VPLS Without a Tunnel Services PIC on page 49

Configuring EXP-Based Traffic Classification for VPLS

You can enable EXP classification on traffic entering core facing VPLS LSI interfaces on a VPLS routing instance by configuring either a logical tunnel interface (**lt-**) or the **no-tunnel-services** statement. By configuring either of these, a default EXP classifier is

enabled on every core facing interface that includes **family mpls** in its configuration. This feature works on MX Series routers only. You can configure an EXP classifier explicitly at the **[edit class-of-service]** hierarchy level. For more information about EXP classifiers, see the *Junos OS Class of Service Configuration Guide*.

To enable EXP classification on traffic entering core facing VPLS LSI interfaces on a VPLS routing instance, include the **no-tunnel-services** statement:

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

You can include this statement at the following hierarchy levels:

- **[edit routing-instances *routing-instance-name* protocols vpls]**
- **[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls]**

Configuring Interfaces for VPLS Routing

On each PE router and for each VPLS routing instance, specify which interfaces are intended for the VPLS traffic traveling between PE and CE routers. To specify the interface for VPLS traffic, include the **interface** statement in the routing instance configuration:

```
interface interface-name;
```

You can include this statement at the following hierarchy levels:

- **[edit routing-instances *routing-instance-name*]**
- **[edit logical-systems *logical-system-name* routing-instances *routing-instance-name*]**

You must also define each interface by including the following statements:

```
vlan-tagging;
encapsulation encapsulation-type;
unit logical-unit-number {
   vlan-id vlan-id-number;
   family vpls;
}
```

You can include these statements at the following hierarchy levels:

- **[edit interfaces *interface-name*]**
- **[edit logical-systems *logical-system-name* interfaces *interface-name*]**

NOTE: You must specify the interface encapsulation using one of the VPLS-supported interface encapsulation types: **ethernet-vpls**, **extended-vlan-vpls**, **flexible-ethernet-services**, or **vlan-vpls**. If you do not specify a VPLS-supported interface encapsulation type, the commit fails.

The following sections provide describe how to configure interfaces for VPLS routing. For detailed information about configuring interfaces and the statements at the **[edit interfaces]** hierarchy level, see the *Junos OS Network Interfaces Configuration Guide*.

To configure an interface for VPLS, you perform the steps in the following sections:

Configuring the Interface Name

Specify both the physical and logical portions of the interface name, in the following format:

physical.*logical*

For example, in **ge-1/2/1.2**, **ge-1/2/1** is the physical portion of the interface name and **2** is the logical portion. If you do not specify the logical portion of the interface name, **0** is set by default.

A logical interface can be associated with only one routing instance.

If you enable a routing protocol on all instances by specifying **interfaces all** when configuring the master instance of the protocol at the **[edit protocols]** hierarchy level, and you configure a specific interface for VPLS routing at the **[edit routing-instances *routing-instance-name*]** hierarchy level, the latter interface statement takes precedence and the interface is used exclusively for VPLS.

If you explicitly configure the same interface name at both the **[edit protocols]** and **[edit routing-instances *routing-instance-name*]** hierarchy levels and then attempt to commit the configuration, the commit operation fails.

When a logical interface is configured with VPLS encapsulation and without an explicitly configured VPLS family, you can commit the configuration even though there is no VPLS routing instance present. However, the following warning message is displayed in the system logs:

“Warning: interface *interface name* needs to be in a VPLS routing instance to support family VPLS.”

In the following configuration example, only **vlan-vpls** is configured, the **family vpls** statement is not explicitly configured, and no routing instance is present.

```
ge-0/0/0 {
 vlan-tagging;
 encapsulation vlan-vpls;
 unit 0 {
  encapsulation vlan-vpls;
  vlan-id 600;
```

```
    }
}
```

Configuring the VPLS Interface Encapsulation

You need to specify an encapsulation type for each PE-router-to-CE-router interface configured for VPLS. This section describes the **encapsulation** statement configuration options available for VPLS. For a full description of all of the options available for this statement, see the *Junos OS Network Interfaces Configuration Guide*.

To configure the encapsulation type on the physical interface, include the **encapsulation** statement:

```
encapsulation (ethernet-vpls | extended-vlan-vpls | vlan-vpls);
```

You can include the **encapsulation** statement for physical interfaces at the following hierarchy levels:

- **[edit interfaces *interface-name*]**
- **[edit logical-systems *logical-system-name* interfaces *interface-name*]**

You can configure the following physical interface encapsulations for VPLS routing instances:

- **ethernet-vpls**—Use Ethernet VPLS encapsulation on Ethernet interfaces that have VPLS enabled and that must accept packets carrying standard Tag Protocol ID (TPID) values. On M Series routers (except the M320 router), the 4-port Fast Ethernet TX PIC and the 1-port, 2-port, and 4-port, 4-slot Gigabit Ethernet PICs can use the Ethernet VPLS encapsulation type.
- **extended-vlan-vpls**—Use extended virtual LAN (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. On M Series routers (except the M320 router), the 4-port Fast Ethernet TX PIC and the 1-port, 2-port, and 4-port, 4-slot Gigabit Ethernet PICs can use the Ethernet VPLS encapsulation type.

  NOTE: **The built-in Gigabit Ethernet PIC on an M7i router does not support extended VLAN VPLS encapsulation.**

- **flexible-ethernet-services**—For Gigabit Ethernet IQ interfaces and Gigabit Ethernet PICs with small form-factor pluggable transceivers (SFPs) (except the 10-port Gigabit Ethernet PIC and the built-in Gigabit Ethernet port on the M7i router), use flexible Ethernet services encapsulation when you want to configure multiple per-unit Ethernet encapsulations. Aggregated Ethernet bundles can use this encapsulation type. This encapsulation type allows you to configure any combination of route, TCC, CCC, Layer 2 virtual private networks (VPNs), and VPLS encapsulations on a single physical port. If you configure flexible Ethernet services encapsulation on the physical interface, VLAN IDs from 1 through 511 are no longer reserved for normal VLANs.
- **vlan-vpls**—Use VLAN VPLS encapsulation on Ethernet interfaces with VLAN tagging and VPLS enabled. Interfaces with VLAN VPLS encapsulation accept packets carrying

standard TPID values only. On M Series routers (except the M320 router), the 4-port Fast Ethernet TX PIC and the 1-port, 2-port, and 4-port, 4-slot Gigabit Ethernet PICs can use the Ethernet VPLS encapsulation type.

To configure the encapsulation type for logical interfaces, include the **encapsulation** statement:

```
encapsulation (ether-vpls-over-atm-llc | vlan-vpls);
```

You can include the **encapsulation** statement for logical interfaces at the following hierarchy levels:

- **[edit interfaces *interface-name* unit *number*]**
- **[edit logical-systems logical-system-name interfaces *interface-name* unit *number*]**

You can configure the following logical interface encapsulations for VPLS routing instances:

- **ether-vpls-over-atm-llc**—Use Ethernet VPLS over Asynchronous Transfer Mode (ATM) logical link control (LLC) encapsulation to bridge Ethernet interfaces and ATM interfaces over a VPLS routing instance (as described in RFC 2684, *Multiprotocol Encapsulation over ATM Adaptation Layer 5*). Packets from the ATM interfaces are converted to standard ENET2/802.3-encapsulated Ethernet frames with the frame check sequence (FCS) field removed. This encapsulation type is supported on ATM intelligent queuing (IQ) interfaces only.
- **vlan-vpls**—Use VLAN VPLS encapsulation on Ethernet interfaces with VLAN tagging and VPLS enabled. Interfaces with VLAN VPLS encapsulation accept packets carrying standard TPID values only. On M Series routers (except the M320 router), the 4-port Fast Ethernet TX PIC and the 1-port, 2-port, and 4-port, 4-slot Gigabit Ethernet PICs can use the Ethernet VPLS encapsulation type.

When you configure the physical interface encapsulation as **vlan-vpls**, you also need to configure the same interface encapsulation for the logical interface. You need to configure the **vlan-vpls** encapsulation on the logical interface because the **vlan-vpls** encapsulation allows you to configure a mixed mode, where some of the logical interfaces use regular Ethernet encapsulation (the default for logical interfaces) and some use **vlan-vpls**. For more information, see the *Junos OS Network Interfaces Configuration Guide*.

Enabling VLAN Tagging

The Junos OS supports receiving and forwarding routed Ethernet frames with 802.1Q virtual local area network (VLAN) tags and running Virtual Router Redundancy Protocol (VRRP) over 802.1Q-tagged interfaces. For VPLS to function properly, configure the router to receive and forward frames with 802.1Q VLAN tags by including the **vlan-tagging** statement at the **[edit interfaces *interface-name*]** hierarchy level:

```
[edit interfaces interface-name]
vlan-tagging;
```

Gigabit Ethernet interfaces can be partitioned; you can assign up to 4095 different logical interfaces, one for each VLAN, but you are limited to a maximum of 1024 VLANs on any

single Gigabit Ethernet or 10-Gigabit Ethernet port. Fast Ethernet interfaces can also be partitioned, with a maximum of 1024 logical interfaces for the 4-port FE PIC and 16 logical interfaces for the M40e router. Table 4 on page 45 lists VLAN ID range by interface type.

Table 4: VLAN ID Range by Interface Type

Interface Type	VLAN ID Range
Fast Ethernet	512 through 1023
Gigabit Ethernet	512 through 4094

Configuring VLAN IDs for Logical Interfaces

You can bind a VLAN identifier to a logical interface by including the **vlan-id** statement:

vlan-id *number*;

You can include this statement at the following hierarchy levels:

- **[edit interfaces *interface-name* unit *logical-unit-number*]**
- **[edit logical-systems *logical-system-name* interfaces *interface-name* unit *logical-unit-number*]**

You can also configure a logical interface to forward packets and learn MAC addresses within each VPLS routing instance configured with a VLAN ID that matches a VLAN ID specified in a list using the **vlan-id-list** statement. VLAN IDs can be entered individually using a space to separate each ID, entered as an inclusive list separating the starting VLAN ID and ending VLAN ID with a hyphen, or a combination of both.

For example, to configure the VLAN IDs 20 and 45 and the range of VLAN IDs between 30 and 40, issue the following command from the CLI:

set interfaces ge-1/0/1 unit 1 vlan-id-list [20 30-40 45];

To configure a list of VLAN IDs for a logical interface, include the **vlan-id-list** statement:

vlan-id-list *list-of-vlan-ids*;

You can include this statement at the following hierarchy levels:

- **[edit interfaces *interface-name* unit *logical-unit-number*]**
- **[edit logical-systems *logical-system-name* interfaces *interface-name* unit *logical-unit-number*]**

For more information about how to configure VLANs, see the *Junos OS Network Interfaces Configuration Guide*. For detailed information about how VLAN identifiers in a VPLS routing instance are processed and translated, see the *MX Series Layer 2 Configuration Guide*.

Configuring Aggregated Ethernet 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.

For more information about how aggregated Ethernet interfaces function in the context of VPLS, see "VPLS and Aggregated Ethernet Interfaces" on page 5.

To configure aggregated Ethernet interfaces for VPLS, configure the interface for the VPLS routing instance as follows:

```
interfaces aex {
    vlan-tagging;
    encapsulation encapsulation-type;
    unit logical-unit-number {
        vlan-id number;
    }
}
```

You can configure the following physical link-layer encapsulation types for the VPLS aggregated Ethernet interface:

- **ethernet-vpls**
- **extended-vlan-vpls**
- **flexible-ethernet-services**
- **vlan-vpls**

For the **interface** configuration statement, in **ae*x***, the ***x*** represents the interface instance number to complete the link association; ***x*** can be from 0 through 127, for a total of 128 aggregated interfaces.

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

The aggregated Ethernet interface must also be configured for the VPLS routing instance as shown in the following example:

```
[edit]
routing-instances {
    green {
        instance-type vpls;
        interface ae0.0;
        route-distinguisher 10.255.234.34:1;
        vrf-target target:11111:1;
        protocols {
            vpls {
                site-range 10;
                site green3 {
                    site-identifier 3;
                }
            }
        }
    }
}
```

Interface **ae0.0** represents the aggregated Ethernet interface in the routing instance configuration. The VPLS routing instance configuration is otherwise standard.

Configuring VPLS Load Balancing

By default, when there are multiple equal-cost paths to the same destination for the active route, the Junos OS uses a hash algorithm to select one of the next-hop addresses to install in the forwarding table. Whenever the set of next hops for a destination changes, the next-hop address is reselected using the hash algorithm.

You can configure the Junos OS so that, for the active route, all next-hop addresses for a destination are installed in the forwarding table. This feature is called per-packet load balancing. You can use load balancing to spread traffic across multiple paths between routers. You can also configure per-packet load balancing to optimize VPLS traffic flows across multiple paths.

You can load-balance VPLS traffic based on Layer 2 media access control (MAC) information, IP information and MPLS labels, or MPLS labels only.

NOTE: This feature is not supported on J Series Services Routers or MX Series routers. VPLS load balancing based on IP information and MPLS labels is supported only on the M120 and M320 routers.

To optimize VPLS traffic flows across multiple paths, include the **family multiservice** statement at the **[edit forwarding-options hash-key]** hierarchy level:

```
family multiservice {
    destination-mac;
    label-1;
    label-2;
    payload {
        ip {
            layer-3 {
                (destination-ip-only | source-ip-only);
            }
            layer-3-only;
            layer-4;
        }
    }
    source-mac;
    symetric-hash {
        complement;
    }
}
```

To load-balance based on Layer 2 information, include the following configuration options:

- **destination-mac**—Include the destination MAC address in the hash key used to load-balance the VPLS traffic.
- **source-mac**—Include the source MAC address in the hash key used to load-balance the VPLS traffic.

You can include the source MAC address in the hash key, the destination MAC address, or both.

For IPv4 traffic, only the IP source and destination addresses are included in the hash key. For MPLS and IPv4 traffic, one or two MPLS labels and IPv4 source and destination addresses are included. For MPLS Ethernet pseudowires, only one or two MPLS labels are included in the hash key. Optionally, you can include only Layer 3 information the IPv4 payload in the hash key.

To load-balance based on IP information and MPLS labels, include the following configuration options:

- **label-1**—Include the first MPLS label in the hash key used to load-balance VPLS traffic.
- **label-2**—Include the second MPLS label in the hash key used to load-balance VPLS traffic.
- **payload**—Include bits from the IP payload in the hash key used to load-balance VPLS traffic.
- **ip**—Include the IP address of the IPv4 payload in the hash key used to load-balance VPLS traffic.
- **layer-3-only**—Include only Layer 3 information in the hash key used to load-balance VPLS traffic

For more information about how to configure per-packet load balancing, see the *Junos OS Policy Framework Configuration Guide*.

Configuring VPLS Fast Reroute Priority

When a path is rerouted after a link failure by using the MPLS fast reroute feature, the router repairs the affected next hops by switching them from the active label switched path (LSP) to the standby LSP. To specify the order in which the router repairs next hops and restores traffic convergence for VPLS routing instances after a fast reroute event, you can use the **fast-reroute-priority** statement to configure **high**, **medium**, or **low** fast reroute priority for a VPLS routing instance. By default, the fast reroute priority for a VPLS routing instance is **low**.

The router repairs next hops and restores known unicast, unknown unicast, broadcast, and multicast traffic for VPLS routing instances in the following order, based on the fast reroute priority configuration:

1. The router repairs next hops for high-priority VPLS routing instances.
2. The router repairs next hops for medium-priority VPLS routing instances.
3. The router repairs next hops for low-priority VPLS routing instances.

Because the router repairs next hops for VPLS routing instances configured with **high** fast reroute priority first, the traffic traversing high-priority VPLS instances is restored faster than the traffic for VPLS instances configured with **medium** or **low** fast reroute priority. The ability to prioritize specific VPLS routing instances for faster convergence

and traffic restoration enables service providers to offer differentiated service levels to their customers.

Within a particular fast reroute priority level (**high**, **medium**, or **low**), the router follows no particular order for traffic restoration of VPLS routing instances.

NOTE: VPLS fast reroute priority is not supported on EX Series switches or J Series routers.

To configure **high**, **medium**, or **low** fast reroute priority for a VPLS routing instance, include the **fast-reroute-priority** statement:

```
fast-reroute-priority (high | medium | low);
```

You can include this statement at the following hierarchy levels:

- **[edit logical-systems** *logical-system-name* **routing-instances** *routing-instance-name* **forwarding-options]**
- **[edit routing-instances** *routing-instance-name* **forwarding-options]**

You can configure fast reroute priority only for routing instances with the **instance-type** set to **vpls**. If you attempt to configure fast reroute priority for a routing instance with an **instance-type** other than **vpls**, the router displays a warning message and the configuration fails.

The following example snippet shows configuration of **high** fast reroute priority for a VPLS routing instance named **test-vpls**:

```
test-vpls {
    instance-type vpls;
    forwarding-options {
        fast-reroute-priority high;
    }
}
```

To display the fast reroute priority setting configured for a VPLS routing instance, use the **show route instance detail** operational command. For information about using this command, see the *Junos OS Routing Protocols and Policies Command Reference*.

Configuring VPLS Without a Tunnel Services PIC

VPLS normally uses a dynamic virtual tunnel logical interface on a Tunnel Services PIC to model traffic from a remote site (a site on a remote PE router that is in a VPLS domain). All traffic coming from a remote site is treated as coming in over the virtual port representing this remote site, for the purposes of Ethernet flooding, forwarding, and learning. An MPLS lookup based on the inner VPN label is done on a PE router. The label is stripped and the Layer 2 Ethernet frame contained within is forwarded to a Tunnel Services PIC. The PIC loops back the packet and then a lookup based on Ethernet MAC addresses is completed. This approach requires that the router have a Tunnel Services PIC and that the PE router complete two protocol lookups.

You can configure VPLS without a Tunnel Services PIC by configuring the **no-tunnel-services** statement. This statement creates a label-switched interface (LSI) to provide VPLS functionality. An LSI MPLS label is used as the inner label for VPLS. This label maps to a VPLS routing instance. On the PE router, the LSI label is stripped and then mapped to a logical LSI interface. The Layer 2 Ethernet frame is then forwarded using the LSI interface to the correct VPLS routing instance.

By default, VPLS requires a Tunnel Services PIC. To configure VPLS on a router without a Tunnel Services PIC and create an LSI, include the **no-tunnel-services** statement:

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

For a list of the hierarchy levels at which you can include this statement, see the summary section for this statement.

To configure a VPLS routing instance on a router without a tunnel services PIC, include the **no-tunnel-services** statement at the **[edit routing-instances *routing-instance-name* protocols vpls]** hierarchy level. To configure static VPLS on a router without a tunnel services PIC, include the **no-tunnel-services** statement at the **[edit protocols vpls static-vpls]** hierarchy level.

When you configure VPLS without a Tunnel Services PIC by including the **no-tunnel-services** statement, the following limitations apply:

- An Enhanced FPC is required.
- ATM1 interfaces are not supported.
- Aggregated SONET/SDH interfaces are not supported as core-facing interfaces.
- Channelized interfaces are not supported as core-facing interfaces.
- GRE-encapsulated interfaces are not supported as core-facing interfaces.

Related Documentation

- Configuring Static Pseudowires for VPLS on page 39

Mapping VPLS Traffic to Specific LSPs

You can map VPLS traffic to specific LSPs by configuring forwarding table policies. This procedure is optional but can be useful. The following example illustrates how you can map lower priority VPLS routing instances to slower LSPs while mapping other higher priority VPLS routing instances to faster LSPs. In this example configuration, **a-to-b1** and **a-to-c1** are high-priority LSPs between the PE routers, while **a-to-b2** and **a-to-c2** are low-priority LSPs between the PE routers.

To map VPLS traffic, include the **policy-statement vpls-priority** statement:

```
policy-statement vpls-priority {
    term a {
        from {
            rib mpls.0;
            community company-1;
        }
```

```
        then {
            install-nexthop lsp [ a-to-b1 a-to-c1 ];
            accept;
        }
    }
    term b {
        from {
            rib mpls.0;
            community company-2;
        }
        then {
            install-nexthop lsp-regex [ "^a-to-b2$" "^a-to-c2$" ];
            accept;
        }
    }
}
community company-1 members target:11111:1;
community company-2 members target:11111:2;
```

You can include the **policy-statement vpls-priority** statement at the following hierarchy levels:

- **[edit policy-options]**
- **[edit logical-systems *logical-system-name* policy-options]**

Include the **export** statement to apply the **vpls-priority** policy to the forwarding table:

```
export vpls-priority;
```

You can include this statement at the following hierarchy levels:

- **[edit routing-options forwarding-table]**
- **[edit logical-systems *logical-system-name* routing-options forwarding-table]**

For more information about how to configure routing policies, see the *Junos OS Policy Framework Configuration Guide*.

Configuring Firewall Filters and Policers for VPLS

You can configure both firewall filters and policers for VPLS. Firewall filters allow you to filter packets based on their components and to perform an action on packets that match the filter. Policers allow you to limit the amount of traffic that passes into or out of an interface.

VPLS filters and policers act on a Layer 2 frame that includes the media access control (MAC) header (after any VLAN rewrite or other rules are applied), but does not include the cyclical redundancy check (CRC) field.

You can apply VPLS filters and policers on the PE router to customer-facing interfaces only.

The following sections explain how to configure filters and policers for VPLS:

Configuring a VPLS Filter

To configure a filter for VPLS, include the **filter** statement at the **[edit firewall family vpls]** hierarchy level:

```
[edit firewall family vpls]
filter filter-name {
  interface-specific;
  term term-name {
    from {
      match-conditions;
    }
    then {
      actions;
    }
  }
}
```

For more information about how to configure firewall filters, see the *Junos OS Firewall Filter and Policer Configuration Guide*. For information on how to configure a VPLS filter match condition, see "Standard Firewall Filter Match Conditions for VPLS Traffic" on page 56.

To configure a filter for VPLS traffic, complete the following tasks:

Configuring an Interface-Specific Counter for VPLS

When you configure a firewall filter for VPLS and apply it to multiple interfaces, you can specify individual counters specific to each interface. This allows you to collect separate statistics on the traffic transiting each interface.

To generate an interface-specific counter for VPLS, you configure the **interface-specific** statement. A separate instantiation of the filter is generated. This filter instance has a different name (based on the interface name) and collects statistics on the interface specified only.

To configure interface-specific counters, include the **interface-specific** statement at the **[edit firewall family vpls filter *filter-name*]** hierarchy level:

```
[edit firewall family vpls filter filter-name]
interface-specific;
```

NOTE: The counter name is restricted to 24 bytes. If the renamed counter exceeds this maximum length, it might be rejected.

For more information about the **interface-specific** statement and an example of how to configure it, see the *Junos OS Firewall Filter and Policer Configuration Guide*.

Configuring an Action for the VPLS Filter

You can configure the following actions for a VPLS filter at the **[edit firewall family vpls filter *filter-name* term *term-name* then]** hierarchy level: **accept**, **count**, **discard**, **forwarding-class**, **loss-priority**, **next**, **policer**.

Configuring VPLS FTFs

Forwarding table filters (FTFs) are filters configured for forwarding tables. For VPLS, they are attached to the destination MAC (DMAC) forwarding table of the VPLS routing instance. You define VPLS FTFs in the same manner as any other type of FTF. You can only apply a VPLS FTF as an input filter.

To specify a VPLS FTF, include the **filter input** statement at the **[edit routing-instance *routing-instance-name* forwarding-options family vpls]** hierarchy level:

```
[edit routing-instance routing-instance-name forwarding-options family vpls]
filter input filter-name;
```

For the statement summaries of these statements, see the *Junos OS Policy Framework Configuration Guide*.

Changing Precedence for Spanning-Tree BPDU Packets

Spanning tree BPDU packets are automatically set to a high precedence. The queue number on these packets is set to 3. On M Series routers (except the M320 router) by default, a queue value of 3 indicates high precedence. To enable this higher precedence on BPDU packets, an instance-specific BPDU precedence filter named **default_bpdu_filter** is automatically attached to the VPLS DMAC table. This filter places a high precedence on all packets sent to **01:80:c2:00:00:00/24**.

You can overwrite this filter by configuring a VPLS FTF filter and applying it to the VPLS routing instance. For more information, see "Configuring VPLS FTFs" on page 53 and "Applying a VPLS Filter to a VPLS Routing Instance" on page 54.

Applying a VPLS Filter to an Interface

To apply a VPLS filter to an interface, include the **filter** statement:

```
filter {
    input input-filter-name;
    output output-filter-name;
    group index;
}
```

You can include this statement at the following hierarchy levels:

- **[edit interfaces** *interface-name* **unit** *number* **family vpls]**
- **[edit logical-systems** *logical-system-name* **interfaces** *interface-name* **unit** *number* **family vpls]**

In the **input** statement, list the name of the VPLS filter to be evaluated when packets are received on the interface. In the **output** statement, list the name of the VPLS filter to be evaluated when packets are transmitted on the interface.

NOTE: For output interface filters, MAC addresses are learned after the filter action is completed. When an output interface filter's action is **discard**, the packet is dropped before the MAC address is learned. However, an input interface filter learns the MAC address before discarding the packet.

For the statement summaries for these statements, see the *Junos OS Network Interfaces Configuration Guide*.

Applying a VPLS Filter to a VPLS Routing Instance

You can apply a VPLS filter to a VPLS routing instance. The filter checks traffic passing through the specified routing instance.

Input routing instance filters learn the MAC address before the filter action is completed, so if the filter action is **discard**, the MAC address is learned before the packet is dropped.

To apply a VPLS filter to packets arriving at a VPLS routing instance and specify the filter, include the **filter input** statement at the **[edit routing-instances** *routing-instance-name* **forwarding-options family vpls]** hierarchy level:

```
[edit routing-instances routing-instance-name forwarding-options family vpls]
filter input input-filter-name;
```

Configuring a Filter for Flooded Traffic

You can configure a VPLS filter to filter flooded packets. CE routers typically flood the following types of packets to PE routers in VPLS routing instances:

- Layer 2 broadcast packets
- Layer 2 multicast packets
- Layer 2 unicast packets with an unknown destination MAC address
- Layer 2 packets with a MAC entry in the DMAC routing table

You can configure filters to manage how these flooded packets are distributed to the other PE routers in the VPLS routing instance.

To apply a flooding filter to packets arriving at the PE router in the VPLS routing instance, and specify the filter, include the **flood input** statement:

```
flood input filter-name;
```

You can include this statement at the following hierarchy levels:

- **[edit routing-instances** *routing-instance-name* **forwarding-options family vpls]**
- **[edit logical-systems** *logical-system-name* **routing-instances** *routing-instance-name* **forwarding-options family vpls]**

Configuring a VPLS Policer

You can configure a policer for VPLS traffic. The VPLS policer configuration is similar to the configuration of any other type of policer.

VPLS policers have the following characteristics:

- You cannot police the default VPLS routes stored in the flood table from PE router–sourced flood traffic.
- When specifying policing bandwidth, the VPLS policer considers all Layer 2 bytes in a packet to determine the packet length.

To configure a VPLS policer, include the **policer** statement at the **[edit firewall]** hierarchy level:

```
[edit firewall]
policer policer-name {
    bandwidth-limit limit;
    burst-size-limit limit;
    then action;
}
```

For the statement summaries of these statements and more information about how to configure policers, see the *Junos OS Firewall Filter and Policer Configuration Guide*.

To apply a VPLS policer to an interface, include the **policer** statement:

```
policer {
    input input-policer-name;
    output output-policer-name;
}
```

You can include this statement at the following hierarchy levels:

- **[edit interfaces** *interface-name* **unit** *number* **family vpls]**
- **[edit logical-systems** *logical-system-name* **interfaces** *interface-name* **unit** *number* **family vpls**

In the **input** statement, list the name of the VPLS policer to be evaluated when packets are received on the interface. In the **output** statement, list the name of the VPLS policer to be evaluated when packets are transmitted on the interface. This type of VPLS policer can only apply to unicast packets. For information about how to filter flood packets, see "Configuring a Filter for Flooded Traffic" on page 54.

For the statement summaries for these statements, see the *Junos OS Network Interfaces Configuration Guide*.

Standard Firewall Filter Match Conditions for VPLS Traffic

In the **from** statement in the VPLS filter term, you specify conditions that the packet must match for the action in the **then** statement to be taken. All conditions in the **from** statement must match for the action to be taken. The order in which you specify match conditions is not important, because a packet must match all the conditions in a term for a match to occur.

If you specify no match conditions in a term, that term matches all packets.

An individual condition in a **from** statement can contain a list of values. For example, you can specify numeric ranges. You can also specify multiple source addresses or destination addresses. When a condition defines a list of values, a match occurs if one of the values in the list matches the packet.

Individual conditions in a **from** statement can be negated. When you negate a condition, you are defining an explicit mismatch. For example, the negated match condition for **forwarding-class** is **forwarding-class-except**. If a packet matches a negated condition, it is immediately considered not to match the **from** statement, and the next term in the filter is evaluated, if there is one. If there are no more terms, the packet is discarded.

You can configure a standard firewall filter with match conditions for Virtual Private LAN Service (VPLS) traffic (**family vpls**). Table 5 on page 56 describes the ***match-conditions*** you can configure at the **[edit firewall family vpls filter *filter-name* term *term-name* from]** hierarchy level.

NOTE: Not all match conditions for VPLS traffic are supported on all routing platforms. A number of match conditions for VPLS traffic are supported only on MX Series 3D Universal Edge Routers.

Table 5: Standard Firewall Filter Match Conditions for VPLS Traffic

Match Condition	Description
destination-mac-address ***address***	Match the destination media access control (MAC) address of a VPLS packet.

Table 5: Standard Firewall Filter Match Conditions for VPLS Traffic *(continued)*

Match Condition	Description
destination-port *number*	(MX Series routers only) Match the UDP or TCP destination port field. You cannot specify both the **port** and **destination-port** match conditions in the same term. In place of the numeric value, you can specify one of the following text synonyms (the port numbers are also listed): **afs** (1483), **bgp** (179), **biff** (512), **bootpc** (68), **bootps** (67), **cmd** (514), **cvspserver** (2401), **dhcp** (67), **domain** (53), **eklogin** (2105), **ekshell** (2106), **exec** (512), **finger** (79), **ftp** (21), **ftp-data** (20), **http** (80), **https** (443), **ident** (113), **imap** (143), **kerberos-sec** (88), **klogin** (543), **kpasswd** (761), **krb-prop** (754), **krbupdate** (760), **kshell** (544), **ldap** (389), **ldp** (646), **login** (513), **mobileip-agent** (434), **mobilip-mn** (435), **msdp** (639), **netbios-dgm** (138), **netbios-ns** (137), **netbios-ssn** (139), **nfsd** (2049), **nntp** (119), **ntalk** (518), **ntp** (123), **pop3** (110), **pptp** (1723), **printer** (515), **radacct** (1813), **radius** (1812), **rip** (520), **rkinit** (2108), **smtp** (25), **snmp** (161), **snmptrap** (162), **snpp** (444), **socks** (1080), **ssh** (22), **sunrpc** (111), **syslog** (514), **tacacs** (49), **tacacs-ds** (65), **talk** (517), **telnet** (23), **tftp** (69), **timed** (525), **who** (513), or **xdmcp** (177).
destination-port-except *number*	(MX Series routers only) Do not match on the TCP or UDP destination port field. You cannot specify both the **port** and **destination-port** match conditions in the same term.
destination-prefix-list *name*	(MX Series routers only) Match destination prefixes in the specified list. Specify the name of a prefix list defined at the **[edit policy-options prefix-list** *prefix-list-name*] hierarchy level. NOTE: VPLS prefix lists support only IPv4 addresses. IPv6 addresses included in a VPLS prefix list will be discarded.
destination-prefix-list *name* **except**	(MX Series routers only) Do not match destination prefixes in the specified list. For more information, see the **destination-prefix-list** match condition.
dscp *number*	(MX Series routers only) Match the Differentiated Services code point (DSCP). The DiffServ protocol uses the type-of-service (ToS) byte in the IP header. The most significant 6 bits of this byte form the DSCP. For more information, see the *Junos OS Class of Service Configuration Guide*. You can specify a numeric value from **0** through **63**. To specify the value in hexadecimal form, include **0x** as a prefix. To specify the value in binary form, include **b** as a prefix. In place of the numeric value, you can specify one of the following text synonyms (the field values are also listed): • RFC 3246, *An Expedited Forwarding PHB (Per-Hop Behavior)*, defines one code point: **ef** (46). • RFC 2597, *Assured Forwarding PHB Group*, defines 4 classes, with 3 drop precedences in each class, for a total of 12 code points: **af11** (10), **af12** (12), **af13** (14), **af21** (18), **af22** (20), **af23** (22), **af31** (26), **af32** (28), **af33** (30), **af41** (34), **af42** (36), **af43** (38)
dscp-except *number*	(MX Series routers only) Do not match on the DSCP. For details, see the **dscp** match condition.

Table 5: Standard Firewall Filter Match Conditions for VPLS Traffic *(continued)*

Match Condition	Description
ether-type *values*	Match the 2-octet IEEE 802.3 Length/EtherType field to the specified value or list of values. You can specify decimal or hexadecimal values from 0 through 65535 (0xFFFF). A value from 0 through 1500 (0x05DC) specifies the length of an Ethernet Version 1 frame. A value from 1536 (0x0600) through 65535 specifies the EtherType (nature of the MAC client protocol) of an Ethernet Version 2 frame. In place of the numeric value, you can specify one of the following text synonyms (the hexadecimal values are also listed): **aarp** (0x80F3), **appletalk** (0x809B), **arp** (0x0806), **ipv4** (0x0800), **ipv6** (0x86DD), **mpls-multicast** (0x8848), **mpls-unicast** (0x8847), **oam** (0x8902), **ppp** (0x880B), **pppoe-discovery** (0x8863), **pppoe-session** (0x8864), or **sna** (0x80D5).
ether-type-except *values*	Do not match the 2-octet Length/EtherType field to the specified value or list of values. For details about specifying the ***values***, see the **ether-type** match condition.
forwarding-class *class*	Match the forwarding class. Specify **assured-forwarding**, **best-effort**, **expedited-forwarding**, or **network-control**.
forwarding-class-except *class*	Do not match the forwarding class. For details, see the **forwarding-class** match condition.
icmp-code *message-code*	Match the ICMP message code field. If you configure this match condition, we recommend that you also configure the **next-header icmp** or **next-header icmp6** match condition in the same term. If you configure this match condition, you must also configure the **icmp-type** *message-type* match condition in the same term. An ICMP message code provides more specific information than an ICMP message type, but the meaning of an ICMP message code is dependent on the associated ICMP message type. In place of the numeric value, you can specify one of the following text synonyms (the field values are also listed). The keywords are grouped by the ICMP type with which they are associated: • parameter-problem: **ip6-header-bad** (0), **unrecognized-next-header** (1), **unrecognized-option** (2) • time-exceeded: **ttl-eq-zero-during-reassembly** (1), **ttl-eq-zero-during-transit** (0) • destination-unreachable: **address-unreachable** (3), **administratively-prohibited** (1), **no-route-to-destination** (0), **port-unreachable** (4)
icmp-code-except *message-code*	Do not match the ICMP message code field. For details, see the **icmp-code** match condition.

Table 5: Standard Firewall Filter Match Conditions for VPLS Traffic *(continued)*

Match Condition	Description
icmp-code *number*	(MX Series routers only) Match the ICMP message code field. If you configure this match condition, we recommend that you also configure the **ip-protocol icmp** or **ip-protocol icmp6** match condition in the same term. If you configure this match condition, you must also configure the **icmp-type** *message-type* match condition in the same term. An ICMP message code provides more specific information than an ICMP message type, but the meaning of an ICMP message code is dependent on the associated ICMP message type. In place of the numeric value, you can specify one of the following text synonyms (the field values are also listed). The keywords are grouped by the ICMP type with which they are associated: • parameter-problem: **ip6-header-bad** (0), **unrecognized-next-header** (1), **unrecognized-option** (2) • time-exceeded: **ttl-eq-zero-during-reassembly** (1), **ttl-eq-zero-during-transit** (0) • destination-unreachable: **address-unreachable** (3), **administratively-prohibited** (1), **no-route-to-destination** (0), **port-unreachable** (4)
icmp-code-except *number*	(MX Series routers only) Do not match on the ICMP code field. For details, see the **icmp-code** match condition.
icmp-type *number*	(MX Series routers only) Match the ICMP message type field. If you configure this match condition, we recommend that you also configure the **ip-protocol icmp**, **ip-protocol icmp6**, or **ip-protocol icmpv6** match condition in the same term. In place of the numeric value, you can specify one of the following text synonyms (the field values are also listed): **destination-unreachable** (1), **echo-reply** (129), **echo-request** (128), **membership-query** (130), **membership-report** (131), **membership-termination** (132), **neighbor-advertisement** (136), **neighbor-solicit** (135), **node-information-reply** (140), **node-information-request** (139), **packet-too-big** (2), **parameter-problem** (4), **redirect** (137), **router-advertisement** (134), **router-renumbering** (138), **router-solicit** (133), or **time-exceeded** (3).
icmp-type-except *number*	(MX Series routers only) Do not match the ICMP message type field. For details, see the **icmp-type** match condition.
interface *interface-name*	Interface on which the packet was received. You can configure a match condition that matches packets based on the interface on which they were received. NOTE: If you configure this match condition with an interface that does not exist, the term does not match any packet.
interface-group *group-number*	Match the logical interface on which the packet was received to the specified interface group or set of interface groups. For ***group-number***, specify a single value or a range of values from **0** through **255**. To assign a logical interface to an interface group ***group-number***, specify the ***group-number*** at the **[interfaces** *interface-name* **unit** *number* **family** *family* **filter group]** hierarchy level. For more information, see Filtering Packets Received on a Set of Interface Groups Overview. NOTE: This match condition is not supported on T4000 Type 5 FPCs.

Table 5: Standard Firewall Filter Match Conditions for VPLS Traffic *(continued)*

Match Condition	Description
interface-group-except *group-name*	Do not match the logical interface on which the packet was received to the specified interface group or set of interface groups. For details, see the **interface-group** match condition. NOTE: This match condition is not supported on T4000 Type 5 FPCs.
interface-set *interface-set-name*	Match the interface on which the packet was received to the specified interface set. To define an interface set, include the **interface-set** statement at the **[edit firewall]** hierarchy level. For more information, see Filtering Packets Received on an Interface Set Overview.
ip-address *address*	(MX Series routers only) 32-bit address that supports the standard syntax for IPv4 addresses.
ip-destination-address *address*	(MX Series routers only) 32-bit address that is the final destination node address for the packet.
ip-precedence *ip-precedence-field*	(MX Series routers only) IP precedence field. In place of the numeric field value, you can specify one of the following text synonyms (the field values are also listed): **critical-ecp** (0xa0), **flash** (0x60), **flash-override** (0x80), **immediate** (0x40), **internet-control** (0xc0), **net-control** (0xe0), **priority** (0x20), or **routine** (0x00).
ip-precedence-except *ip-precedence-field*	(MX Series routers only) Do not match on the IP precedence field.
ip-protocol *number*	(MX Series routers only) IP protocol field.
ip-protocol-except *number*	(MX Series routers only) Do not match on the IP protocol field.
ip-source-address *address*	(MX Series routers only) IP address of the source node sending the packet.
learn-vlan-1p-priority *number*	(MX Series routers only) Match on the IEEE 802.1p learned VLAN priority bits in the provider VLAN tag (the only tag in a single-tag frame with 802.1Q VLAN tags or the outer tag in a dual-tag frame with 802.1Q VLAN tags). Specify a single value or multiple values from **0** through **7**. Compare with the **user-vlan-1p-priority** match condition.
learn-vlan-1p-priority-except *number*	(MX Series routers only) Do not match on the IEEE 802.1p learned VLAN priority bits. For details, see the **learn-vlan-1p-priority** match condition.
learn-vlan-id *number*	(MX Series routers only) VLAN identifier used for MAC learning.
learn-vlan-id-except *number*	(MX Series routers only) Do not match on the VLAN identifier used for MAC learning.

Table 5: Standard Firewall Filter Match Conditions for VPLS Traffic *(continued)*

Match Condition	Description
loss-priority *level*	Packet loss priority (PLP) level. Specify a single level or multiple levels: **low**, **medium-low**, **medium-high**, or **high**. Supported on M120 and M320 routers; M7i and M10i routers with the Enhanced CFEB (CFEB-E); and MX Series routers. For IP traffic on M320, MX Series, and T Series routers with Enhanced II Flexible PIC Concentrators (FPCs), you must include the **tri-color** statement at the **[edit class-of-service]** hierarchy level to commit a PLP configuration with any of the four levels specified. If the **tri-color** statement is not enabled, you can only configure the **high** and **low** levels. This applies to all protocol families. For information about the **tri-color** statement and about using behavior aggregate (BA) classifiers to set the PLP level of incoming packets, see the *Junos OS Class of Service Configuration Guide*.
loss-priority-except *level*	Do not match on the packet loss priority level. Specify a single level or multiple levels: **low**, **medium-low**, **medium-high**, or **high**. For information about using behavior aggregate (BA) classifiers to set the PLP level of incoming packets, see the *Junos OS Class of Service Configuration Guide*.
port *number*	(MX Series routers only) TCP or UDP source or destination port. You cannot specify both the **port** match condition and either the **destination-port** or **source-port** match condition in the same term.
port-except *number*	(MX Series routers only) Do not match on the TCP or UDP source or destination port. You cannot specify both the **port** match condition and either the **destination-port** or **source-port** match condition in the same term.
prefix-list *name*	(MX Series routers only) Match the destination or source prefixes in the specified list. Specify the name of a prefix list defined at the **[edit policy-options prefix-list** *prefix-list-name*] hierarchy level. NOTE: VPLS prefix lists support only IPV4 addresses. IPV6 addresses included in a VPLS prefix list will be discarded.
prefix-list *name* **except**	(MX Series routers only) Do not match the destination or source prefixes in the specified list. For more information, see the **destination-prefix-list** match condition.
source-mac-address *address*	Source MAC address of a VPLS packet.
source-port *number*	(MX Series routers only) TCP or UDP source port field. You cannot specify the **port** and **source-port** match conditions in the same term.
source-port-except *number*	(MX Series routers only) Do not match on the TCP or UDP source port field. You cannot specify the **port** and **source-port** match conditions in the same term.
source-prefix-list *name*	(MX Series routers only) Match the source prefixes in the specified prefix list. Specify a prefix list name defined at the **[edit policy-options prefix-list** *prefix-list-name***]** hierarchy level. NOTE: VPLS prefix lists support only IPV4 addresses. IPV6 addresses included in a VPLS prefix list will be discarded.

Table 5: Standard Firewall Filter Match Conditions for VPLS Traffic *(continued)*

Match Condition	Description
source-prefix-list *name* **except**	(MX Series routers only) Do not match the source prefixes in the specified prefix list. For more information, see the **source-prefix-list** match condition.
tcp-flags *flags*	Match one or more of the low-order 6 bits in the 8-bit TCP flags field in the TCP header. To specify individual bit fields, you can specify the following text synonyms or hexadecimal values: • **fin** (0x01) • **syn** (0x02) • **rst** (0x04) • **push** (0x08) • **ack** (0x10) • **urgent** (0x20) In a TCP session, the SYN flag is set only in the initial packet sent, while the ACK flag is set in all packets sent after the initial packet. You can string together multiple flags using the bit-field logical operators. If you configure this match condition for IPv6 traffic, we recommend that you also configure the **next-header tcp** match condition in the same term to specify that the TCP protocol is being used on the port.
traffic-type *type-name*	(MX Series routers only) Traffic type. Specify **broadcast**, **multicast**, **unknown-unicast**, or **known-unicast**.
traffic-type-except *type-name*	(MX Series routers only) Do not match on the traffic type. Specify **broadcast**, **multicast**, **unknown-unicast**, or **known-unicast**.
user-vlan-1p-priority *number*	(MX Series routers only) Match on the IEEE 802.1p user priority bits in the customer VLAN tag (the inner tag in a dual-tag frame with 802.1Q VLAN tags). Specify a single value or multiple values from **0** through **7**. Compare with the **learn-vlan-1p-priority** match condition.
user-vlan-1p-priority-except *number*	(MX Series routers only) Do not match on the IEEE 802.1p user priority bits. For details, see the **user-vlan-1p-priority** match condition.
user-vlan-id *number*	(MX Series routers only) Match the first VLAN identifier that is part of the payload.
user-vlan-id-except *number*	(MX Series routers only) Do not match on the first VLAN identifier that is part of the payload.
vlan-ether-type *value*	VLAN Ethernet type field of a VPLS packet.
vlan-ether-type-except *value*	Do not match on the VLAN Ethernet type field of a VPLS packet.

Related Documentation

- Guidelines for Configuring Standard Firewall Filters
- Standard Firewall Filter Terminating Actions

- Standard Firewall Filter Nonterminating Actions

Specifying the VT Interfaces Used by VPLS Routing Instances

By default, the Junos OS automatically selects one of the virtual tunnel (VT) interfaces available to the router for de-encapsulating traffic from a remote site. The Junos OS cycles through the currently available VT interfaces, regularly updating the list of available VT interfaces as new remote sites are discovered and new connections are brought up. However, you can also explicitly configure which VT interfaces will receive the VPLS traffic.

By including the **tunnel-services** statement at the **[edit routing-instances *routing-instance-name* protocols vpls]** hierarchy level, you can specify that traffic for particular VPLS routing instances be forwarded to specific VT interfaces. Doing so allows you to load-balance VPLS traffic among all the available VT interfaces on the router.

The **tunnel-services** statement includes the following options:

- **devices**—Specifies the VT interfaces acceptable for use by the VPLS routing instance. If you do not configure this option, all VT interfaces available to the router can be used for de-encapsulating traffic for this instance.
- **primary**—Specifies the primary VT interface to be used by the VPLS routing instance. The VT interface specified is used to de-encapsulate all VPLS traffic from the MPLS core network for this routing instance. If the VT interface specified is unavailable, then one of the other acceptable VT interfaces (specified in the devices option) is used for handling the VPLS traffic. If you do not configure this option, any acceptable VT interface can be used to de-encapsulate VPLS traffic from the core.

To specify that traffic for a particular VPLS routing instance be forwarded to specific VT interfaces, include the **tunnel-services** statement:

```
tunnel-services {
    devices device-names;
    primary primary-device-name;
}
```

These statements can be configured at the following hierarchy levels:

- **[edit routing-instances *routing-instance-name* protocols vpls]**
- **[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls]**

Configuring VPLS Multihoming

VPLS multihoming allows you to connect a customer site to multiple PE routers to provide redundant connectivity while preventing the formation of Layer 2 loops in the service provider's network. A VPLS site multihomed to two or more PE routers provides redundant connectivity in the event of a PE router-to-CE device link failure or the failure of a PE

router. For more information about VPLS multihoming, see "VPLS Multihoming Overview" on page 7.

NOTE: If you want to enable multihoming for a VPLS routing instance, you cannot also enable LDP signaling. You can only enable BGP signaling.

The following sections describe how to configure VPLS multihoming. Some information is also provided on single-homed site configuration versus multihomed site configuration.

VPLS Multihomed Site Configuration

The following describes the requirements for a VPLS multihomed site configuration:

- Assign the same site ID on all PE routers connected to the same CE devices.
- Assign the same route distinguisher on all PE routers connected to the same CE devices.
- Reference all interfaces assigned to the multihomed VPLS site on each PE router. Only one of these interfaces is used to send and receive traffic for this site at a time.
- Either designate a primary interface or allow the router to select the interface to be used as the primary interface.

  If the router selects the interface, the interface used to connect the PE router to the site depends on the order in which interfaces are listed in the PE router's configuration. The first operational interface in the set of configured interfaces is chosen to be the designated interface. If this interface fails, the next interface in the list is selected to send and receive traffic for the site.
- Configure multihoming for the site.

The following configuration shows the statements you need to configure to enable VPLS multihoming:

```
[edit routing-instances routing-instance-name]
instance-type vpls;
interface interface-name;
interface interface-name;
protocols vpls {
  site site-name {
    active-interface {
      any;
      primary interface-name;
    }
    interface interface-name;
    interface interface-name;
    multi-homing;
    site-identifier number;
  }
}
route-distinguisher (as-number:id | ip-address:id);
```

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

Most of these statements are explained in more detail in the rest of this chapter. The following sections explain how to configure the statements that are specific to VPLS multihoming:

- Specifying an Interface as the Active Interface on page 65
- Configuring Multihoming on the PE Router on page 65

Specifying an Interface as the Active Interface

You need to specify one of the interfaces for the multihomed site as the primary interface. If there are multiple interfaces, the remaining interfaces are activated only when the primary interface goes down. If no active interfaces are configured at the site level, all traffic for a VPLS site travels through a single, non-multihomed PE router.

You must configure one of the following options for the **active-interface** statement:

- **any**—One configured interface is randomly designated as the active interface for the VPLS site.
- **primary**—Specify the name of the multihomed interface to be used as the primary interface by the VPLS site.

To specify a multihomed interface as the primary interface for the VPLS site, include the **active-interface** statement:

```
active-interface {
  any;
  primary interface-name;
}
```

You can include this statement at the following hierarchy levels:

- **[edit routing-instances *routing-instance-name* protocols vpls site *site-name*]**
- **[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls site *site-name*]**

Configuring Multihoming on the PE Router

When a CE device is connected to the same VPLS site on more than one PE router, include the **multi-homing** statement on all associated PE routers. Configuration of this statement tracks BGP peers. If no BGP peer is available, VPLS deactivates all active interfaces for a site. To specify that the PE router is part of a multihomed VPLS site, include the **multi-homing** statement:

```
multi-homing;
```

You can include this statement at the following hierarchy levels:

- **[edit routing-instances *routing-instance-name* protocols vpls site *site-name*]**
- **[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls site *site-name*]**

Include the **multi-homing** statement on all PE routers associated with a particular VPLS site.

VPLS Single-Homed Site Configuration

All VPLS single-homed sites are connected to the same default VE device. All interfaces in a VPLS routing instance that are not configured as part of a multihomed site are assumed to be single-homed to the default VE device.

Flooding Unknown Traffic Using Point-to-Multipoint LSPs

For a VPLS routing instance, you can flood unknown unicast, broadcast, and multicast traffic using point-to-multipoint (also called *P2MP*) LSPs. By default, VPLS relies upon ingress replication to flood unknown traffic to the members of a VPLS routing instance. This can cause replication of data at routing nodes shared by multiple VPLS members, as shown in Figure 6 on page 66. The flood data is tripled between PE router PE1 and provider router P1 and doubled between provider routers P1 and P2. By configuring point-to-multipoint LSPs to handle flood traffic, the VPLS routing instance can avoid this type of traffic replication in the network, as shown in Figure 7 on page 66.

Figure 6: Flooding Unknown VPLS Traffic Using Ingress Replication

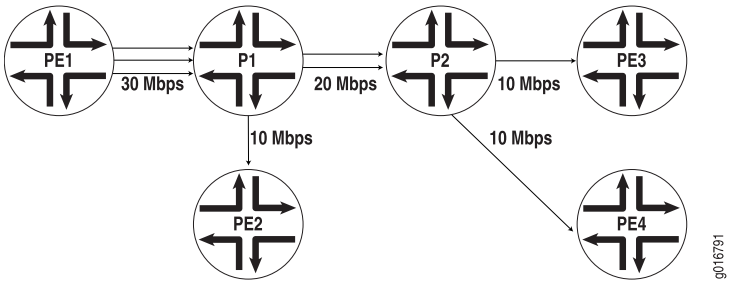
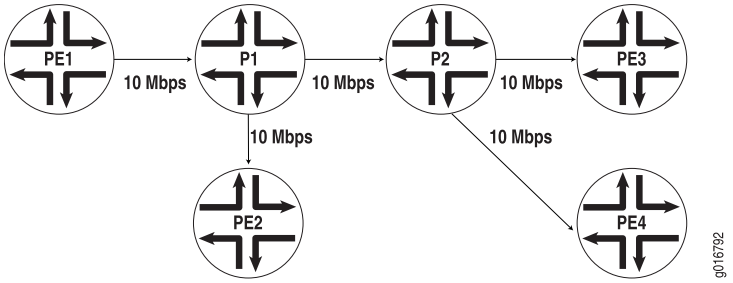


Figure 7: Flooding Unknown VPLS Traffic Using a Point-to-Multipoint LSP



The point-to-multipoint LSP used for VPLS flooding can be either static or dynamic. In either case, for each VPLS routing instance, the PE router creates a dedicated point-to-multipoint LSP. All of the neighbors of the VPLS routing instance are added to

the point-to-multipoint LSP when the feature is enabled. If there are *n* PE routers in the VPLS routing instance, *n* point-to-multipoint LSPs are created in the network where each PE router is the root of the point-to-multipoint tree and includes the rest of the *n – 1* PE routers as leaf nodes. If you configured static point-to-multipoint LSPs for flooding, any additional VPLS neighbors added to the routing instance later are not automatically added to the point-to-multipoint LSP. You will need to manually add the new VPLS neighbors to the static point-to-multipoint flooding LSP. If you configure dynamic point-to-multipoint LSPs, whenever VPLS discovers a new neighbor through BGP, a sub-LSP for this neighbor is added to the point-to-multipoint LSP for the routing instance.

This feature can be enabled incrementally on any PE router that is part of a specific VPLS routing instance. The PE routers can then use point-to-multipoint LSPs to flood traffic, whereas other PE routers in the same VPLS routing instance can still use ingress replication to flood traffic. However, when this feature is enabled on any PE router, you must ensure that all PE routers in the VPLS routing instance that participate in the flooding of traffic over point-to-multipoint LSPs are upgraded to Junos OS Release 8.3 or later to support this feature.

To flood unknown unicast, broadcast, and multicast traffic using point-to-multipoint LSPs, configure the **rsvp-te** statement as follows:

```
rsvp-te {
  label-switched-path-template {
    (default-template | lsp-template-name);
  }
  static-lsp lsp-name;
}
```

You can include this statement at the following hierarchy levels:

- **[edit routing-instance *routing-instance-name* provider-tunnel]**
- **[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* provider-tunnel]**

You can configure either a static point-to-multipoint LSP for VPLS flooding or a dynamic point-to-multipoint LSP.

NOTE: **You cannot specify both the static and label-switched-path-template statements at the same time.**

The following sections describe how to configure static and dynamic point-to-multipoint LSPs for flooding unknown traffic in a VPLS routing instance:

- Configuring Static Point-to-Multipoint Flooding LSPs on page 67
- Configuring Dynamic Point-to-Multipoint Flooding LSPs on page 68

Configuring Static Point-to-Multipoint Flooding LSPs

The **static-lsp** option creates a static flooding point-to-multipoint LSP that includes all of the neighbors in the VPLS routing instance. Flood traffic is sent to all of the VPLS

neighbors using the generated point-to-multipoint LSP. VPLS neighbors added to the routing instance later are not automatically added to the point-to-multipoint LSP. You will need to manually add the new VPLS neighbors to the static point-to-multipoint flooding LSP. By configuring static point-to-multipoint LSPs for flooding, you have more control over which path each sub-LSP follows.

To configure a static flooding point-to-multipoint LSP, specify the name of the static flooding point-to-multipoint LSP by including the **static-lsp** statement:

```
static-lsp lsp-name;
```

You can include this statement at the following hierarchy levels:

- **[edit routing-instances *routing-instance-name* provider-tunnel rsvp-te]**
- **[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* provider-tunnel rsvp-te]**

Configuring Dynamic Point-to-Multipoint Flooding LSPs

To configure a dynamic point-to-multipoint flooding LSP, include the **label-switched-path-template** statement option at the **[edit routing-instances *routing-instance-name* provider-tunnel rsvp-te]** hierarchy level:

```
[edit routing-instances routing-instance-name provider-tunnel rsvp-te]
label-switched-path-template {
   (default-template | lsp-template-name);
}
```

You can automatically generate the point-to-multipoint LSP to be used for flooding unknown traffic or you can manually configure the point-to-multipoint LSP:

- Configuring Dynamic Point-to-Multipoint Flooding LSPs with the Default Template on page 68
- Configuring Dynamic Point-to-Multipoint Flooding LSPs with a Preconfigured Template on page 69

Configuring Dynamic Point-to-Multipoint Flooding LSPs with the Default Template

The **default-template** option, specified at the **[edit routing-instances *routing-instance-name* provider-tunnel rsvp-te label-switched-path-template]** hierarchy level, causes the point-to-multipoint LSPs to be created with default parameters. The default parameters are for a minimally configured point-to-multipoint LSP. The name of this point-to-multipoint LSP is also generated automatically and is based on the following model:

id*:vpls:*router-id*:*routing-instance-name

The following **show** command output for **show mpls lsp p2mp** illustrates how a point-to-multipoint flood LSP name could appear if you configure the **label-switched-path-template** statement with the **default-template** option:

```
user@host> show mpls lsp p2mp ingress
```

```
Ingress LSP: 2 sessions P2MP name: static, P2MP branch count: 3
To              From            State Rt ActivePath       P     LSPname
10.255.14.181   10.255.14.172   Up     0                  *     vpn02-vpn11
10.255.14.177   10.255.14.172   Up     0 path2            *     vpn02-vpn07
10.255.14.174   10.255.14.172   Up     0 path3            *     vpn02-vpn04
P2MP name: 9:vpls:10.255.14.172:green, P2MP branch count: 2
To              From            State Rt ActivePath       P     LSPname
10.255.14.177   10.255.14.172   Up     0                  *
11:vpls:10.255.14.172:green
10.255.14.174   10.255.14.172   Up     0                  *
10:vpls:10.255.14.172:green
Total 5 displayed, Up 5, Down 0
```

The dynamically generated point-to-multipoint LSP name is **9:vpls:10.255.14.172:green**.

Configuring Dynamic Point-to-Multipoint Flooding LSPs with a Preconfigured Template

You can configure a point-to-multipoint flooding LSP template for the VPLS routing instance. The template allows you to specify the properties of the dynamic point-to-multipoint LSPs that are used to flood traffic for the VPLS routing instance. You can specify all of the standard options available for a point-to-multipoint LSP within this template. These properties are inherited by the dynamic point-to-multipoint flood LSPs.

To configure a point-to-multipoint LSP template for flooding VPLS traffic, specify all of the properties you want to include in a point-to-multipoint LSP configuration. To specify this LSP as a point-to-multipoint flooding template, include the **p2mp** and **template** statements:

```
p2mp;
template;
```

You can include these statements at the following hierarchy levels:

- **[edit protocols mpls label-switched-path *p2mp-lsp-template-name*]**
- **[edit logical-systems *logical-system-name* protocols mpls label-switched-path *p2mp-lsp-template-name*]**

For more information about how to configure the **p2mp** statement and point-to-multipoint LSPs, see the *Junos OS MPLS Applications Configuration Guide*.

Once you have configured the point-to-multipoint LSP template, specify the name of the point-to-multipoint LSP template with the **label-switched-path-template** statement:

```
label-switched-path-template p2mp-lsp-template-name;
```

You can include this statement at the following hierarchy levels:

- **[edit routing-instances *routing-instance-name* provider-tunnel rsvp-te]**
- **[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* provider-tunnel rsvp-te]**

Configuring VPLS and Integrated Routing and Bridging

Traditional Layer 2 switching environments consist of Layer 2 devices (such as switches) that partition data into broadcast domains. The broadcast domains can be created through physical topologies or logically through virtual local area networks (VLANs). For MX Series routers, you can logically configure broadcast domains within virtual switch routing instances, VPLS routing instances, or bridging domains. The individual routing instances or bridging domains are differentiated through VLAN identifiers and these instances or domains function much like traditional VLANs.

For detailed information and configuration instructions on bridging domains and spanning tree protocol, see the *Junos OS Network Interfaces Configuration Guide*, the *Junos OS Routing Protocols Configuration Guide*, and the *Junos OS Feature Guides*.

The following sections provide configuration information specific to VPLS in regards to integrated routing and bridging:

Configuring MAC Address Flooding and Learning for VPLS

In a VPLS routing instance or bridge domain, when a frame is received from a CE interface, it is flooded to the other CE interfaces and all of the VE interfaces if the destination MAC address is not learned or if the frame is either broadcast or multicast. If the destination MAC address is learned on another CE device, such a frame is unicasted to the CE interface on which the MAC address is learned. This might not be desirable if the service provider does not want CE devices to communicate with each other directly.

To prevent CE devices from communicating directly include the **no-local-switching** statement at the **[edit bridge-domains *bridge-domain-name*]** hierarchy level:

```
[edit bridge-domains bridge-domain-name]
no-local-switching;
```

The **no-local-switching** statement is available only on MX Series routers. If you include it, frames arriving on a CE interface are sent to VE or core-facing interfaces only.

Configuring MSTP for VPLS

When you configure integrated routing and bridging, you might also need to configure the Multiple Spanning Tree Protocol (MSTP). When you configure MSTP on a provider edge (PE) router running VPLS, you must also configure **ethernet-vpls** encapsulation on the customer-facing interfaces. VLAN-based VPLS interface encapsulations are not supported with MSTP.

Configuring Interoperability Between BGP Signaling and LDP Signaling in VPLS

A single VPLS routing instance can encompass one set of PE routers that use BGP for signaling and another set of PE routers that use LDP for signaling. Within each set, all of the PE routers are fully meshed in both the control and data planes and have a

bidirectional pseudowire to each of the other routers in the set. However, the BGP-signaled routers cannot be directly connected to the LDP-signaled routers. To be able to manage the two separate sets of PE routers in a single VPLS routing instance, a border PE router must be configured to interconnect the two sets of routers.

The VPLS RFCs and Internet drafts require that all of the PE routers participating in a single VPLS routing instance must be fully meshed in the data plane. In the control plane, each fully meshed set of PE routers in a VPLS routing instance is called a PE router mesh group. The border PE router must be reachable by and have bidirectional pseudowires to all of the PE routers that are a part of the VPLS routing instance, both the LDP-signaled and BGP-signaled routers.

For LDP BGP interworking to function, LDP-signaled routers can be configured with forwarding equivalence class (FEC) 128 or FEC 129.

The following sections describe how to configure BGP LDP interworking for VPLS:

LDP BGP Interworking Platform Support

LDP BGP interworking is supported on the following Juniper Networks routers and routing platforms:

- M7i
- M10i
- M40e
- M120
- M320
- MX Series routers
- T Series routers
- TX Matrix routers

Configuring FEC 128 VPLS Mesh Groups for LDP BGP Interworking

To configure FEC 128 LDP BGP interworking for VPLS, include the **mesh-group** statement in the VPLS routing instance configuration of the PE border router:

```
mesh-group mesh-group-name {
  local-switching;
  mac-flush [ explicit-mac-flush-message-options ];
```

```
    neighbor address;
    peer-as all;
    vpls-id number;
}
```

You can include this statement at the following hierarchy levels:

- **[edit routing-instances *routing-instance-name* protocols vpls]**
- **[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls]**

Using the **neighbor** statement, configure each PE router that is a part of the mesh group. You must separate the LDP-signaled routers and the BGP-signaled routers into their own respective mesh groups. The LDP-signaled routers can be divided into multiple mesh groups. The BGP-signaled routers must be configured within a single mesh group for each routing instance.

Configuring FEC 129 VPLS Mesh Groups for LDP BGP Interworking

Configuration for a mesh group for FEC 129 is very similiar to the configuration for FEC 128.

Note the following differences for FEC 129:

- Each user-defined mesh group must have a unique route distinguisher. Do not use the route distinguisher that is defined for the default mesh group at the **[edit routing-intances]** hierarchy level.
- Each user-defined mesh group must have its own import and export route target.
- Each user-defined mesh group can have a unique Layer 2 VPN ID. By default, all the mesh groups that are configured for the a VPLS routing-instance use the same Layer 2 VPN ID, the one that you configure at the **[edit routing-instances]** hierarchy level.

Configuring Switching Between Pseudowires Using VPLS Mesh Groups

To configure switching between Layer 2 circuit pseudowires using VPLS mesh groups, you can do either of the following:

- Configure a mesh group for each Layer 2 circuit pseudowire terminating at a VPLS routing instance. The Junos OS can support up to 16 mesh groups on MX Series routers and up to 128 on M Series and T Series routers. However, two mesh groups are created by default, one for the CE routers and one for the PE routers. Therefore, the maximum number of user-defined mesh groups is 14 for MX Series routers and 126 for M Series and T Series routers. PE router mesh groups are not supported on J Series routers.
- Configure a single mesh group, terminate all the Layer 2 circuit pseudowires into it, and enable local switching between the pseudowires by including the **local-switching** statement at the **[edit routing-instances *routing-instance-name* protocols vpls mesh-group *mesh-group-name*]** hierarchy level. By default, you cannot configure local switching for mesh groups (except for the CE mesh group) because all of the VPLS PE routers must be configured in a full mesh. However, local switching is useful if you are

terminating Layer 2 circuit pseudowires in a mesh group configured for an LDP signaled VPLS routing instance.

NOTE: Do not include the **local-switching** statement on PE routers configured in a full mesh VPLS network.

To terminate multiple pseudowires at a single VPLS mesh group, include the **local-switching** statement:

```
local-switching;
```

You can include this statement at the following hierarchy levels:

- **[edit routing-instances *routing-instance-name* protocols vpls mesh-group *mesh-group-name*]**
- **[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls mesh-group *mesh-group-name*]**

Configuring Integrated Routing and Bridging Support for LDP BGP Interworking with VPLS

Beginning with Junos OS Release 9.4, you can configure an integrated routing and bridging (IRB) interface on a router that functions as an autonomous system border router (ASBR) in an inter-AS VPLS environment between BGP-signaled VPLS and LDP-signaled VPLS. Previously, IRB interfaces were supported only on Provider Edge (PE) routers.

To configure a IRB support for LDP BGP Interworking with VPLS, include the **routing-interface *interface-name*** statement.

You can include this statement at the following hierarchy levels:

- [edit routing-instances *routing-instance-name*]
- [edit logical-routers *logical-router-name* routing-instances *routing-instance-name*]

Configuring Inter-AS VPLS with MAC Processing at the ASBR

Inter-AS VPLS with MAC processing at the ASBR enables you to interconnect customer sites that are located in different ASs. In addition, you can configure the ASs with different signaling protocols. You can configure one of the ASs with BGP-signaled VPLS and the other with LDP-signaled VPLS. For more information about how to configure LDP-signaled and BGP signaled VPLS, see "Configuring Interoperability Between BGP Signaling and LDP Signaling in VPLS" on page 70.

For inter-AS VPLS to function properly, you need to configure IBGP peering between the PE routers, including the ASBRs in each AS, just as you do for a typical VPLS configuration. You also need to configure EBGP peering between the ASBRs in the separate ASs. The EBGP peering is needed between the ASBRs only. The link between the ASBR routers does not have to be Ethernet. You can also connect a CE router directly to one of the ASBRs, meaning you do not have to have a PE router between the ASBR and the CE router.

The configuration for the connection between the ASBRs makes inter-AS VPLS with MAC operations unique. The other elements of the configuration are described in other sections of this manual. An extensive configuration example for inter-AS VPLS with MAC operations is provided in the *Junos OS Feature Guides*.

The following sections describe how to configure inter-AS VPLS with MAC operations:

Inter-AS VPLS with MAC Operations Configuration Summary

This section provides a summary of all of the elements which must be configured to enable inter-AS VPLS with MAC operations. These procedures are described in detail later in this chapter and in other parts of the *Junos OS VPNs Configuration Guide*.

The following lists all of major elements of an inter-AS VPLS with MAC operations configuration:

- Configure IBGP between all of the routers within each AS, including the ASBRs.
- Configure EBGP between the ASBRs in the separated ASs. The EBGP configuration includes the configuration that interconnects the ASs.
- Configure a full mesh of LSPs between the ASBRs.
- Configure a VPLS routing instance encompassing the ASBR routers. The ASBRs are VPLS peers and are linked by a single pseudowire. Multihoming between ASs is not supported. A full mesh of pseudowires is needed between the ASBR routers in all of the interconnected ASs.
- Configure the VPLS routing instances using either BGP signaling or LDP signaling. LDP BGP interworking is supported for inter-AS VPLS with MAC operations, so it is possible to interconnect the BGP-signaled VPLS routing instances with the LDP-signaled VPLS routing instances.
- Configure a single VPLS mesh group for all of the ASBRs interconnected using inter-AS VPLS.

Configuring the ASBRs for Inter-AS VPLS

This section describes the configuration on the ASBRs needed to enable inter-AS VPLS with MAC operations.

On each ASBR, you need to configure a VPLS mesh group within the VPLS routing instance which needs to include all of the PE routers within the AS, in addition to the ASBR. You need to configure the same mesh group for each of the ASs you want to interconnect using inter-AS VPLS. The mesh group name should be identical on each AS. You also must include the **peer-as all** statement. This statement enables the router to establish a single pseudowire to each of the other ASBRs.

To configure the mesh group on each ASBR, include the **mesh-group** and **peer-as all** statements:

```
mesh-group mesh-group-name {
```

```
    peer-as all;
}
```

You can include these statements at the following hierarchy levels:

- **[edit routing-instances *routing-instance-name* protocols vpls]**
- **[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls]**

Related Documentation

- Example: Configuring BGP Autodiscovery for LDP VPLS on page 89
- Example: Configuring BGP Autodiscovery for LDP VPLS with User-Defined Mesh Groups on page 106

Example: Configuring Ingress Replication for IP Multicast Using MBGP MVPNs

Requirements

The routers used in this example are Juniper Networks M Series Multiservice Edge Routers, T Series Core Routers, or MX Series 3D Universal Edge Routers. When using ingress replication for IP multicast, each participating router must be configured with BGP for control plane procedures and with ingress replication for the data provider tunnel, which forms a full mesh of MPLS point-to-point LSPs. The ingress replication tunnel can be selective or inclusive, depending on the configuration of the provider tunnel in the routing instance.

Overview

The **ingress-replication** provider tunnel type uses unicast tunnels between routers to create a multicast distribution tree.

The **mpls-internet-multicast** routing instance type uses ingress replication provider tunnels to carry IP multicast data between routers through an MPLS cloud, using MBGP (or Next Gen) MVPN. Ingress replication can also be configured when using MVPN to carry multicast data between PE routers.

The **mpls-internet-multicast** routing instance is a non-forwarding instance used only for control plane procedures. It does not support any interface configurations. Only one **mpls-internet-multicast** routing instance can be defined for a logical system. All multicast and unicast routes used for IP multicast are associated only with the default routing instance (**inet.0**), not with a configured routing instance. The **mpls-internet-multicast** routing instance type is configured for the default master instance on each router, and is also included at the **[edit protocols pim]** hierarchy level in the default instance.

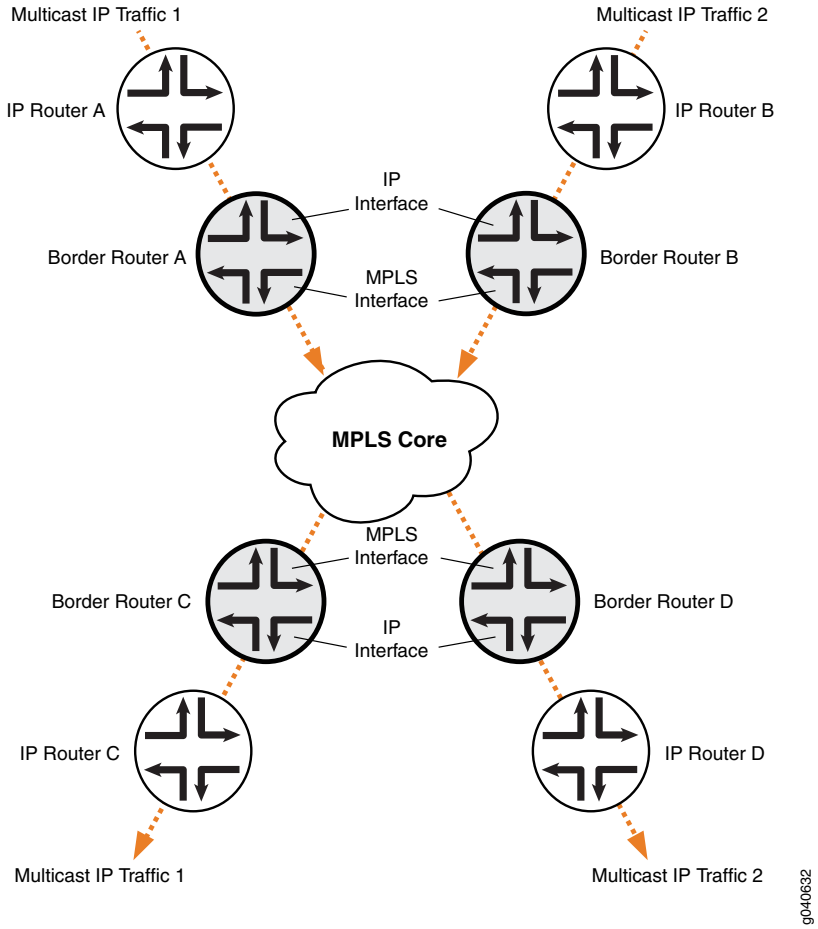
For each **mpls-internet-multicast** routing instance, the **ingress-replication** statement is required under the **provider-tunnel** statement and also under the **[edit routing-instances *routing-instance-name* provider-tunnel selective group source]** hierarchy level.

When a new destination needs to be added to the ingress replication provider tunnel, the resulting behavior differs depending on which mode has been configured for the tunnel:

- **existing-unicast-tunnel**—In this default mode, an existing unicast tunnel to the destination is used. If a unicast tunnel is not available, the destination is not added. This is the only mode available when using LDP LSPs and ingress replication.
- **create-new-ucast-tunnel**—When this mode is configured, a new unicast tunnel to the destination is created, and is deleted when the destination is no longer needed. Use this mode for RSVP LSPs using ingress replication.

The IP topology consists of routers on the edge of the IP multicast domain. Each router has a set of IP interfaces configured toward the MPLS cloud and a set of interfaces configured toward the IP routers. See Figure 8 on page 77. Internet multicast traffic is carried between the IP routers, through the MPLS cloud, using ingress replication tunnels for the data plane and a full-mesh IBGP session for the control plane.

Figure 8: Internet Multicast Topology



Configuration

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
set routing-instances IM-A instance-type mpls-internet-multicast
set routing-instances IM-A provider-tunnel ingress-replication create-new-ucast-tunnel
set routing-instances IM-A provider-tunnel ingress-replication label-switched-path
  label-switched-path-template default-template
set routing-instances IM-A provider-tunnel selective group group-address source
  source-address ingress-replication label-switched-path
set routing-instances IM-A protocols mvpn
set protocols pim mpls-internet-multicast
```

Step-by-Step Procedure

The following example requires you to navigate various levels in the configuration hierarchy. For information about navigating the CLI, see Using the CLI Editor in Configuration Mode in the *Junos OS CLI User Guide*.

The following example shows how to configure ingress replication on IP multicast instance **IM-A** with the routing instance type **mpls-internet-multicast**. Additionally, this example shows how to configure a selective provider tunnel that selects a new unicast tunnel each time a new destination needs to be added to the multicast distribution tree.

1. Configure the routing instance type for IM-A to be **mpls-internet-multicast**.

   ```
   [edit routing-instances]
   user@host# set IM-A instance-type mpls-internet-multicast
   ```

2. Configure the ingress replication provider tunnel to create a new unicast tunnel each time a destination needs to be added to the multicast distribution tree.

   ```
   [edit routing-instances]
   user@host# set IM-A provider-tunnel ingress-replication create-new-ucast-tunnel
   ```

   NOTE: Alternatively, use the **existing-unicast-tunnel** statement if an existing tunnel should be used each time a destination needs to be added. It is the only mode available when using LDP LSPs and ingress replication.

3. Configure the point-to-point LSP to use the default template settings (this is needed only when using RSVP tunnels).

   ```
   [edit routing-instances]
   user@host# set IM-A provider-tunnel ingress-replication label-switched-path
   label-switched-path-template default-template
   ```

4. Configure selective ingress replication provider tunnels.

   ```
   [edit routing-instances]
   user@host# set IM-A provider-tunnel selective group 232.1.1.1/32 source
   192.168.195.145/32 ingress-replication label-switched-path
   ```

5. Configure the MVPN Protocol in the routing instance.

   ```
   [edit routing-instances]
   user@host# set IM-A protocols mvpn
   user@host# up
   ```

6. Add the **mpls-internet-multicast** configuration statement under the **[edit protocols pim]** hierarchy level in the master instance.

   ```
   [edit protocols]
   user@host# set pim mpls-internet-multicast
   ```

7. Commit the configuration.

```
[edit]

user@host# commit
```

8. Use the **show ingress-replication mvpn** command to check the ingress replication status.

```
[edit]

user@host# run show ingress-replication mvpn

Ingress Tunnel: mvpn:1
  Application: MVPN
  Unicast tunnels
    Leaf Address       Tunnel-type       Mode       State
    10.255.245.2       P2P LSP           New        Up
    10.255.245.4       P2P LSP           New        Up
```

9. Use the **show mvpn instance** command to show the ingress replication tunnel type.

```
[edit]

user@host# run show mvpn instance IM-A

MVPN instance:
Legend for provider tunnel
I-P-tnl -- inclusive provider tunnel S-P-tnl -- selective provider tunnel

Legend for c-multicast routes properties (Pr)
DS -- derived from (*, c-g)          RM -- remote VPN route
Instance : IM-A
   MVPN Mode : SPT-ONLY
   Provider tunnel: S-P-tnl:INGRESS-REPLICATION:MPLS Label 18:10.255.245.6
   Neighbor               S-P-tnl
   10.255.245.2           INGRESS-REPLICATION:MPLS Label 22:10.255.245.2
   10.255.245.7           INGRESS-REPLICATION:MPLS Label 19:10.255.245.7
```

Related Documentation

- Configuring Routing Instances for an MBGP MVPN
- mpls-internet-multicast
- ingress-replication
- create-new-ucast-tunnel
- existing-unicast-tunnel
- show ingress-replication mvpn

Tracing VPLS Traffic and Operations

To trace VPLS traffic, include the **traceoptions** statement:

```
traceoptions {
  file filename <files number> <size size> <world-readable | no-world-readable>;
  flag flag <flag-modifier> <disable>;
}
```

You can include this statement at the following hierarchy levels:

- **[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls]**
- **[edit routing-instances *routing-instance-name* protocols vpls]**

The following trace flags display the operations associated with VPLS:

- **all**—All VPLS tracing options
- **connections**—VPLS connections (events and state changes)
- **error**—Error conditions
- **nlri**—VPLS advertisements received or sent using BGP
- **route**—Trace-routing information
- **topology**—VPLS topology changes caused by reconsideration or advertisements received from other PE routers using BGP

Configuring the Label Block Size

VPLS MPLS packets have a two-label stack. The outer label is used for normal MPLS forwarding in the service provider's network. If BGP is used to establish VPLS, the inner label is allocated by a PE router as part of a label block. One inner label is needed for each remote VPLS site. Four sizes are supported. We recommend using the default size of 8, unless the network design requires a different size for optimal label usage, to allow the router to support a larger number of VPLS instances.

If you allocate a large number of small label blocks to increase efficiency, you also increase the number of routes in the VPLS domain. This has an impact on the control plane overhead.

Changing the configured label block size causes all existing pseudowires to be deleted. For example, if you configure the label block size to be 4 and then change the size to 8, all existing label blocks of size 4 are deleted, which means that all existing pseudowires are deleted. The new label block of size 8 is created, and new pseudowires are established.

Four label block sizes are supported: 2, 4, 8, and 16. Consider the following scenarios:

- 2—Allocate the label blocks in increments of 2. For a VPLS domain that has only two sites with no future expansion plans.
- 4—Allocate the label blocks in increments of 4.
- 8 (default)—Allocate the label blocks in increments of 8.
- 16—Allocate the label blocks in increments of 16. A label block size of 16 enables you to minimize the number of routes in the VPLS domain. Use this setting only if the number of routes is the most important concern.

Configure the label block size:

```
[edit routing-instances instance-name protocols vpls]
user@router# set label-block-size 2
```

Related Documentation

- Configuring VPLS Routing Instances on page 28

Configuring Y.1731 Functionality for VPLS to Support Delay and Delay Variation

For VPLS, you can configure the Ethernet frame delay measurement (ETH-DM) functionality to trigger two-way ETH-DM and allow concurrent ETH-DM CLI sessions from the same local maintenance association end point (MEP). The feature also provides the option to perform ETH-DM for a given 802.1q priority, to set the size of the data type, length, and value (TLV), to disable the **session-id-tlv** option, and to generate XML output.

This feature complements the ITU-T Y.1731 Ethernet service OAM feature. On-demand delay measurement for VPLS is supported on MX Series routers installed with Rev-B DPCs. Only the two-way delay measurement feature is supported for VPLS connections.

MX Series routers with modular port concentrators (MPCs) and 10-Gigabit Ethernet MPCs with SFP+ support ITU-T Y.1731 functionality on VPLS for frame-delay and delay-variation.

This feature is currently supported only for up MEPs. Set the MEP direction to up by configuring the **up** option for the **direction** statement at the **[edit protocols oam ethernet connectivity-fault-management maintenance-domain *md-name* maintenance-association *ma-name* mep *mep-id*]** hierarchy level.

This feature also provides support for an optional configuration where you can delegate the server-side processing (for two-way delay measurement) to the Packet Forwarding Engine (PFE) to prevent overloading on the Routing Engine. To enable this feature, include the **delegate-server-processing** statement at the **[edit protocols oam ethernet connectivity-fault-management performance-monitoring]** hierarchy level. By default, the server-side processing is done by the Routing Engine.

The following commands enable you to monitor and maintain the Y.1731 feature for VPLS:

- To display the delay measurement values across a VPLS connection, use the **monitor ethernet delay-measurement two-way (*remote-mac-address* | mep *mep-id*) maintenance-domain *name* maintenance-association *name* count *count* wait *time* priority 802.1p-value *size* no-session-id-tlv xml** command.
- The feature also provides support for enhanced continuity measurement by using an existing continuity check protocol. The continuity for every remote MEP is measured as the percentage of time that a remote MEP was operationally up over the total administratively enabled time.

  To display the continuity measurement information, use the **show oam ethernet connectivity-fault-management mep-database maintenance-domain *name* maintenance-association *name* local-mep *identifier* remote-mep *identifier*** command.
- You can restart the continuity measurement by clearing the currently measured operational uptime and administrative enabled time. To clear the existing continuity measurement and restart counting the operational uptime, use the **clear oam ethernet connectivity-fault-management continuity-measurement maintenance-domain *name* maintenance-association *name* local-mep *identifier* remote-mep *identifier*** command.
- To clear the delay statistics, issue a **clear oam ethernet connectivity-fault-management statistics** command or a **clear oam ethernet connectivity-fault-management delay-statistics two-way maintenance-domain *md-name* maintenance-association *ma-name*** command.

Related Documentation

- ITU-T Y.1731 Ethernet Service OAM
- Configuring MEP Interfaces to Support Ethernet Frame Delay Measurements
- Example: Configuring Two-Way Ethernet Frame Delay Measurements with Single-Tagged Interfaces

CHAPTER 4

VPLS Example

Example: Building a VPLS From Router 1 to Router 3 to Validate Label Blocks

This example illustrates how VPLS label blocks are allocated for a specific configuration. It is organized in the following sections:

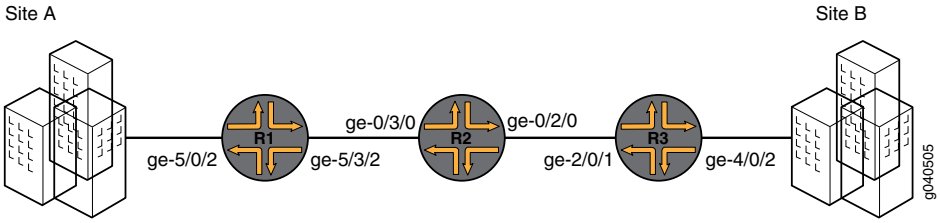
Requirements

This configuration example requires three Juniper Networks routers.

Overview and Topology

In the network shown in Figure 9 on page 83 Router 1 is establishing a pseudowire to Router 3

Figure 9: Router 1 to Router 3 Topology



Each PE filters the VPLS NLRI contained in the BGP update messages based on route target communities. Those VPLS NLRI instances that match the route target (in this case 8717:2000:2:1) are imported for further processing. The NLRI for Router 1 and Router 3 is shown in Table 6 on page 84.

Table 6: NLRI Exchange Between for Router 1 and Router 3

Router 1 NLRI Advertisement to Router 3	Router 3 NLRI Advertisement to Router 1
RD - 8717:1000	RD - 8717:1000
VE ID - 1	VE ID - 2
VE Block Offset - 1	VE Block Offset - 1
VE Block Size - 8	VE Block Size - 8
Label Base - 262161	Label Base - 262153

To set up a pseudowire to Router 3, Router 1 must select a label to use to send traffic to Router 3 and also select a label that it expects Router 3 to use to send traffic to itself. The site ID contained in the VPLS NLRI from Router 3 is 2.

Router 1 learns of the existence of site ID 2 in the same VPLS domain. Using the equation VBO <= Local Site ID < (VBO +VBS), Router 1 checks if the route advertised by site ID 2 fits in the label block and block offset that it previously advertised to Router 3. In this example it does fit, so the site ID 2 is mapped by the VPLS NLRI advertised by Router 1, and Router 1 is ready to set up a pseudowire to Router 3.

To select the label to reach Router 3, Router 1 looks at the label block advertised by Router 3 and performs a calculation. The calculation a PE router uses to check if its site ID is mapped in the label block from the remote peer is VBO <= Local Site ID < (VBO +VBS). So, Router 1 selects label (262153 + (1 -1)) = 262153 to send traffic to Router 3. Using the same equation, Router 1 looks at its own label block that it advertised and selects label (262161 + (2 - 1)) = 262162 to receive traffic from Router 3. Router 1 programs its forwarding state such that any traffic destined to Router 3 carries the pseudowire label 262153 and any traffic coming from Router 3 is expected to have the pseudowire label 262162. This completes the operations on the VPLS NLRI received from Router 3. Router 1 now has a pseudowire set up to Router 3.

Router 3 operation is very similar to the Router 1 operation. Since the Router 3 site ID of 2 fits in the label block and block offset advertised by Router 1, Router 3 selects label (262161 + (2 - 1)) = 262162 to send traffic to Router 1. Router 3 looks at its own label block that it advertised and selects label (262153 + (1 - 1)) = 262153 to receive traffic from Router 1. This completes the creation of a pseudowire to Router 1.

By default, for VPLS operation Junos OS uses a virtual tunnel (VT) loopback interface to represent a pseudowire. This example uses a label-switched interface (LSI) instead of a VT interface because there is no change in the VPLS control plane operation. Thus, for an MX platform, if there is a tunnel physical interface card (PIC) configured, it is mandatory to include the **no-tunnel-services** statement at the **[edit routing-instances *routing-instance-name* protocols vpls]** hierarchy level.

Configuration

The following sections present the steps to configure and verify the example in Figure 9 on page 83.

Configuring Router 1

Step-by-Step Procedure

1. Configure Router 1. Create the **edut** routing instance. Specify the **vpls** instance type. Configure the route distinguisher and specify the value **8717:1000**. Configure the route target and specify the value **8717:100** Configure the VPLS protocol. Specify **10** as the site range. Specify **1** as the site ID. Include the **no-tunnel-services** statement.

```
[edit routing-instances]
edut {
   instance-type vpls;
   interface ge-5/0/2.0;
   route-distinguisher 8717:1000;
   vrf-target target:8717:100;
   protocols {
      vpls {
         site-range 10;
         no-tunnel-services;
         site router-1 {
            site-identifier 1;
         }
      }
   }
}
```

Configuring Router 3

Step-by-Step Procedure

1. Configure Router 3. Create the **edut** routing instance. Specify the **vpls** instance type. Configure the route distinguisher and specify the value **8717:2000**. Configure the route target and specify the value **8717:200** Configure the VPLS protocol. Specify **10** as the site range. Specify **2** as the site ID. Include the **no-tunnel-services** statement.

```
[edit routing-instances]
edut {
   instance-type vpls;
   interface ge-4/0/2.0;
   route-distinguisher 8717:2000;
   vrf-target target:8717:100;
   protocols {
      vpls {
         site-range 10;
         no-tunnel-services;
         site router-3 {
            site-identifier 2;
         }
```

```
        }
      }
    }
```

Verifying the VPLS Label Allocations

Step-by-Step Procedure

1. As shown in the figure and the configuration, Site A is attached to Router 1. Site A is assigned a site ID of 1. Before Router 1 can announce its membership to VPLS **edut** using a BGP update message, Router 1 needs to allocate a default label block. In this example, the label base of the label block allocated by Router 1 is 262161. Since Router 1's site ID is 1, Router 1 associates the assigned label block with block offset of 1. The following messages aresent from Router 1 to Router 3 and displayed using the **monitor traffic interface** ***interface-name*** command:

```
user@Router1> monitor traffic interface ge-5/3/2

Jun 14 12:26:31.280818 BGP SEND 10.10.10.1+179 -> 10.10.10.3+53950
Jun 14 12:26:31.280824 BGP SEND message type 2 (Update) length 88
Jun 14 12:26:31.280828 BGP SEND flags 0x40 code Origin(1): IGP
Jun 14 12:26:31.280833 BGP SEND flags 0x40 code ASPath(2) length 0: <null>
Jun 14 12:26:31.280837 BGP SEND flags 0x40 code LocalPref(5): 100
Jun 14 12:26:31.280844 BGP SEND flags 0xc0 code Extended Communities(16): 2:8717:100 800a:19:0:0
Jun 14 12:26:31.280848 BGP SEND flags 0x90 code MP_reach(14): AFI/SAFI 25/65
Jun 14 12:26:31.280853 BGP SEND         nhop 10.10.10.1 len 4
Jun 14 12:26:31.280862 BGP SEND         8717:1000:1:1 (label base : 262161 range : 8, ce id: 1, offset: 1)
Jun 14 12:26:31.405067 BGP RECV 10.10.10.3+53950 -> 10.10.10.1+179
Jun 14 12:26:31.405074 BGP RECV message type 2 (Update) length 88
Jun 14 12:26:31.405080 BGP RECV flags 0x40 code Origin(1): IGP
Jun 14 12:26:31.405085 BGP RECV flags 0x40 code ASPath(2) length 0: <null>
Jun 14 12:26:31.405089 BGP RECV flags 0x40 code LocalPref(5): 100
Jun 14 12:26:31.405096 BGP RECV flags 0xc0 code Extended Communities(16): 2:8717:100 800a:19:0:0
Jun 14 12:26:31.405101 BGP RECV flags 0x90 code MP_reach(14): AFI/SAFI 25/65
Jun 14 12:26:31.405106 BGP RECV         nhop 10.10.10.3 len 4
Jun 14 12:26:31.405116 BGP RECV         8717:2000:2:1 (label base : 262153 range : 8, ce id: 2, offset:
1)
```

2. As shown in the figure and the configuration, Site B is attached to Router 3. Site B is assigned a site ID of 2. Before Router 3 can announce its membership to VPLS **edut** using a BGP update message, Router 3 assigns a default label block with the label base of **262153**. The block offset for this label block is 1 because its own site ID of 2 fits in the block being advertised. The following messages are sent from Router 3 to Router 1 and displayed using the **monitor traffic interface** ***interface-name*** command:

```
user@Router3> monitor traffic interface ge-2/0/1

Jun 14 12:26:31.282008 BGP SEND 10.10.10.3+53950 -> 10.10.10.1+179
Jun 14 12:26:31.282018 BGP SEND message type 2 (Update) length 88
Jun 14 12:26:31.282026 BGP SEND flags 0x40 code Origin(1): IGP
Jun 14 12:26:31.282034 BGP SEND flags 0x40 code ASPath(2) length 0: <null>
Jun 14 12:26:31.282041 BGP SEND flags 0x40 code LocalPref(5): 100
Jun 14 12:26:31.282052 BGP SEND flags 0xc0 code Extended Communities(16): 2:8717:100 800a:19:0:0
Jun 14 12:26:31.282078 BGP SEND flags 0x90 code MP_reach(14): AFI/SAFI 25/65
Jun 14 12:26:31.282088 BGP SEND         nhop 10.10.10.3 len 4
Jun 14 12:26:31.282102 BGP SEND         8717:2000:2:1 (label base : 262153 range : 8, ce id: 2, offset: 1)

Jun 14 12:26:31.283395 BGP RECV 10.10.10.1+179 -> 10.10.10.3+53950
Jun 14 12:26:31.283405 BGP RECV message type 2 (Update) length 88
```

```
Jun 14 12:26:31.283412 BGP RECV flags 0x40 code Origin(1): IGP
Jun 14 12:26:31.283419 BGP RECV flags 0x40 code ASPath(2) length 0: <null>
Jun 14 12:26:31.283426 BGP RECV flags 0x40 code LocalPref(5): 100
Jun 14 12:26:31.283435 BGP RECV flags 0xc0 code Extended Communities(16): 2:8717:100 800a:19:0:0
Jun 14 12:26:31.283443 BGP RECV flags 0x90 code MP_reach(14): AFI/SAFI 25/65
Jun 14 12:26:31.283471 BGP RECV         nhop 10.10.10.1 len 4
Jun 14 12:26:31.283486 BGP RECV         8717:1000:1:1 (label base : 262161 range : 8, ce id: 1, offset:
1)
```

3. Verify the connection status messages for Router 1 using the **show vpls connections** command. Notice the base label is **262161**, the incoming label from Router 3 is **262162**, and the outgoing label to Router 3 is **262153**.

```
user@Router1> show vpls connections instance edut extensive

Instance: edut
  Local site: router-1 (1)
    Number of local interfaces: 1
    Number of local interfaces up: 1
    IRB interface present: no
    ge-5/0/2.0
    lsi.1049600         2         Intf - vpls edut local site 1 remote site 2
    Label-base        Offset     Range     Preference
    262161            1          8         100
    connection-site           Type  St     Time last up          # Up trans
    2                         rmt   Up     Jun 14 12:26:31 2009           1
      Remote PE: 10.10.10.3, Negotiated control-word: No
      Incoming label: 262162, Outgoing label: 262153
      Local interface: lsi.1049600, Status: Up, Encapsulation: VPLS
        Description: Intf - vpls edut local site 1 remote site 2
    Connection History:
        Jun 14 12:26:31 2009  status update timer
        Jun 14 12:26:31 2009  loc intf up                  lsi.1049600
        Jun 14 12:26:31 2009  PE route changed
        Jun 14 12:26:31 2009  Out lbl Update                    262153
        Jun 14 12:26:31 2009  In lbl Update                     262162
        Jun 14 12:26:31 2009  loc intf down

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
PF -- Profile parse failure      PB -- Profile busy

Legend for interface status
```

```
Up -- operational
Dn -- down
```

4. Verify the connection status messages for Router 3 using the **show vpls connections** command. Notice the base label is **262153**, the incoming label from Router 1 is **262153**, and the outgoing label to Router 1 is **262162**.

```
user@Router3> show vpls connections instance edut extensive

Instance: edut
  Local site: router-3 (2)
    Number of local interfaces: 1
    Number of local interfaces up: 1
    IRB interface present: no
    ge-4/0/2.0
    lsi.1050368         1         Intf - vpls edut local site 2 remote site 1
    Label-base        Offset     Range     Preference
    262153            1          8         100
    connection-site           Type  St     Time last up          # Up trans
    1                         rmt   Up     Jun 14 12:26:31 2009           1
      Remote PE: 10.10.10.1, Negotiated control-word: No
      Incoming label: 262153, Outgoing label: 262162
      Local interface: lsi.1050368, Status: Up, Encapsulation: VPLS
        Description: Intf - vpls edut local site 2 remote site 1
    Connection History:
        Jun 14 12:26:31 2009  status update timer
        Jun 14 12:26:31 2009  loc intf up                  lsi.1050368
        Jun 14 12:26:31 2009  PE route changed
        Jun 14 12:26:31 2009  Out lbl Update                    262162
        Jun 14 12:26:31 2009  In lbl Update                     262153
        Jun 14 12:26:31 2009  loc intf down

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
PF -- Profile parse failure      PB -- Profile busy

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

Related Documentation

- VPLS Label Blocks Operation on page 16

Example: Configuring BGP Autodiscovery for LDP VPLS

This example describes how to configure BGP autodiscovery for LDP VPLS, as specified in forwarding equivalency class (FEC) 129. FEC 129 uses BGP autodiscovery to convey endpoint information, so you do not need to manually configure pseudowires.

Requirements

This example uses the following hardware and software components:

- Four MX Series 3D Universal Edge Routers
- Junos OS Release 10.4R2 or later

If you are using M Series or T Series routers, the PE routers must have either virtual loopback tunnel (**vt**) interfaces or label-switched interfaces (LSIs). 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 LSIs to support the virtual ports. Use of LSIs requires Ethernet-based PICs installed in an Enhanced Flexible PIC Concentrator (FPC).

You do not need to use routers for the CE devices. For example, the CE devices can be EX Series Ethernet Switches.

Overview

All PE routers in a VPLS network operate like a large, distributed Ethernet switch to provide Layer 2 services to attached devices. This example shows a minimum configuration for PE routers and CE devices to create an autodiscovered VPLS network. The topology consists of five routers: two PE routers, two CE routers, and an optional route reflector (RR). The PE routers use BGP to autodiscover two different VPLS instances that are configured on both PE routers. Then the PE routers use LDP to automatically signal two pseudowires between the discovered end points. Finally, the PE routers bring up both VPLS instances for forwarding traffic. Each CE device is configured with two VLANs, with each VLAN belonging to different VPLS instances in the PE routers.

This example includes the following settings:

- **auto-discovery-only**—Allows the router to process only the autodiscovery network layer reachability information (NLRI) update messages for LDP-based Layer 2 VPN and VPLS update messages (BGP_L2VPN_AD_NLRI) (FEC 129). Specifically, the **auto-discovery-only** statement notifies the routing process (rpd) to expect autodiscovery-related NLRI messages so that information can be deciphered and used by LDP and VPLS. You can configure this statement at the global, group, and neighbor levels for BGP. The **auto-discovery-only** statement must be configured on all PE routers in the VPLS. If you configure route reflection, the **auto-discovery-only** statement is also required on P routers that act as the route reflector in supporting FEC 129-related updates.

  The **signaling** statement is not included in this example but is discussed here for completeness. The **signaling** statement allows the router to process only the BGP_L2VPN_NLRIs used for BGP-based Layer 2 VPNs (FEC 128).

  For interoperation scenarios in which a PE router must support both types of NLRI (FEC 128 and FEC 129), you can configure both the **signaling** statement and the **auto-discovery-only** statement. For example, a single PE router might need to process a combination of BGP-signaled virtual private wire service (VPWS) and LDP-signaled VPLS assisted by BGP autodiscovery. Configuring both the **signaling** statement and the **auto-discovery-only** statement together allows both types of signaling to run independently. The **signaling** statement is supported at the same hierarchy levels as the **auto-discovery-only** statement.

- **cluster**—Configuring a route reflector is optional for FEC 129 autodiscovered PE routers. In this example, the **cluster** statement configures Router RR to be a route reflector in the IBGP group. For inbound updates, BGP autodiscovery NLRI messages are accepted if the router is configured to be a route reflector or if the **keep all** statement is configured in the IBGP group.

- **l2vpn-id**—Specifies a globally unique Layer 2 VPN community identifier for the instance. This statement is configurable for routing instances of type **vpls**.

  You can configure the following formats for the community identifier:

  - Autonomous system (AS) number format—**l2vpn-id:*as-number:2-byte-number***. For example: **l2vpn-id:100:200**. The AS number can be in the range from 1 through 65,535.
  - IPv4 format—**l2vpn-id:*ip-address:2-byte-number***. For example: **l2vpn-id:10.1.1.1:2**.

- **vrf-target**—Defines the import and export route targets for the NLRI. You must either configure the **vrf-target** statement or the **vrf-import** and **vrf-export** statements to define the instance import and export policy or the import and export route targets for the NLRI. This example uses the **vrf-target** statement.

- **route-distinguisher**—Forms part of the BGP autodiscovery NLRI and distinguishes to which VPN or VPLS routing instance each route belongs. Each route distinguisher is a 6-byte value. You must configure a unique route distinguisher for each routing instance.

  You can configure the following formats for the route distinguisher:

  - AS number format—***as-number:2-byte-number***

- IPv4 format—*ip-address:2-byte-number*

Two notable statements are included in this example. These statements are important for interoperability with other vendors' equipment. The interoperability statements are not necessary for the topology that is used in this example, but they are included for completeness.

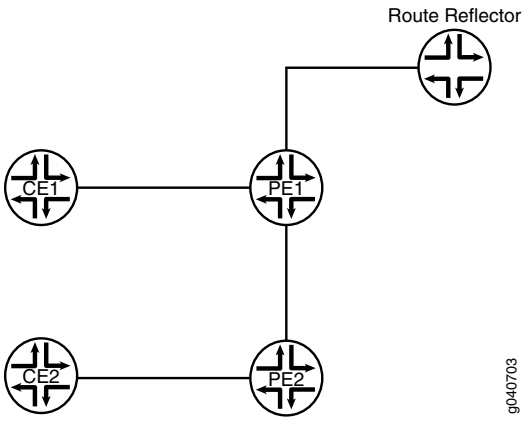
The interoperability statements are as follows:

- **input-vlan-map pop**—Removes an outer VLAN tag from the top of the VLAN tag stack.
- **output-vlan-map push**—Adds an outer VLAN tag in front of the existing VLAN tag.

Topology Diagram

Figure 10 on page 91 shows the topology used in this example.

Figure 10: BGP Autodiscovery for LDP VPLS



Configuration

CLI Quick Configuration

To quickly configure BGP autodiscovery for LDP VPLS, copy the following commands, remove any line breaks, and then paste the commands into the CLI of each device.

On Router PE1:

```
[edit]
set interfaces ge-0/1/0 vlan-tagging
set interfaces ge-0/1/0 encapsulation flexible-ethernet-services
set interfaces ge-0/1/0 unit 100 encapsulation vlan-vpls
set interfaces ge-0/1/0 unit 100 vlan-id 100
set interfaces ge-0/1/0 unit 100 input-vlan-map pop
set interfaces ge-0/1/0 unit 100 output-vlan-map push
set interfaces ge-0/1/0 unit 100 family vpls
set interfaces ge-0/1/0 unit 200 encapsulation vlan-vpls
set interfaces ge-0/1/0 unit 200 vlan-id 200
set interfaces ge-0/1/0 unit 200 family vpls
set interfaces ge-0/1/1 unit 0 description "PE1 to PE2"
set interfaces ge-0/1/1 unit 0 family inet address 8.0.40.100/24
set interfaces ge-0/1/1 unit 0 family iso
set interfaces ge-0/1/1 unit 0 family mpls
```

```
set interfaces ge-0/3/0 unit 0 description "PE1 to RR"
set interfaces ge-0/3/0 unit 0 family inet address 8.0.70.100/24
set interfaces ge-0/3/0 unit 0 family iso
set interfaces ge-0/3/0 unit 0 family mpls
set interfaces lo0 unit 0 family inet address 8.0.0.100/32
set routing-options router-id 8.0.0.100
set routing-options autonomous-system 100
set protocols mpls interface lo0.0
set protocols mpls interface all
set protocols mpls interface fxp0.0 disable
set protocols bgp group int type internal
set protocols bgp group int local-address 8.0.0.100
set protocols bgp group int family l2vpn auto-discovery-only
set protocols bgp group int neighbor 8.0.0.107
set protocols isis level 1 disable
set protocols isis interface all
set protocols isis interface fxp0.0 disable
set protocols isis interface lo0.0
set protocols ldp interface all
set protocols ldp interface fxp0.0 disable
set protocols ldp interface lo0.0
set routing-instances vpls100 instance-type vpls
set routing-instances vpls100 interface ge-0/1/0.100
set routing-instances vpls100 route-distinguisher 8.0.0.100:100
set routing-instances vpls100 l2vpn-id l2vpn-id:100:100
set routing-instances vpls100 vrf-target target:100:100
set routing-instances vpls100 protocols vpls no-tunnel-services
set routing-instances vpls200 instance-type vpls
set routing-instances vpls200 interface ge-0/1/0.200
set routing-instances vpls200 route-distinguisher 8.0.0.100:200
set routing-instances vpls200 l2vpn-id l2vpn-id:100:200
set routing-instances vpls200 vrf-target target:100:208
set routing-instances vpls200 protocols vpls no-tunnel-services
```

On Device CE1:

```
[edit]
set interfaces ge-1/2/1 vlan-tagging
set interfaces ge-1/2/1 mtu 1400
set interfaces ge-1/2/1 unit 100 vlan-id 100
set interfaces ge-1/2/1 unit 100 family inet address 3.0.100.103/24
set interfaces ge-1/2/1 unit 200 vlan-id 200
set interfaces ge-1/2/1 unit 200 family inet address 3.0.200.103/24
set protocols ospf area 0.0.0.0 interface ge-1/2/1.100
set protocols ospf area 0.0.0.0 interface ge-1/2/1.200
```

On Router PE2:

```
[edit]
set interfaces ge-1/1/0 vlan-tagging
set interfaces ge-1/1/0 encapsulation flexible-ethernet-services
set interfaces ge-1/1/0 unit 100 encapsulation vlan-vpls
set interfaces ge-1/1/0 unit 100 vlan-id 100
set interfaces ge-1/1/0 unit 100 input-vlan-map pop
set interfaces ge-1/1/0 unit 100 output-vlan-map push
set interfaces ge-1/1/0 unit 100 family vpls
set interfaces ge-1/1/0 unit 200 encapsulation vlan-vpls
```



```
set interfaces ge-1/1/0 unit 200 vlan-id 200
set interfaces ge-1/1/0 unit 200 family vpls
set interfaces ge-1/2/1 unit 0 description "PE2 to PE1"
set interfaces ge-1/2/1 unit 0 family inet address 8.0.40.104/24
set interfaces ge-1/2/1 unit 0 family iso
set interfaces ge-1/2/1 unit 0 family mpls
set interfaces lo0 unit 0 family inet address 8.0.0.104/32
set routing-options router-id 8.0.0.104
set routing-options autonomous-system 100
set protocols mpls interface lo0.0
set protocols mpls interface all
set protocols mpls interface fxp0.0 disable
set protocols bgp group int type internal
set protocols bgp group int local-address 8.0.0.104
set protocols bgp group int family l2vpn auto-discovery-only
set protocols bgp group int neighbor 8.0.0.107
set protocols isis level 1 disable
set protocols isis interface ge-1/2/1.0
set protocols isis interface lo0.0
set protocols ldp interface all
set protocols ldp interface fxp0.0 disable
set protocols ldp interface lo0.0
set routing-instances vpls100 instance-type vpls
set routing-instances vpls100 interface ge-1/1/0.100
set routing-instances vpls100 route-distinguisher 8.0.0.104:100
set routing-instances vpls100 l2vpn-id l2vpn-id:100:100
set routing-instances vpls100 vrf-target target:100:100
set routing-instances vpls100 protocols vpls no-tunnel-services
set routing-instances vpls200 instance-type vpls
set routing-instances vpls200 interface ge-1/1/0.200
set routing-instances vpls200 route-distinguisher 8.0.0.104:200
set routing-instances vpls200 l2vpn-id l2vpn-id:100:200
set routing-instances vpls200 vrf-target target:100:208
set routing-instances vpls200 protocols vpls no-tunnel-services
```

On Device CE2:

```
[edit]
set interfaces ge-1/1/0 vlan-tagging
set interfaces ge-1/1/0 mtu 1400
set interfaces ge-1/1/0 unit 100 vlan-id 100
set interfaces ge-1/1/0 unit 100 family inet address 3.0.100.105/24
set interfaces ge-1/1/0 unit 200 vlan-id 200
set interfaces ge-1/1/0 unit 200 family inet address 3.0.200.105/24
set protocols ospf area 0.0.0.0 interface ge-1/1/0.100
set protocols ospf area 0.0.0.0 interface ge-1/1/0.200
```

On Router RR:

```
[edit]
set interfaces ge-1/3/2 unit 0 description "RR to PE1"
set interfaces ge-1/3/2 unit 0 family inet address 8.0.70.107/24
set interfaces ge-1/3/2 unit 0 family iso
set interfaces ge-1/3/2 unit 0 family mpls
set interfaces lo0 unit 0 family inet address 8.0.0.107/32
set routing-options router-id 8.0.0.107
set routing-options autonomous-system 100
```

```
set protocols bgp group int type internal
set protocols bgp group int local-address 8.0.0.107
set protocols bgp group int family l2vpn auto-discovery-only
set protocols bgp group int cluster 107.107.107.107
set protocols bgp group int neighbor 8.0.0.100
set protocols bgp group int neighbor 8.0.0.104
set protocols isis level 1 disable
set protocols isis interface all
set protocols isis interface fxp0.0 disable
set protocols isis interface lo0.0
set protocols ldp interface all
set protocols ldp interface fxp0.0 disable
set protocols ldp interface lo0.0
```

Router PE1

Step-by-Step Procedure

To configure Router PE1:

1. Configure the interfaces, the interface encapsulation, and the protocol families.

```
[edit]
user@PE1# edit interfaces
[edit interfaces]
user@PE1# set ge-0/1/0 encapsulation flexible-ethernet-services
user@PE1# set ge-0/1/0 unit 100 encapsulation vlan-vpls
user@PE1# set ge-0/1/0 unit 100 family vpls
user@PE1# set ge-0/1/0 unit 200 encapsulation vlan-vpls
user@PE1# set ge-0/1/0 unit 200 family vpls
user@PE1# set ge-0/1/1 unit 0 description "PE1 to PE2"
user@PE1# set ge-0/1/1 unit 0 family inet address 8.0.40.100/24
user@PE1# set ge-0/1/1 unit 0 family iso
user@PE1# set ge-0/1/1 unit 0 family mpls
user@PE1# set ge-0/3/0 unit 0 description "PE1 to RR"
user@PE1# set ge-0/3/0 unit 0 family inet address 8.0.70.100/24
user@PE1# set ge-0/3/0 unit 0 family iso
user@PE1# set ge-0/3/0 unit 0 family mpls
user@PE1# set lo0 unit 0 family inet address 8.0.0.100/32
```

2. Configure the VLANs.

```
[edit interfaces]
user@PE1# set ge-0/1/0 vlan-tagging
user@PE1# set ge-0/1/0 unit 100 vlan-id 100
user@PE1# set ge-0/1/0 unit 100 input-vlan-map pop
user@PE1# set ge-0/1/0 unit 100 output-vlan-map push
user@PE1# set ge-0/1/0 unit 200 vlan-id 200
user@PE1# exit
```

3. Configure the protocol-independent properties.

   We recommend that the router ID be the same as the local address. (See the **local-address** statement in Step 4.)

```
[edit]
user@PE1# edit routing-options
[edit routing-options]
user@PE1# set router-id 8.0.0.100
```

```
user@PE1# set autonomous-system 100
user@PE1# exit
```

4. Configure IBGP, including the **auto-discovery-only** statement.

```
[edit]
user@PE1# edit protocols
[edit protocols]
user@PE1# set bgp group int type internal
user@PE1# set bgp group int local-address 8.0.0.100
user@PE1# set bgp group int family l2vpn auto-discovery-only
user@PE1# set bgp group int neighbor 8.0.0.107
```

5. Configure MPLS, LDP, and an IGP.

```
[edit protocols]
user@PE1# set mpls interface lo0.0
user@PE1# set mpls interface all
user@PE1# set mpls interface fxp0.0 disable
user@PE1# set isis level 1 disable
user@PE1# set isis interface all
user@PE1# set isis interface fxp0.0 disable
user@PE1# set isis interface lo0.0
user@PE1# set ldp interface all
user@PE1# set ldp interface fxp0.0 disable
user@PE1# set ldp interface lo0.0
user@PE1# exit
```

6. Configure the routing instances.

   The **no-tunnel-services** statement is required if you are using LSI interfaces for VPLS instead of **vt** interfaces.

```
[edit]
user@PE1# edit routing-instances
[edit routing-instances]
user@PE1# set vpls100 instance-type vpls
user@PE1# set vpls100 interface ge-0/1/0.100
user@PE1# set vpls100 route-distinguisher 8.0.0.100:100
user@PE1# set vpls100 l2vpn-id l2vpn-id:100:100
user@PE1# set vpls100 vrf-target target:100:100
user@PE1# set vpls100 protocols vpls no-tunnel-services
user@PE1# set vpls200 instance-type vpls
user@PE1# set vpls200 interface ge-0/1/0.200
user@PE1# set vpls200 route-distinguisher 8.0.0.100:200
user@PE1# set vpls200 l2vpn-id l2vpn-id:100:200
user@PE1# set vpls200 vrf-target target:100:208
user@PE1# set vpls200 protocols vpls no-tunnel-services
```

7. If you are done configuring the device, commit the configuration.

```
[edit]
user@PE1# commit
```

Results From configuration mode, confirm your configuration by entering the **show interfaces**, **show protocols**, **show routing-options**, and **show routing-instances** commands. If the

output does not display the intended configuration, repeat the instructions in this example to correct the configuration.

```
user@PE1# show interfaces
ge-0/1/0 {
    vlan-tagging;
    encapsulation flexible-ethernet-services;
    unit 100 {
        encapsulation vlan-vpls;
        vlan-id 100;
        input-vlan-map pop;
        output-vlan-map push;
        family vpls;
    }
    unit 200 {
        encapsulation vlan-vpls;
        vlan-id 200;
        family vpls;
    }
}
ge-0/1/1 {
    unit 0 {
        description "PE1 to PE2";
        family inet {
            address 8.0.40.100/24;
        }
        family iso;
        family mpls;
    }
}
ge-0/3/0 {
    unit 0 {
        description "PE1 to RR";
        family inet {
            address 8.0.70.100/24;
        }
        family iso;
        family mpls;
    }
}
lo0 {
    unit 0 {
        family inet {
            address 8.0.0.100/32;
        }
    }
}
```

```
user@PE1# show protocols
mpls {
    interface lo0.0;
    interface all;
    interface fxp0 disable;
}
bgp {
    group int {
```

```
        type internal;
        local-address 8.0.0.100;
        family l2vpn {
          auto-discovery-only;
        }
        neighbor 8.0.0.107;
      }
    }
    isis {
      level 1 disable;
      interface all;
      interface lo0.0;
      interface fxp0 disable;
    }
    ldp {
      interface lo0.0;
      interface all;
      interface fxp0 disable;
    }

    user@PE1# show routing-options
    router-id 8.0.0.100;
    autonomous-system 100;

    user@PE1# show routing-instances
    vpls100 {
      instance-type vpls;
      interface ge-0/1/0.100;
      route-distinguisher 8.0.0.100:100;
      l2vpn-id l2vpn-id:100:100;
      vrf-target target:100:100;
      protocols {
        vpls {
          no-tunnel-services;
        }
      }
    }
    vpls200 {
      instance-type vpls;
      interface ge-0/1/0.200;
      route-distinguisher 8.0.0.100:200;
      l2vpn-id l2vpn-id:100:200;
      vrf-target target:100:208;
      protocols {
        vpls {
          no-tunnel-services;
        }
      }
    }
```

Device CE1

Step-by-Step Procedure

To configure Device CE1:

1. Configure interface addresses and the interface maximum transmission unit (MTU).

   [edit]

```
user@CE1# edit interfaces
[edit interfaces]
user@CE1# set ge-1/2/1 mtu 1400
user@CE1# set ge-1/2/1 unit 100 family inet address 3.0.100.103/24
user@CE1# set ge-1/2/1 unit 200 family inet address 3.0.200.103/24
```

2. Configure VLANs.

```
[edit interfaces]
user@CE1# set ge-1/2/1 vlan-tagging
user@CE1# set ge-1/2/1 unit 100 vlan-id 100
user@CE1# set ge-1/2/1 unit 200 vlan-id 200
user@CE1# exit
```

3. Configure an IGP.

```
user@CE1# edit protocols
[edit protocols]
user@CE1# set ospf area 0.0.0.0 interface ge-1/2/1.100
user@CE1# set ospf area 0.0.0.0 interface ge-1/2/1.200
user@CE1# exit
```

4. If you are done configuring the device, commit the configuration.

```
[edit]
user@CE1# commit
```

Results From configuration mode, confirm your configuration by entering the **show interfaces** and **show protocols** commands. If the output does not display the intended configuration, repeat the instructions in this example to correct the configuration.

```
user@CE1# show interfaces
ge-1/2/1 {
    vlan-tagging;
    mtu 1400;
    unit 100 {
        vlan-id 100;
        family inet {
            address 3.0.100.103/24;
        }
    }
    unit 200 {
        vlan-id 200;
        family inet {
            address 3.0.200.103/24;
        }
    }
}
```

```
user@CE1# show protocols
ospf {
    area 0.0.0.0 {
        interface ge-1/2/1.100;
        interface ge-1/2/1.200;
    }
}
```

Router PE2

Step-by-Step Procedure

To configure Router PE2:

1. Configure the interfaces, the interface encapsulation, and the protocol families.

```
[edit]
user@PE2# edit interfaces
[edit interfaces]
user@PE2# set ge-1/1/0 encapsulation flexible-ethernet-services
user@PE2# set ge-1/1/0 unit 100 encapsulation vlan-vpls
user@PE2# set ge-1/1/0 unit 100 family vpls
user@PE2# set ge-1/1/0 unit 200 encapsulation vlan-vpls
user@PE2# set ge-1/1/0 unit 200 family vpls
user@PE2# set ge-1/2/1 unit 0 description "PE2 to PE1"
user@PE2# set ge-1/2/1 unit 0 family inet address 8.0.40.104/24
user@PE2# set ge-1/2/1 unit 0 family iso
user@PE2# set ge-1/2/1 unit 0 family mpls
user@PE2# set lo0 unit 0 family inet address 8.0.0.104/32
```

2. Configure the VLANs.

```
[edit interfaces]
user@PE2# set ge-1/1/0 vlan-tagging
user@PE2# set ge-1/1/0 unit 100 vlan-id 100
user@PE2# set ge-1/1/0 unit 100 input-vlan-map pop
user@PE2# set ge-1/1/0 unit 100 output-vlan-map push
user@PE2# set ge-1/1/0 unit 200 vlan-id 200
user@PE2# exit
```

3. Configure the protocols-independent properties.

   We recommend that the router ID be the same as the local address. (See the **local-address** statement in Step 4.)

```
[edit]
user@PE2# edit routing-options
[edit routing-options]
user@PE2# set router-id 8.0.0.104
user@PE2# set autonomous-system 100
```

4. Configure IBGP, including the **auto-discovery-only** statement.

```
[edit]
user@PE2# edit protocols
[edit protocols]
user@PE2# set bgp group int type internal
user@PE2# set bgp group int local-address 8.0.0.104
user@PE2# set bgp group int family l2vpn auto-discovery-only
user@PE2# set bgp group int neighbor 8.0.0.107
```

5. Configure MPLS, LDP, and an IGP.

```
[edit protocols]
user@PE2# set mpls interface lo0.0
user@PE2# set mpls interface all
user@PE2# set mpls interface fxp0.0 disable
user@PE2# set isis level 1 disable
```

```
user@PE2# set isis interface ge-1/2/1.0
user@PE2# set isis interface lo0.0
user@PE2# set ldp interface all
user@PE2# set ldp interface fxp0.0 disable
user@PE2# set ldp interface lo0.0
user@PE2# exit
```

6. Configure the routing instances.

   The **no-tunnel-services** statement is required if you are using LSI interfaces for VPLS instead of **vt** interfaces.

```
[edit]
user@PE2# edit routing-instances
[edit routing-instances]
user@PE2# set vpls100 instance-type vpls
user@PE2# set vpls100 interface ge-1/1/0.100
user@PE2# set vpls100 route-distinguisher 8.0.0.104:100
user@PE2# set vpls100 l2vpn-id l2vpn-id:100:100
user@PE2# set vpls100 vrf-target target:100:100
user@PE2# set vpls100 protocols vpls no-tunnel-services
user@PE2# set vpls200 instance-type vpls
user@PE2# set vpls200 interface ge-1/1/0.200
user@PE2# set vpls200 route-distinguisher 8.0.0.104:200
user@PE2# set vpls200 l2vpn-id l2vpn-id:100:200
user@PE2# set vpls200 vrf-target target:100:208
user@PE2# set vpls200 protocols vpls no-tunnel-services
```

7. If you are done configuring the device, commit the configuration.

```
[edit]
user@PE2# commit
```

Results From configuration mode, confirm your configuration by entering the **show interfaces**, **show protocols**, **show routing-options**, and **show routing-instances** commands. If the output does not display the intended configuration, repeat the instructions in this example to correct the configuration.

```
user@PE2# show interfaces
ge-1/1/0 {
    vlan-tagging;
    encapsulation flexible-ethernet-services;
    unit 100 {
        encapsulation vlan-vpls;
        vlan-id 100;
        input-vlan-map pop;
        output-vlan-map push;
        family vpls;
    }
    unit 200 {
        encapsulation vlan-vpls;
        vlan-id 200;
        family vpls;
    }
}
ge-1/2/1 {
```



```
    unit 0 {
      description "PE2 to PE1";
      family inet {
        address 8.0.40.104/24;
      }
      family iso;
      family mpls;
    }
  }
  lo0 {
    unit 0 {
      family inet {
        address 8.0.0.104/32;
      }
    }
  }
```

```
user@PE2# show protocols
mpls {
  interface lo0.0;
  interface all;
  interface fxp0 disable;
}
bgp {
  group int {
    type internal;
    local-address 8.0.0.104;
    family l2vpn {
      auto-discovery-only;
    }
    neighbor 8.0.0.107;
  }
}
isis {
  level 1 disable;
  interface ge-1/2/1.0;
  interface lo0.0;
}
ldp {
  interface lo0.0;
  interface all;
  interface fxp0 disable;
}
```

```
user@PE2# show routing-options
router-id 8.0.0.104;
autonomous-system 100;
```

```
user@PE2# show routing-instances
vpls100 {
  instance-type vpls;
  interface ge-1/1/0.100;
  route-distinguisher 8.0.0.104:100;
  l2vpn-id l2vpn-id:100:100;
  vrf-target target:100:100;
  protocols {
    vpls {
```

```
        no-tunnel-services;
      }
    }
  }
  vpls200 {
    instance-type vpls;
    interface ge-1/1/0.200;
    route-distinguisher 8.0.0.104:200;
    l2vpn-id l2vpn-id:100:200;
    vrf-target target:100:208;
    protocols {
      vpls {
        no-tunnel-services;
      }
    }
  }
```

Device CE2

Step-by-Step Procedure

To configure Device CE2:

1. Configure VLAN interfaces.

```
[edit]
user@CE2# edit interfaces ge-1/1/0
[edit interfaces ge-1/1/0]
user@CE2# set vlan-tagging
user@CE2# set mtu 1400
user@CE2# set unit 100 vlan-id 100
user@CE2# set unit 100 family inet address 3.0.100.105/24
user@CE2# set unit 200 vlan-id 200
user@CE2# set unit 200 family inet address 3.0.200.105/24
user@CE2# exit
```

2. Configure OSPF on the interfaces.

```
[edit]
user@CE2# edit protocols ospf area 0.0.0.0
[edit protocols ospf area 0.0.0.0]
user@CE2# set interface ge-1/1/0.100
user@CE2# set interface ge-1/1/0.200
user@CE2# exit
```

3. If you are done configuring the device, commit the configuration.

```
[edit]
user@CE2# commit
```

Results

From configuration mode, confirm your configuration by entering the **show interfaces** and **show protocols** commands. If the output does not display the intended configuration, repeat the instructions in this example to correct the configuration.

```
user@CE2# show interfaces
ge-1/1/0 {
  vlan-tagging;
  mtu 1400;
```

```
    unit 100 {
      vlan-id 100;
      family inet {
        address 3.0.100.105/24;
      }
    }
    unit 200 {
      vlan-id 200;
      family inet {
        address 3.0.200.105/24;
      }
    }
  }
```

```
user@CE2# show protocols
ospf {
  area 0.0.0.0 {
    interface ge-1/1/0.100;
    interface ge-1/1/0.200;
  }
}
```

Router RR

Step-by-Step Procedure

To configure Router RR:

1. Configure interface addresses and the protocol families.

```
[edit]
user@RR# edit interfaces
[edit interfaces]
user@RR# set ge-1/3/2 unit 0 description "RR to PE1"
user@RR# set ge-1/3/2 unit 0 family inet address 8.0.70.107/24
user@RR# set ge-1/3/2 unit 0 family iso
user@RR# set ge-1/3/2 unit 0 family mpls
user@RR# set lo0 unit 0 family inet address 8.0.0.107/32
user@RR# exit
```

2. Configure the autonomous systems and the router ID.

```
[edit]
user@RR# edit routing-options
[edit routing-options]
user@RR# set autonomous-system 100
user@RR# set router-id 8.0.0.107
user@RR# exit
```

3. Configure BGP and set this router to be the route reflector. Route reflection is optional for FEC 129.

```
[edit]
user@RR# edit protocols bgp group int
[edit protocols bgp group int]
user@RR# set type internal
user@RR# set local-address 8.0.0.107
user@RR# set family l2vpn auto-discovery-only
user@RR# set cluster 107.107.107.107
```

```
user@RR# set neighbor 8.0.0.100
user@RR# set neighbor 8.0.0.104
user@RR# exit
```

4. Configure IS-IS for the IGP.

```
[edit]
user@RR# edit protocols isis
[edit protocols isis]
user@RR# set level 1 disable
user@RR# set interface all
user@RR# set interface fxp0.0 disable
user@RR# set interface lo0.0
user@RR# exit
```

5. Configure LDP for the MPLS signaling protocol.

```
[edit]
user@RR# edit protocols ldp
[edit protocols ldp]
user@RR# set interface all
user@RR# set interface fxp0.0 disable
user@RR# set interface lo0.0
user@RR# exit
```

6. If you are done configuring the device, commit the configuration.

```
[edit]
user@RR# commit
```

Results From configuration mode, confirm your configuration by entering the **show interfaces**, **show protocols**, and **show routing-options** commands. If the output does not display the intended configuration, repeat the instructions in this example to correct the configuration.

```
user@RR# show interfaces
ge-1/3/2 {
    unit 0 {
        description "RR to PE1";
        family inet {
            address 8.0.70.107/24;
        }
        family iso;
        family mpls;
    }
}
lo0 {
    unit 0 {
        family inet {
            address 8.0.0.107/32;
        }
    }
}
```

```
user@RR# show protocols
bgp {
    group int {
        type internal;
```

```
        local-address 8.0.0.107;
        family l2vpn {
          auto-discovery-only;
        }
        cluster 107.107.107.107;
        neighbor 8.0.0.100;
        neighbor 8.0.0.104;
      }
    }
    isis {
      level 1 disable;
      interface lo0.0;
      interface all;
      interface fxp0 disable;
    }
    ldp {
      interface lo0.0;
      interface all;
      interface fxp0 disable;
    }

    user@RR# show routing-options
    router-id 8.0.0.107;
    autonomous-system 100;
```

Verification

To verify the operation, use the following commands:

- **show route extensive**
- **show route advertising-protocol bgp** ***neighbor***
- **show route receive-protocol bgp** ***neighbor***
- **show route table bgp.l2vpn.0**
- **show route table vpls100.l2vpn.0**
- **show route table vpls200.l2vpn.0**
- **show vpls connections extensive**
- **show vpls mac-table detail**
- **show vpls statistics**

AD in the routing table output indicates autodiscovery NLRI.

Related Documentation

- Example: Configuring BGP Autodiscovery for LDP VPLS with User-Defined Mesh Groups on page 106
- Configuring Interoperability Between BGP Signaling and LDP Signaling in VPLS on page 70
- Virtual Private LAN Service Overview
- VPLS Protocol Operation

Example: Configuring BGP Autodiscovery for LDP VPLS with User-Defined Mesh Groups

This example describes how to configure user-defined mesh groups for BGP autodiscovery for LDP VPLS, as specified in forwarding equivalency class (FEC) 129. FEC 129 uses BGP autodiscovery to convey endpoint information, so you do not need to manually configure pseudowires. You configure mesh groups on the border router to group the sets of PE routers that are automatically fully meshed and that 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.

Requirements

Before you begin, configure BGP autodiscovery for LDP VPLS. See "Example: Configuring BGP Autodiscovery for LDP VPLS" on page 89.

Overview

Configuration for a mesh group for FEC 129 is very similiar to the mesh-group configuration for FEC 128.

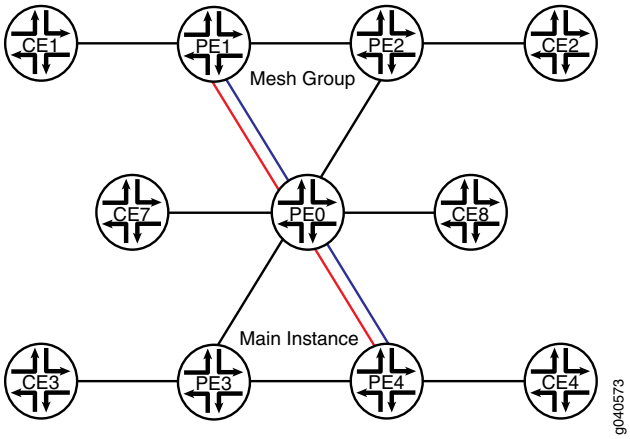
Note the following differences for FEC 129:

- Each user-defined mesh group must have a unique route distinguisher. Do not use the route distinguisher that is defined for the default mesh group at the **[edit routing-intances]** hierarchy level.
- Each user-defined mesh group must have its own import and export route target.
- Each user-defined mesh group can have a unique Layer 2 VPN ID. By default, all the mesh groups that are configured for a VPLS routing instance use the same Layer 2 VPN ID as the one that you configure at the **[edit routing-instances]** hierarchy level.

Topology Diagram

Figure 11 on page 107 shows a topology that includes a user-defined mesh group.

Figure 11: BGP Autodiscovery for LDP VPLS with a User-Defined Mesh Group



Configuration

CLI Quick Configuration

To quickly configure a mesh group, copy the following commands, remove any line breaks, and then paste the commands into the CLI of each device.

```
[edit]
set routing-instances red instance-type vpls
set routing-instances red route-distinguisher 10.10.10.2:3
set routing-instances red l2vpn-id l2vpn-id:100:3
set routing-instances red vrf-target target:100:3
set routing-instances red protocols vpls mesh-group regional-1 route-distinguisher
  10.10.10.2:33
set routing-instances red protocols vpls mesh-group regional-1 vrf-target target:100:33
```

Step-by-Step Procedure

To configure a mesh group:

1. Set the routing instance type to VPLS.

   ```
   [edit]
   user@PE1# set routing-instances red instance-type vpls
   ```

2. Configure the route distinguisher for the routing instance.

   This route distinguisher is used for the default mesh group.

   ```
   [edit]
   user@PE1# set routing-instances red route-distinguisher 10.10.10.2:3
   ```

3. Set the Layer 2 VPN ID for the default mesh group.

   ```
   user@PE1# set routing-instances red l2vpn-id l2vpn-id:100:3
   ```

4. Set the import and export route target for the default mesh group.

   ```
   user@PE1# set routing-instances red vrf-target target:100:3
   ```

5. Set the route distinguisher for the user-defined mesh group.

   ```
   user@PE1# set routing-instances red protocols vpls mesh-group regional-1
     route-distinguisher 10.10.10.2:33
   ```

6. Set the import and export route target for the user-defined mesh group.

```
user@PE1# set routing-instances red protocols vpls mesh-group regional-1 vrf-target
  target:100:33
```

7. If you are done configuring the device, commit the configuration.

```
[edit]
user@PE1# commit
```

Results From configuration mode, confirm your configuration by entering the **show routing-instances** command. If the output does not display the intended configuration, repeat the instructions in this example to correct the configuration.

```
user@PE1# show routing-instances
red {
   instance-type vpls;
   route-distinguisher 10.10.10.2:3;
   l2vpn-id l2vpn-id:100:3;
   vrf-target target:100:3;
   protocols {
      vpls {
         mesh-group regional-1 {
            route-distinguisher 10.10.10.2:33;
            vrf-target target:100:33;
         }
      }
   }
}
```

Verification

To verify the operation, run the following commands:

- **show route extensive**
- **show route advertising-protocol bgp** *neighbor*
- **show route receive-protocol bgp** *neighbor*
- **show route table bgp.l2vpn.0**
- **show route table red.l2vpn.0**
- **show vpls connections extensive**
- **show vpls mac-table detail**
- **show vpls statistics**

AD in the routing table output indicates autodiscovery NLRI.

Related Documentation

- Example: Configuring BGP Autodiscovery for LDP VPLS on page 89
- Configuring Interoperability Between BGP Signaling and LDP Signaling in VPLS on page 70
- Virtual Private LAN Service Overview

- VPLS Protocol Operation

CHAPTER 5

Additional Examples

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.

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.

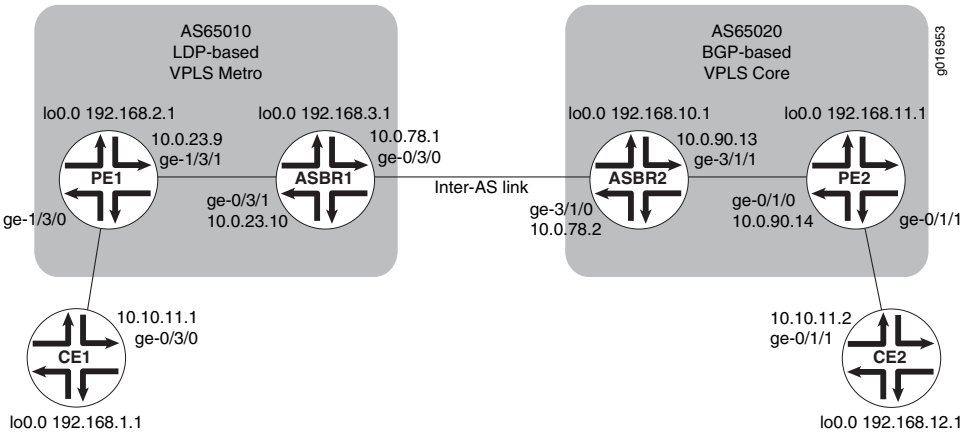
The sample metro network is configured for LDP-signaled VPLS. The core network is configured for BGP-signaled VPLS.

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 12 on page 113 shows the topology used in this example.

Figure 12: 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 on page 113
- Configuring OSPF on page 115
- Configuring the Internal BGP Peer Group on page 116
- Configuring LDP on page 118
- Configuring MPLS on page 119
- Configuring the External BGP Peer Group Between the Loopback Interfaces on page 119
- Configuring the External BGP Peer Group Between the Inter-AS Link Interfaces on page 120
- Configuring the VPLS Routing Instances on page 124

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

VPLS Label Blocks Operation

A virtual private LAN service (VPLS) is a Layer 2 (L2) service that emulates a local area network (LAN) across a wide area network (WAN). VPLS labels are defined and exchanged in the Border Gateway Protocol (BGP) control plane. In the Junos OS implementation, label blocks are allocated and used in the VPLS control plane for two primary functions: autodiscovery and signaling.

- Autodiscovery—A method for automatically recognizing each provider edge (PE) router in a particular VPLS domain, using BGP update messages.
- Signaling—Each pair of PE routers in a VPLS domain sends and withdraws VPN labels to each other. The labels are used to establish and dismantle pseudowires between the routers. Signaling is also used to transmit certain characteristics of a pseudowire.

The PE router uses BGP extended communities to identify the members of its VPLS. Once the PE router discovers its members, it is able to establish and tear down

pseudowires between members by exchanging and withdrawing labels and transmitting certain characteristics of the pseudowires.

The PE router sends common update messages to all remote PE routers, using a distinct BGP update message, thereby reducing the control plane load. This is achieved by using VPLS label blocks.

Elements of Network Layer Reachability Information

VPLS BGP network layer reachability information (NLRI) is used to exchange VPLS membership and parameters. The elements of a VPLS BGP NLRI are defined in Table 3 on page 17.

Table 7: NLRI Elements

Element	Acronym	Description	Default Size (Octets)
Length		Total length of the NLRI size represented in bytes.	2
Route Distinguisher	RD	Unique identifier for each routing instance configured on a PE.	8
VPLS Edge ID	VE ID	Unique number to identify the edge site.	2
VE Block Offset	VBO	Value used to identify a label block from which a label value is selected to set up pseudowires for a remote site.	2
VE Block Size	VBS	Indicates the number of pseudowires that peers can have in a single block.	2
Label Base	LB	Starting value of the label in the advertised label block.	3

Requirements for NLRI Elements

Junos OS requires a unique route distinguisher (RD) for each routing instance configured on a PE router. A PE router might use the same RD across a VPLS (or VPN) domain or it might use different RDs. Using different RDs helps identify the originator of the VPLS NLRI.

The VPLS edge (VE) ID can be a unique VE ID, site ID, or customer edge (CE) ID. The VE ID is used by a VPLS PE router to index into label blocks used to derive the transmit and receive VPN labels needed for transport of VPLS traffic. The VE ID identifies a particular site, so it needs to be unique within the VPLS domain, except for some scenarios such as multihoming.

All PE routers have full mesh connectivity with each other to exchange labels and set up pseudowires. The VE block size (VBS) is a configurable value that represents the number of label blocks required to cover all the pseudowires for the remote peer.

A single label block contains 8 labels (1 octet) by default. The default VBS in Junos OS is 2 blocks (2 octets) for a total of 16 labels.

How Labels are Used in Label Blocks

Each PE router creates a mapping of the labels in the label block to the sites in a VPLS domain. A PE router advertising a label block with a block offset indicates which sites can use the labels to reach it. When a PE router is ready to advertise its membership to a VPLS domain, it allocates a label block and advertises the VPLS NLRI. In this way, other PE routers in the same VPLS domain can learn of the existence of the VPLS and set up pseudowires to it if needed. The VPLS NLRI advertised for this purpose is referred to as the *default VPLS NLRI*. The label block in the default VPLS NLRI is referred to as the *default label block*.

Label Block Composition

A label block (set of labels) is used to reach a given site ID. A single label block contains 8 labels (1 octet) by default. The VBS is 2 octets by default in Junos OS.

The label block advertised is defined as a label base (LB) and a VE block size (VBS). It is a contiguous set of labels (LB, LB+1,...LB+VBS-1). For example, when Router PE-A sends a VPLS update, it sends the same label block information to all other PE routers. Each PE router that receives the LB advertisement infers the label intended for Router PE-A by adding its own site ID to the label base.

In this manner, each receiving PE gets a unique label for PE-A for that VPLS. This simple method is enhanced by using a VE block offset (VBO).

A label block is defined as: <Label Base (LB), VE block offset (VBO), VE block size (VBS)> is the set {LB+VBO, LB+VBO+1,...,LB+VBO+VBS-1}.

Label Blocks in Junos OS

Instead of a single large label block to cover all VE IDs in a VPLS, the Junos OS implementation contains several label blocks, each with a different label base. This makes label block management easier, and also allows Router PE-A to seemlessly integrate a PE router joining a VPLS with a site ID not covered by the set of label blocks that Router PE-A has already advertised.

VPLS Label Block Structure

This section illustrates how a label block is uniquely identified.

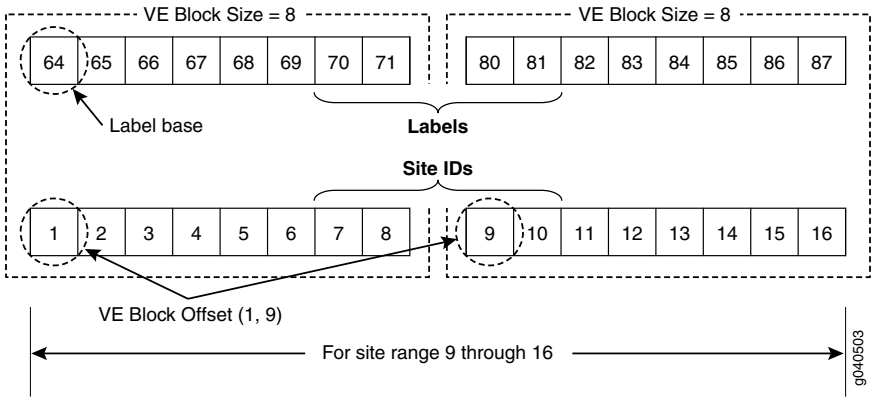
A VPLS BGP NLRI with site ID V, VE block offset VBO, VE block size VBS, and label base LB communicates the following to its peers:

- Label block for V: Labels from LB to (LB + VBS -1).
- Remote VE set for V: from VBO to (VBO + VBS -1).

The label block advertised is a set of labels used to reach a given site ID. If there are several label blocks, the remote VE set helps to identify which label block to use. The

example in Figure 4 on page 19 illustrates label blocks. There are two blocks and each block has eight labels. In this example, the label values are 64 to 71 and 80 to 87.

Figure 13: VPLS Label Block Structure



To create a one-to-one mapping of these 16 labels to 16 sites, assume the site IDs are the numbers 1 to 16, as shown in the illustration. The site block indicates which site ID can use which label in the label block. So, in the first block, site ID 1 uses 64, site ID 2 uses 65, and so forth. Finally, site ID 8 uses 71. The 9th site ID will use the second block instead of the first block.

The labels are calculated by comparing the values of VBO < = Local site ID < (VBO +VBS). Consequently, site ID 9 uses 80, site ID 10 uses 81, and so on.

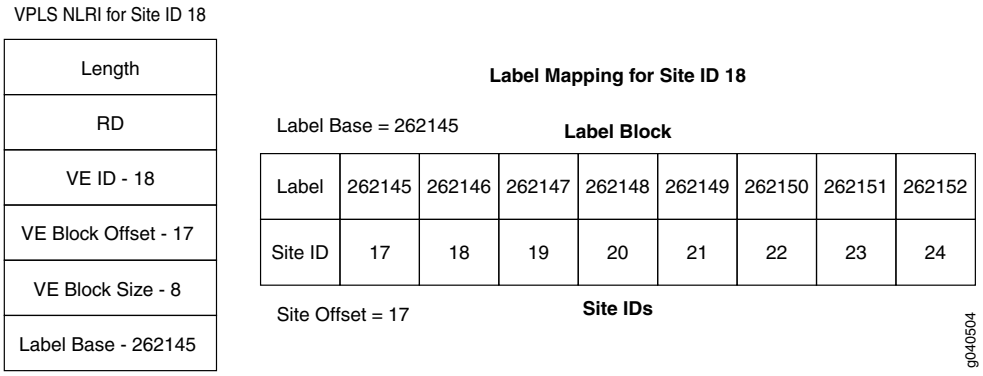
To further illustrate the one-to-one mapping of labels to sites, assume a label block with site offset of 1 and a label base of 10. The combination of label base and block offset contained in the VPLS NLRI provides the mapping of labels to site IDs. The block offset is the starting site ID that can use the label block as advertised in the VPLS NLRI.

To advertise the default VPLS NLRI, a PE router picks a starting block offset that fits its own site ID and is such that the end block offset is a multiple of a single label block. In Junos OS a single label block is eight labels by default.

The end block offset is the last site ID that maps to the last label in the label block. The end offset for the first block is 8 which maps to label 17 and the second block is 16. For example, a site with ID 3 picks a block offset of 1 and advertises a label block of size 8 to cover sites with IDs 1 to 8. A site with ID 10 picks a block offset of 9 to cover sites with IDs 9 to 16.

The VPLS NLRI shown in Figure 5 on page 20 is for site ID 18. The label base contains value 262145. The block offset contains value 17. The illustration shows which site IDs correspond to which labels.

Figure 14: Label Mapping Example



If a PE router configured with site ID 17 is in the same VPLS domain as a PE router configured with site ID 18, it receives the VPLS NLRI as shown in Figure 3. So it uses label 262145 to send traffic to site 18. Similarly, a PE router configured with site ID 19 uses label 262147 to send traffic to a PE router configured with site ID 18. However, only PE routers configured with site IDs 17 to 24 can use the label block shown to set up pseudowires.

Related Documentation

- Example: Building a VPLS From Router 1 to Router 3 to Validate Label Blocks on page 83

Example: Building a VPLS From Router 1 to Router 3 to Validate Label Blocks

This example illustrates how VPLS label blocks are allocated for a specific configuration. It is organized in the following sections:

- Requirements on page 141
- Overview and Topology on page 141
- Configuration on page 143

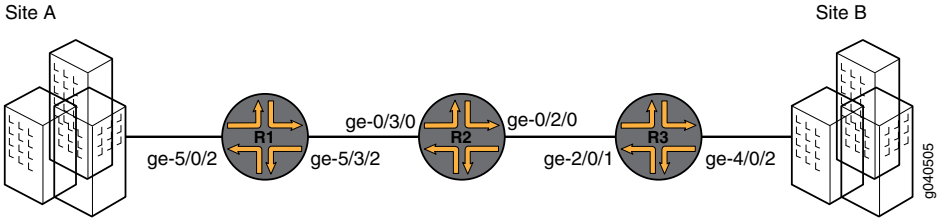
Requirements

This configuration example requires three Juniper Networks routers.

Overview and Topology

In the network shown in Figure 9 on page 83 Router 1 is establishing a pseudowire to Router 3

Figure 15: Router 1 to Router 3 Topology



Each PE filters the VPLS NLRI contained in the BGP update messages based on route target communities. Those VPLS NLRI instances that match the route target (in this case

8717:2000:2:1) are imported for further processing. The NLRI for Router 1 and Router 3 is shown in Table 6 on page 84.

Table 8: NLRI Exchange Between for Router 1 and Router 3

Router 1 NLRI Advertisement to Router 3	Router 3 NLRI Advertisement to Router 1
RD - 8717:1000	RD - 8717:1000
VE ID - 1	VE ID - 2
VE Block Offset - 1	VE Block Offset - 1
VE Block Size - 8	VE Block Size - 8
Label Base - 262161	Label Base - 262153

To set up a pseudowire to Router 3, Router 1 must select a label to use to send traffic to Router 3 and also select a label that it expects Router 3 to use to send traffic to itself. The site ID contained in the VPLS NLRI from Router 3 is 2.

Router 1 learns of the existence of site ID 2 in the same VPLS domain. Using the equation VBO <= Local Site ID < (VBO +VBS), Router 1 checks if the route advertised by site ID 2 fits in the label block and block offset that it previously advertised to Router 3. In this example it does fit, so the site ID 2 is mapped by the VPLS NLRI advertised by Router 1, and Router 1 is ready to set up a pseudowire to Router 3.

To select the label to reach Router 3, Router 1 looks at the label block advertised by Router 3 and performs a calculation. The calculation a PE router uses to check if its site ID is mapped in the label block from the remote peer is VBO <= Local Site ID < (VBO +VBS). So, Router 1 selects label (262153 + (1 -1)) = 262153 to send traffic to Router 3. Using the same equation, Router 1 looks at its own label block that it advertised and selects label (262161 + (2 - 1)) = 262162 to receive traffic from Router 3. Router 1 programs its forwarding state such that any traffic destined to Router 3 carries the pseudowire label 262153 and any traffic coming from Router 3 is expected to have the pseudowire label 262162. This completes the operations on the VPLS NLRI received from Router 3. Router 1 now has a pseudowire set up to Router 3.

Router 3 operation is very similar to the Router 1 operation. Since the Router 3 site ID of 2 fits in the label block and block offset advertised by Router 1, Router 3 selects label (262161 + (2 - 1)) = 262162 to send traffic to Router 1. Router 3 looks at its own label block that it advertised and selects label (262153 + (1 - 1)) = 262153 to receive traffic from Router 1. This completes the creation of a pseudowire to Router 1.

By default, for VPLS operation Junos OS uses a virtual tunnel (VT) loopback interface to represent a pseudowire. This example uses a label-switched interface (LSI) instead of a VT interface because there is no change in the VPLS control plane operation. Thus, for an MX platform, if there is a tunnel physical interface card (PIC) configured, it is mandatory to include the **no-tunnel-services** statement at the **[edit routing-instances *routing-instance-name* protocols vpls]** hierarchy level.

Configuration

The following sections present the steps to configure and verify the example in Figure 9 on page 83.

Configuring Router 1

Step-by-Step Procedure

1. Configure Router 1. Create the **edut** routing instance. Specify the **vpls** instance type. Configure the route distinguisher and specify the value **8717:1000**. Configure the route target and specify the value **8717:100** Configure the VPLS protocol. Specify **10** as the site range. Specify **1** as the site ID. Include the **no-tunnel-services** statement.

```
[edit routing-instances]
edut {
   instance-type vpls;
   interface ge-5/0/2.0;
   route-distinguisher 8717:1000;
   vrf-target target:8717:100;
   protocols {
      vpls {
         site-range 10;
         no-tunnel-services;
         site router-1 {
            site-identifier 1;
         }
      }
   }
}
```

Configuring Router 3

Step-by-Step Procedure

1. Configure Router 3. Create the **edut** routing instance. Specify the **vpls** instance type. Configure the route distinguisher and specify the value **8717:2000**. Configure the route target and specify the value **8717:200** Configure the VPLS protocol. Specify **10** as the site range. Specify **2** as the site ID. Include the **no-tunnel-services** statement.

```
[edit routing-instances]
edut {
   instance-type vpls;
   interface ge-4/0/2.0;
   route-distinguisher 8717:2000;
   vrf-target target:8717:100;
   protocols {
      vpls {
         site-range 10;
         no-tunnel-services;
         site router-3 {
            site-identifier 2;
         }
```

```
        }
      }
    }
```

Verifying the VPLS Label Allocations

Step-by-Step Procedure

1. As shown in the figure and the configuration, Site A is attached to Router 1. Site A is assigned a site ID of 1. Before Router 1 can announce its membership to VPLS **edut** using a BGP update message, Router 1 needs to allocate a default label block. In this example, the label base of the label block allocated by Router 1 is 262161. Since Router 1's site ID is 1, Router 1 associates the assigned label block with block offset of 1. The following messages aresent from Router 1 to Router 3 and displayed using the **monitor traffic interface** ***interface-name*** command:

```
user@Router1> monitor traffic interface ge-5/3/2

Jun 14 12:26:31.280818 BGP SEND 10.10.10.1+179 -> 10.10.10.3+53950
Jun 14 12:26:31.280824 BGP SEND message type 2 (Update) length 88
Jun 14 12:26:31.280828 BGP SEND flags 0x40 code Origin(1): IGP
Jun 14 12:26:31.280833 BGP SEND flags 0x40 code ASPath(2) length 0: <null>
Jun 14 12:26:31.280837 BGP SEND flags 0x40 code LocalPref(5): 100
Jun 14 12:26:31.280844 BGP SEND flags 0xc0 code Extended Communities(16): 2:8717:100 800a:19:0:0
Jun 14 12:26:31.280848 BGP SEND flags 0x90 code MP_reach(14): AFI/SAFI 25/65
Jun 14 12:26:31.280853 BGP SEND         nhop 10.10.10.1 len 4
Jun 14 12:26:31.280862 BGP SEND         8717:1000:1:1 (label base : 262161 range : 8, ce id: 1, offset: 1)
Jun 14 12:26:31.405067 BGP RECV 10.10.10.3+53950 -> 10.10.10.1+179
Jun 14 12:26:31.405074 BGP RECV message type 2 (Update) length 88
Jun 14 12:26:31.405080 BGP RECV flags 0x40 code Origin(1): IGP
Jun 14 12:26:31.405085 BGP RECV flags 0x40 code ASPath(2) length 0: <null>
Jun 14 12:26:31.405089 BGP RECV flags 0x40 code LocalPref(5): 100
Jun 14 12:26:31.405096 BGP RECV flags 0xc0 code Extended Communities(16): 2:8717:100 800a:19:0:0
Jun 14 12:26:31.405101 BGP RECV flags 0x90 code MP_reach(14): AFI/SAFI 25/65
Jun 14 12:26:31.405106 BGP RECV         nhop 10.10.10.3 len 4
Jun 14 12:26:31.405116 BGP RECV         8717:2000:2:1 (label base : 262153 range : 8, ce id: 2, offset:
1)
```

2. As shown in the figure and the configuration, Site B is attached to Router 3. Site B is assigned a site ID of 2. Before Router 3 can announce its membership to VPLS **edut** using a BGP update message, Router 3 assigns a default label block with the label base of **262153**. The block offset for this label block is 1 because its own site ID of 2 fits in the block being advertised. The following messages are sent from Router 3 to Router 1 and displayed using the **monitor traffic interface** ***interface-name*** command:

```
user@Router3> monitor traffic interface ge-2/0/1

Jun 14 12:26:31.282008 BGP SEND 10.10.10.3+53950 -> 10.10.10.1+179
Jun 14 12:26:31.282018 BGP SEND message type 2 (Update) length 88
Jun 14 12:26:31.282026 BGP SEND flags 0x40 code Origin(1): IGP
Jun 14 12:26:31.282034 BGP SEND flags 0x40 code ASPath(2) length 0: <null>
Jun 14 12:26:31.282041 BGP SEND flags 0x40 code LocalPref(5): 100
Jun 14 12:26:31.282052 BGP SEND flags 0xc0 code Extended Communities(16): 2:8717:100 800a:19:0:0
Jun 14 12:26:31.282078 BGP SEND flags 0x90 code MP_reach(14): AFI/SAFI 25/65
Jun 14 12:26:31.282088 BGP SEND         nhop 10.10.10.3 len 4
Jun 14 12:26:31.282102 BGP SEND         8717:2000:2:1 (label base : 262153 range : 8, ce id: 2, offset: 1)

Jun 14 12:26:31.283395 BGP RECV 10.10.10.1+179 -> 10.10.10.3+53950
Jun 14 12:26:31.283405 BGP RECV message type 2 (Update) length 88
```

```
Jun 14 12:26:31.283412 BGP RECV flags 0x40 code Origin(1): IGP
Jun 14 12:26:31.283419 BGP RECV flags 0x40 code ASPath(2) length 0: <null>
Jun 14 12:26:31.283426 BGP RECV flags 0x40 code LocalPref(5): 100
Jun 14 12:26:31.283435 BGP RECV flags 0xc0 code Extended Communities(16): 2:8717:100 800a:19:0:0
Jun 14 12:26:31.283443 BGP RECV flags 0x90 code MP_reach(14): AFI/SAFI 25/65
Jun 14 12:26:31.283471 BGP RECV         nhop 10.10.10.1 len 4
Jun 14 12:26:31.283486 BGP RECV         8717:1000:1:1 (label base : 262161 range : 8, ce id: 1, offset:
1)
```

3. Verify the connection status messages for Router 1 using the **show vpls connections** command. Notice the base label is **262161**, the incoming label from Router 3 is **262162**, and the outgoing label to Router 3 is **262153**.

```
user@Router1> show vpls connections instance edut extensive

Instance: edut
  Local site: router-1 (1)
    Number of local interfaces: 1
    Number of local interfaces up: 1
    IRB interface present: no
    ge-5/0/2.0
    lsi.1049600         2         Intf - vpls edut local site 1 remote site 2
    Label-base        Offset     Range     Preference
    262161            1          8         100
    connection-site           Type  St     Time last up          # Up trans
    2                         rmt   Up     Jun 14 12:26:31 2009           1
      Remote PE: 10.10.10.3, Negotiated control-word: No
      Incoming label: 262162, Outgoing label: 262153
      Local interface: lsi.1049600, Status: Up, Encapsulation: VPLS
        Description: Intf - vpls edut local site 1 remote site 2
    Connection History:
        Jun 14 12:26:31 2009  status update timer
        Jun 14 12:26:31 2009  loc intf up                  lsi.1049600
        Jun 14 12:26:31 2009  PE route changed
        Jun 14 12:26:31 2009  Out lbl Update                    262153
        Jun 14 12:26:31 2009  In lbl Update                     262162
        Jun 14 12:26:31 2009  loc intf down

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
PF -- Profile parse failure      PB -- Profile busy

Legend for interface status
```

```
Up -- operational
Dn -- down
```

4. Verify the connection status messages for Router 3 using the **show vpls connections** command. Notice the base label is **262153**, the incoming label from Router 1 is **262153**, and the outgoing label to Router 1 is **262162**.

```
user@Router3> show vpls connections instance edut extensive

Instance: edut
  Local site: router-3 (2)
    Number of local interfaces: 1
    Number of local interfaces up: 1
    IRB interface present: no
    ge-4/0/2.0
    lsi.1050368         1         Intf - vpls edut local site 2 remote site 1
    Label-base        Offset     Range     Preference
    262153            1          8         100
    connection-site           Type  St     Time last up          # Up trans
    1                         rmt   Up     Jun 14 12:26:31 2009           1
      Remote PE: 10.10.10.1, Negotiated control-word: No
      Incoming label: 262153, Outgoing label: 262162
      Local interface: lsi.1050368, Status: Up, Encapsulation: VPLS
        Description: Intf - vpls edut local site 2 remote site 1
    Connection History:
        Jun 14 12:26:31 2009  status update timer
        Jun 14 12:26:31 2009  loc intf up                  lsi.1050368
        Jun 14 12:26:31 2009  PE route changed
        Jun 14 12:26:31 2009  Out lbl Update                    262162
        Jun 14 12:26:31 2009  In lbl Update                     262153
        Jun 14 12:26:31 2009  loc intf down

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
PF -- Profile parse failure      PB -- Profile busy

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

Related Documentation

- VPLS Label Blocks Operation on page 16

Next-Generation VPLS Point-to-Multipoint Forwarding Overview

VPLS is a Layer 2 solution for efficiently sending multicast traffic over a multiprotocol label switching (MPLS) core.

VPLS emulates the broadcast domain of a LAN across an MPLS network cloud. Traditional MPLS implementations of VPLS require that all participating ingress provider edge (PE) routers make separate copies of each broadcast or multicast packet to send to all other PE routers that are part of the VPLS site for the same extended LAN. In a large virtual private network (VPN), replication overhead can be significant for each ingress router and its attached core-facing links.

Juniper Networks has several important VPLS enhancements that provide a solution for the replication overhead issue:

- Point-to-multipoint LSP support provides efficient distribution of multicast traffic such as IP-based television (IPTV).
- Multihoming support integrates the path selection capability of BGP with VPLS to allow a customer edge (CE) Ethernet switch to have a backup path across the network.

This document explains the use of point-to-multipoint LSPs in the MPLS core as an alternative to ingress replication. Point-to-multipoint LSPs enable ingress routers to send only one copy of each packet into the MPLS cloud. Each PE router maintains a point-to-multipoint tree so traffic can be efficiently sent to all VPN sites. This process requires the fewest possible replications of the packets and does the replication at the most optimal points in the network.

The benefits of this approach are:

- Conservation of bandwidth
- Increased PE router efficiency
- Improved traffic engineering for flows of flooded traffic
- Manual control or several levels of automatic operation
- Simplified multicast optimization, which is ideal for IPTV or network access wholesale

The Internet Engineering Task Force (IETF) supports two standardized VPLS implementations: *RFC 4761: Virtual Private LAN Service (VPLS) Using BGP for Auto-Discovery and Signaling* and *RFC 4762: Virtual Private LAN Service (VPLS) Using LDP Signaling*.

Juniper Networks has implemented VPLS solutions based on both RFCs. BGP-based VPLS is the superior solution, but LDP-based VPLS is supported for those service providers that have already deployed this alternative.

For a detailed technology overview of LDP-BGP VPLS interworking see *LDP-BGP VPLS Interworking at* http://www.juniper.net/us/en/local/pdf/whitepapers/2000282-en.pdf.

Next-Generation VPLS Point-to-Multipoint Forwarding Applications

VPLS provides a multipoint-to-multipoint Ethernet service that can span one or more metro areas and provides connectivity between multiple sites as if these sites were attached to the same Ethernet LAN.

VPLS uses an IP and MPLS service provider infrastructure. From a service provider's point of view, use of IP and MPLS routing protocols and procedures instead of the Spanning Tree Protocol (STP), and MPLS labels instead of VLAN IDs, significantly improves the scalability of the VPLS service.

VPLS Protocol Operation

VPLS carries Ethernet traffic across a service provider network, so it must mimic an Ethernet network in some ways. When a PE router configured with a VPLS routing instance receives a packet from a CE device, it first determines whether it knows the destination of the VPLS packet. If it does, it forwards the packet to the appropriate PE router or CE device. If it does not, it broadcasts the packet to all the other PE routers and CE devices that are members of that VPLS routing instance. In both cases, the CE device receiving the packet must be different from the one sending the packet.

When a PE router receives a packet from another PE router, it first determines whether it knows the destination of the VPLS packet. If the destination is known, the PE router either forwards the packet or drops it, depending on whether the destination is a local or remote CE device. The PE router has three options (scenarios):

- If the destination is a local CE device, the PE router forwards the packet to it.
- If the destination is a remote CE device (connected to another PE router), it discards the packet.
- If it cannot determine the destination of the VPLS packet, the PE router floods it to its attached CE devices.

A VPLS can be directly connected to an Ethernet switch. Layer 2 information gathered by an Ethernet switch, such as media access control (MAC) addresses and interface ports, is included in the VPLS routing instance table. However, instead of all VPLS interfaces being physical switch ports, the router allows remote traffic for a VPLS instance to be delivered across an MPLS 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 in almost the same way as traffic sent to a local port.

The VPLS routing table is populated with MAC addresses and interface information for both physical and virtual ports. One difference between a physical port and a virtual port is that on a virtual port, the router captures the outgoing MPLS label used to reach the remote site and an incoming MPLS label for VPLS traffic received from the remote site. The virtual port is generated dynamically on a Tunnel Services PIC when you configure VPLS on a Juniper Networks M Series Multiservice Edge Router or T Series Core Router. A Tunnel Services PIC is required on each M Series or T Series VPLS router.

If your router has an Enhanced FPC installed, you can configure VPLS without a Tunnel Services PIC. To do so, you use a label-switched interface (LSI) to provide VPLS

functionality. An LSI MPLS label is used as the inner label for VPLS. This label maps to a VPLS routing instance. On the PE router, the LSI label is stripped and then mapped to a logical LSI interface. The Layer 2 Ethernet frame is then forwarded using the LSI interface to the correct VPLS routing instance. To configure VPLS on a router without a Tunnel Services PIC, include the **no-tunnel-services** statement.

One restriction on 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. This also means that the core network of PE routers must be fully meshed. Additionally, if a CE Ethernet switch has two or more connections to the same PE router, you must enable the Spanning Tree Protocol (STP) on the CE switch to prevent loops.

Point-to-Multipoint Implementation

In next-generation VPLS, point-to-multipoint LSPs are used to flood broadcast, multicast, and unknown unicast traffic across a VPLS core network to all the PE routers. This is more efficient in terms of bandwidth utilization between the PE router and provider (P) router.

If point-to-multipoint LSPs are not being used, the PE router needs to forward multiple copies of broadcast, multicast, and unknown unicast packets to all PE routers. If point-to-multipoint LSPs are used, the PE router floods one copy of each packet to the P router, where it is replicated close to the egress router.

NOTE: For next-generation VPLS, both point-to-point LSPs and point-to-multipoint LSPs are needed between the PE routers.

In VPLS, point-to-multipoint LSPs are only used to transport broadcast frames, multicast frames, and unicast frames with an unknown destination MAC address. All other frames are still transported using point to-point LSPs. This structure is much more efficient for bandwidth use, particularly near the source of the broadcast, multicast, and unknown frames. However, it also results in more state in the network because each PE router is the ingress of one point-to-multipoint LSP that touches all other PE routers and one point-to-point LSP going to each of the other PE routers.

Enabling point-to-multipoint LSPs for any VPLS instance starts the flooding of unknown-unicast, broadcast, and multicast traffic using point-to-multipoint LSPs.

For each VPLS instance, a PE router creates a dedicated point-to-multipoint LSP. Whenever VPLS discovers a new neighbor through BGP, a source-to-leaf sub-LSP is added for this neighbor in the point-to-multipoint LSP instance.

If there are *n* PE routers in the VPLS instance, then the discovery of a new neighbor through BGP creates *n* point-to-multipoint LSPs in the network, where each PE router is the root of the tree and the rest of the *n-1* PE routers are leaf nodes (or source-to-leaf sub-LSPs).

Each point-to-multipoint LSP created by PE routers can be identified using an RSVP-traffic engineering point-to-multipoint session object, which is passed as a provider multicast service interface (PMSI) tunnel attribute by BGP while advertising VPLS routes. Using this tunnel attribute, incoming source-to-leaf sub-LSP add request messages (RSVP-path

message) can be associated with the right VPLS instance and originator PE router. As a result, label allocation is done in such a way that when traffic arrives on the LSP, it is not only terminated on the right VPLS instance, but the originator PE router is also identified so that source MAC addresses can be learned.

Point-to-multipoint LSPs can be enabled incrementally on any PE router that is part of a specific VPLS instance. This means a PE router that has this feature uses point-to-multipoint LSPs to flood traffic, whereas other PE routers in the same VPLS instance can use ingress replication to flood the traffic. However, when point-to-multipoint LSPs are enabled on any PE router, make sure that all the PE routers that are part of the same VPLS instance also support this feature.

NOTE: Penultimate-hop popping (PHP) is disabled for point-to-multipoint LSPs terminating in a VPLS instance.

Limitations of Point-to-Multipoint LSPs

When implementing point-to-multipoint LSPs remember the following limitations:

- There is no mechanism to allow only multicast traffic to go over the point-to-multipoint LSP.
- Point-to-multipoint LSPs do not support inter-AS traffic. Only intra-AS traffic is supported.
- Point-to-multipoint LSPs do not support graceful restart for ingress LSPs. This also affects VPLS when flooding is done using point-to-multipoint LSPs.
- The same point-to-multipoint LSP cannot be shared across multiple VPLS instances.
- When this feature is enabled, ingress PE routers use only point-to-multipoint LSPs for flooding. The router initiates the creation of source-to-leaf sub-LSPs for each PE router that is part of the same VPLS instance. Any PE router for which this source-to-leaf sub-LSP fails to come up does not receive any flooded traffic from the ingress PE router.
- It is possible that flooding of unknown unicast traffic over point-to-multipoint LSPs may lead to packet reordering, because as soon as learning is done, unicast traffic is sent out using point-to-point pseudowire LSPs.
- Static LSPs and LSPs configured using the **label-switched-path-template** statement cannot be configured at the same time.
- When an LSP is configured using the **static-lsp** statement, a point-to-multipoint LSP is created statically to include all neighbors in the VPLS instance.

Before enabling the point-to-multipoint LSP feature on any PE router, make sure that all the other PE routers that are part of the same VPLS instance are upgraded to a Junos OS Release that supports it. If a router in the VPLS instance does not support point-to-multipoint LSPs, it may lose all the traffic sent on the point-to-multipoint LSP. Therefore, do not enable this feature if there is a single router in a VPLS instance that is not capable of supporting this feature, either because it is not running the appropriate

Junos OS Release or because it is a router from a vendor that does not support this feature.

Simultaneous Transit and Egress Router Operation

A PE router that plays the role of both an MPLS transit router and an MPLS egress router can do so by receiving either one or two copies of a packet to fulfill each of its roles.

To fulfill both roles while using only a single copy of a packet, Juniper Networks M Series and T Series routers require a Tunnel Services PIC configured with virtual tunnel (vt) interfaces and ultimate-hop popping must be enabled. With a virtual tunnel interface and ultimate-hop popping, a single copy of the received packet is forwarded beyond the PE router to fulfill the transit router role and is also consumed internally by the virtual tunnel interface to fulfill the egress router role.

If a label-switched interface (LSI) logical interface is used, then two copies of each packet must be received on the point-to-multipoint LSP, one to fulfill the transit router role and one to fulfill the egress router role.

Implementation

Some implementations of VPLS use ingress replication. Ingress replication is simple but inefficient. It sends multiple copies of the same packet on a link, especially the PE-P link. This causes wasted bandwidth when there is a heavy broadcast and multicast traffic.

As shown in the sample network in Figure 16 on page 151 the ingress PE router makes three copies of every broadcast, multicast, and flooded packet for each VPLS instance.

Figure 16: Ingress Replication

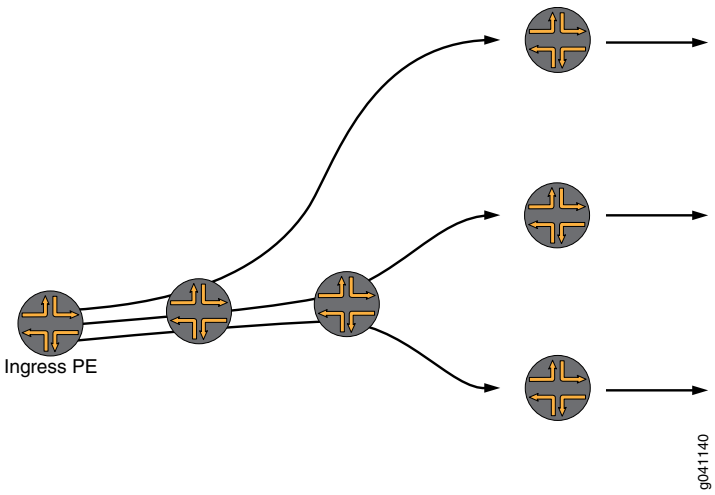
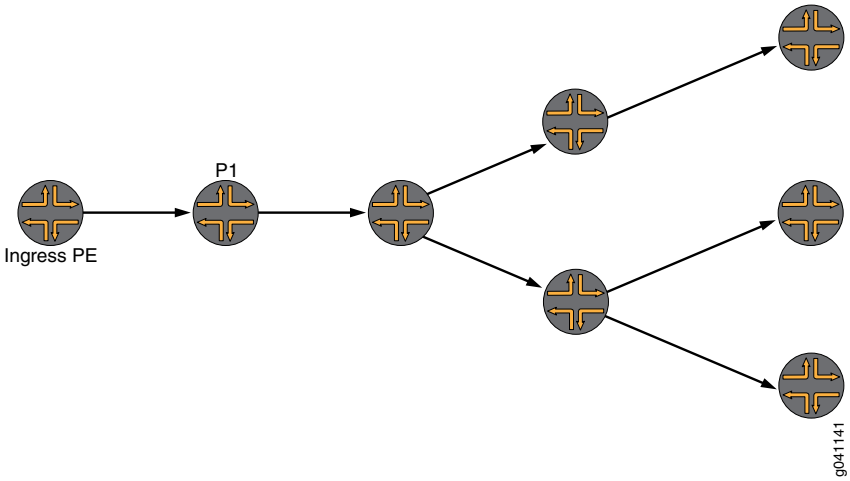


Figure 17 on page 152 shows how a point-to-multipoint LSP works for multicast.

In a VPLS using point-to-multipoint LSPs, the ingress PE router sends a single copy of the multicast packet to Router P1. Router P1 makes two copies for this point-to-multipoint LSP. Each of the other P routers also makes multiple copies of the packet. This moves replication closer to the endpoints and results in significant improvements in the network bandwidth utilization.

Figure 17: Point-to-Multipoint Replication



Related Documentation

- Example: NG-VPLS Using Point-to-Multipoint LSPs on page 152

Example: NG-VPLS Using Point-to-Multipoint LSPs

This example shows how to configure next-generation VPLS (NG_VPLS) using point-to-multipoint LSPs. The topology is shown in Figure 18 on page 153 and Figure 19 on page 154. This example is organized in the following sections:

- Requirements on page 152
- Overview and Topology on page 152
- Configuration on page 155

Requirements

Table 9 on page 152 lists the hardware that is used and the software that is required for this example:

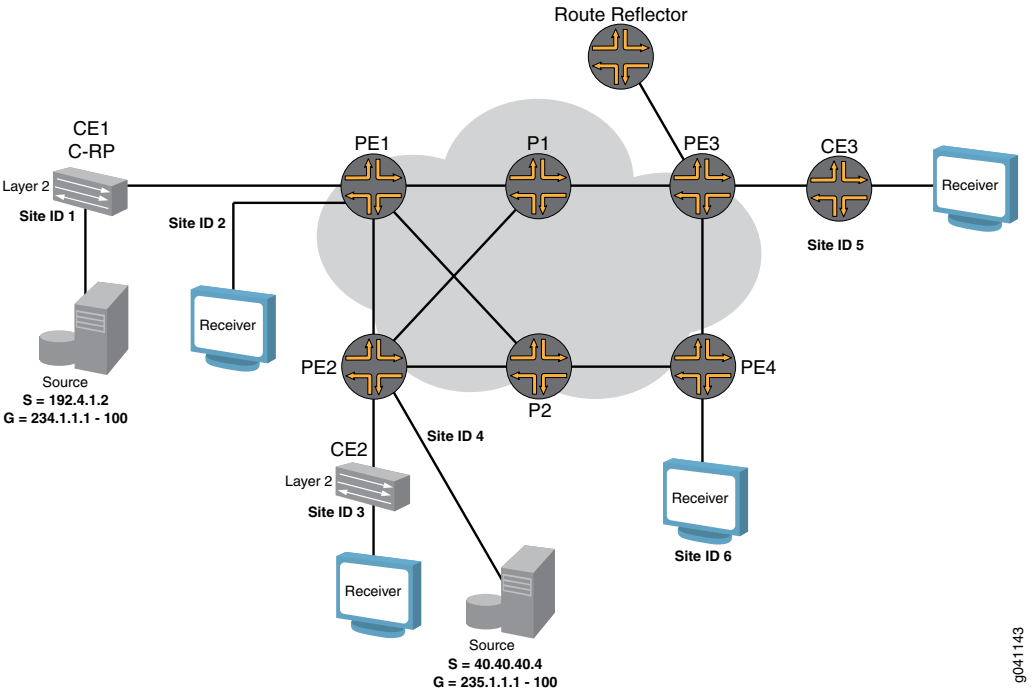
Table 9: Hardware and Software Used

Equipment	Components	Software
Six MX Series 3D Universal Edge Routers	DPC-4 10GE-X, DPC-40 1GE-X	Junos OS Release 9.3R4 or later
One T Series Core Router	FPC3, 10GE-Xenpak	Junos OS Release 9.3R4 or later
Eight EX4200 Ethernet Switches	EX4200 virtual switches	Junos OS Release 9.3R4 or later
One M7i Multiservice Edge Router	Gigabit Ethernet interfaces	Junos OS Release 9.3R4 or later

Overview and Topology

The logical topology of the NG-VPLS example is shown in Figure 18 on page 153.

Figure 18: Logical Topology of NG-VPLS Using Point-to-Multipoint LSPs

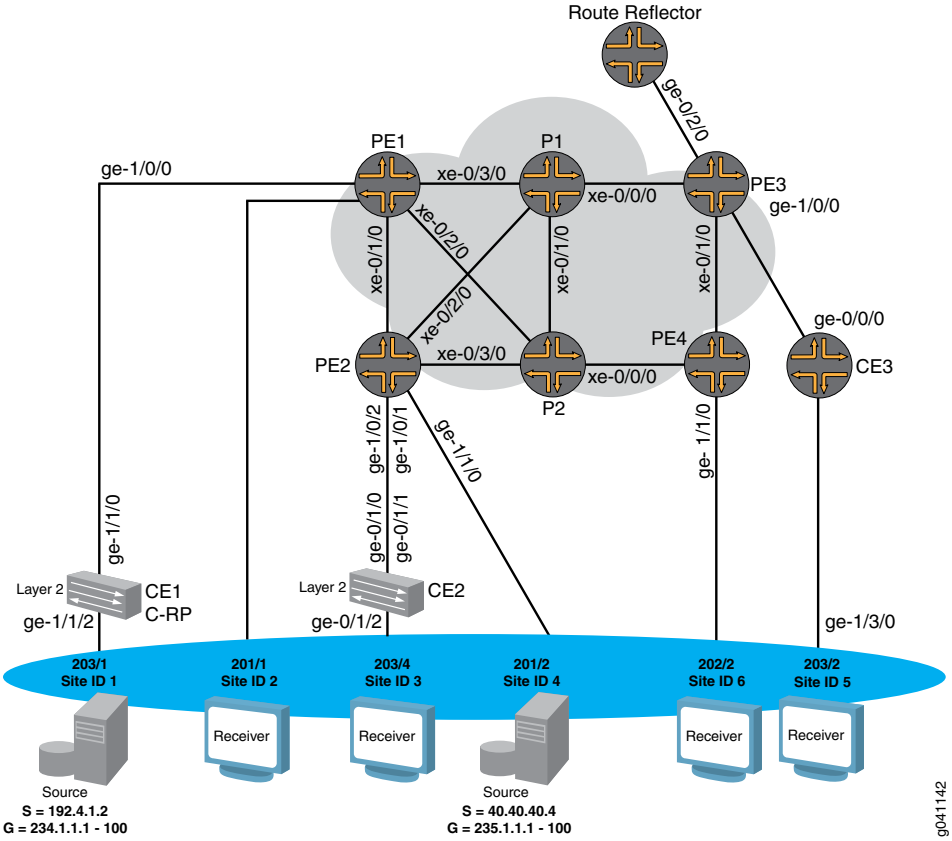


The routers in this example are preconfigured with the following:

- OSPF area 0 is configured on all the PE routers and P routers with traffic engineering enabled.
- All of the core-facing interfaces are configured with the **mpls** protocol address family.
- The RSVP and MPLS protocols are enabled for all the core-facing interfaces.
- All the MX Series routers have their network services mode set to Ethernet. The network services mode is configured by including the **network-services** statement and specifying the **ethernet** option.
- All the PE routers are configured for autonomous system **65000**.

The physical topology of the NG-VPLS example is shown in Figure 19 on page 154. The topology consists of six MX Series routers connected with redundant links in the core. Four MX Series routers are acting as PE routers and two are core routers.

Figure 19: Physical Topology of NG-VPLS Using Point-to-Multipoint LSPs



Note the following topology details:

- A route reflector is configured in the topology to reflect the family **l2-vpn** routes to all the PE routers for BPG-VPLS.
- The GOLD VPLS routing instance is configured with two sites in each of the PE routers.
- One GOLD site is connected to the CE router and the other one is directly connected to the test equipment on each PE router.
- The **no-tunnel-services** statement is included in the GOLD VPLS instance to enable the use of LSI interfaces for VPLS tunnel services.
- Router CE1 and Router CE2 are EX Series Virtual Chassis switches acting as CE routers.
- Router CE3 is an M7i router acting as a CE router.
- Two multicast sources are configured. One is connected to Router CE1 (Site 1) and the other to Router PE2 (Site 4) to simulate different scenarios.
- Router CE1 is configured as the rendezvous point (RP).
- Unicast traffic is enabled on all the test equipment ports and is sent to all the sites in the GOLD VPLS instance.

Configuration

This example shows how to configure next-generation VPLS using point-to-multipoint LSPs. It is organized in the following sections:

Configuring the PE Router Interfaces

Step-by-Step Procedure

On the customer-facing PE interfaces, enable VLAN tagging, configure the encapsulation type, and enable the VPLS address family. There are four possible interface encapsulations for VPLS routing instances that you can choose depending on your needs.

1. If your network requires that each logical interface on the PE router-to-CE router link be configured to only accept packets with VLAN ID **1000**, include the **vlan-tagging** statement, include the **encapsulation** statement, and specify **vlan-vpls** as the encapsulation type. Also include the **vlan-id** statement and specify **1000** as the VLAN ID.

   ```
   [edit interfaces]
   ge-1/1/0 {
      vlan-tagging;
      encapsulation vlan-vpls;
      unit 1 {
         encapsulation vlan-vpls;
         vlan-id 1000;
         family vpls;
      }
   }
   ```

   With this configuration, you can configure multiple logical interfaces with different VLAN IDs and associate each logical interface with a different routing instance.

2. If your network requires each physical interface on the PE router to CE router link to be configured to use the entire Ethernet port as part of a single VPLS instance, include the **encapsulation** statement, and specify **ethernet-vpls** as the encapsulation type.

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

```
    encapsulation ethernet-vpls;
    unit 0 {
      family vpls;
    }
  }
```

With this encapsulation mode, you cannot create multiple logical units (VLANs).

3. If your network requires that each logical interface of the single physical interface on the PE router to CE router link be configured to use a mix of different encapsulations, include the **encapsulation** statement, and specify **flexible-ethernet-services** as the encapsulation type at the **[edit interfaces *interface-name*]** hierarchy level. Also include the **encapsulation** statement, and specify **vlan-vpls** or **vlan-ccc** as the encapsulation type at the **[edit interfaces *interface-name* unit *logical-unit-number*]** hierarchy level.

```
[edit interfaces]
ge-1/2/0 {
  vlan-tagging;
  encapsulation flexible-ethernet-services;
  unit 1 {
    encapsulation vlan-vpls;
  }
  unit 2 {
    encapsulation vlan-ccc;
  }
}
```

4. If your network requires support for using a mix of single and dual tagged VLANs configured in different logical interfaces on a single physical interface, include the **encapsulation** statement, and specify **flexible-vlan-tagging** as the encapsulation type.

5. Configure the core-facing CE router interfaces. The CE router and PE router logical interface configuration must match encapsulation types and VLAN IDs. Typically the IP address is configured on the core-facing CE router interfaces if the CE device is a router and terminates the Layer 2 domain into the Layer 3 network. In this example, the interface is configured for single tagging with a VLAN ID of **1000**.

```
[edit interfaces]
ge-1/1/0 {
  vlan-tagging;
  unit 1 {
    vlan-id 1000;
    family inet {
      address 40.40.40.1/24;
    }
  }
}
```

Configuring a Route Reflector for all PE Routers for BGP-Based VPLS

Step-by-Step Procedure

Configuring a route reflector is the preferred method to enable any BGP-based service offerings. Configuring a route reflector avoids the requirement for a full mesh of BGP peer sessions, and it scales well. BGP redundancy can be achieved using multiple route reflectors in a single cluster.

1. To enable BGP to carry Layer 2 VPN and VPLS NLRI messages, create a peer group, include the **family** statement, specify the **l2vpn** option, and include the **signaling** statement. To configure the route reflector cluster and complete the BGP peer sessions, include the **cluster** statement and specify the IP address for the cluster ID. Then include the **neighbor** statement and specify the IP address of the PE routers that are BGP client peers in the cluster.

```
[edit protocols]
bgp {
  group RR {
    type internal;
    local-address 7.7.7.7;
    family l2vpn {
      signaling;
    }
    cluster 7.7.7.7;
    neighbor 1.1.1.1;  # To PE1
    neighbor 2.2.2.2;  # To PE2
    neighbor 3.3.3.3;  # To PE3
    neighbor 4.4.4.4;  # To PE4
  }
}
```

2. Configure OSPF and enable traffic engineering on the route reflector to create the Constrained Shortest Path First (CSPF) database for the egress LSPs terminating from the PE routers.

```
[edit protocols]
ospf {
  traffic-engineering;
  area 0.0.0.0 {
    interface all;
    interface fxp0.0 {
      disable;
    }
  }
}
```

3. Enable the MPLS and RSVP protocols on all interfaces connected to the MPLS core. This terminates the RSVP egress LSPs from the PE routers.

```
[edit protocols]
rsvp {
  interface all;
  interface fxp0.0 {
    disable;
  }
}
```

```
mpls {
  interface all;
  interface fxp0.0 {
    disable;
  }
}
```

Establishing BGP-Based VPLS with a Route Reflector

Step-by-Step Procedure

For BGP-based VPLS, all PE routers need to have a full mesh of BGP peer sessions with each other or have a single peer with the route reflector. The route reflector reflects the routes received from the other PE routers. In this example, the PE router is configured to establish a peer relationship with the route reflector.

1. To have all the PE routers establish a BGP client peer session with the route reflector, create an internal peer group, include the **local-address** statement, and specify the IP address of the PE router. Also include the **neighbor** statement, and specify the IP address of the route reflector. To enable BGP to carry Layer 2 VPN and VPLS NLRI messages, include the **family** statement, specify the **l2vpn** option, and include the **signaling** statement.

   ```
   [edit protocols]
   bgp {
     group to-RR {
       type internal;
       local-address 1.1.1.1;
       family l2vpn {
         signaling;
       }
       neighbor 7.7.7.7;  # To the route reflector
     }
   }
   ```

2. Configure a point-to-point RSVP LSP from the PE routers to the route reflector. To create the LSP, include the **label-switched-path** statement, give the LSP a meaningful name, include the **to** statement and specify the IP address of the route reflector as the LSP end point. This LSP is needed to resolve the BGP next hops in the **inet.3** routing table for the routes received from the route-reflector.

   ```
   [edit protocols]
   mpls {
     label-switched-path to-RR {
       to 7.7.7.7;
     }
     interface all;
     interface fxp0.0 {
       disable;
     }
   }
   ```

Configuring Point-to-Point LSPs Between PE Routers

Step-by-Step Procedure

In next-generation VPLS, point-to-multipoint LSPs are only used to transport broadcast, multicast, and unknown unicast frames. All other frames are still transported using point-to-point RSVP LSPs. This is a more efficient use of bandwidth, particularly near the source of the unknown, broadcast, and multicast frames. The trade-off is more state in the network, because each PE router is the ingress of one point-to-multipoint LSP that touches all other PE routers, and *n* point-to-point LSPs are needed, one going to each of the other PE routers.

1. To create a point-to-point LSP, include the **label-switched-path** statement, give the LSP a meaningful name, include the **to** statement, and specify the IP address of the other PE router as the LSP endpoint. The example shows the configuration of LSPs from Router PE1 to Routers PE2, PE3, and PE4.

```
[edit protocols]
mpls {
   label-switched-path to-PE2 {
      to 2.2.2.2;
   }
   label-switched-path to-PE3 {
      to 3.3.3.3;
   }
   label-switched-path to-PE4 {
      to 4.4.4.4;
   }
}
```

Configuring Dynamic and Static Point-to-Multipoint LSPs Between PE Routers

Step-by-Step Procedure

This procedure describes how to enable the creation of dynamic point-to-multipoint LSPs and how to configure static point-to-multipoint LSPs. On a router configured with static point-to-multipoint LSPs, the LSPs come up immediately. On a router configured with dynamic point-to-multipoint LSPs, the LSP comes up only after receiving BGP neighbor information from the route reflector or from the other PE routers participating in the VPLS domain.

For each VPLS instance, a PE router with dynamic point-to-multipoint LSPs enabled creates a dedicated point-to-multipoint LSP based on the point-to-multipoint template. Whenever VPLS discovers a new neighbor through BGP, a sub-LSP for this neighbor is added to the point-to-multipoint LSP.

If there are *n* PE routers in the VPLS instance then the router creates *n* point-to-multipoint LSPs in the network where each PE router is the root of the tree and includes the rest of the *n-1* PE routers as leaf nodes connected through a source-to-leaf sub-LSP.

1. In this step, you configure Router PE1 and Router PE2 to use a dynamic point-to-multipoint LSP template for LSP creation. When these routers receive a new BGP route advertised from the route reflector for a new neighbor, they create a point-to-multipoint sub-LSP to that neighbor. To create the dynamic point-to-multipoint LSP template, include the **label-switched-path** statement, give the LSP template a meaningful name, include the **template** statement and include

the **p2mp** statement. Also enable link protection and configure the optimize timer to periodically reoptimize the LSP path.

```
[edit protocols]
mpls {
   label-switched-path vpls-GOLD-p2mp-template {
      template;  # identify as a template
      optimize-timer 50;
      link-protection;  # link protection is enabled on point-to-multipoint LSPs
      p2mp;
   }
}
```

2. In this step, you configure static point-to-multipoint LSPs. Creating static point-to-multipoint LSPs is similar to creating point-to-point LSPs, except you can also configure other RSVP parameters under each point-to-multipoint LSP.

   To create static point-to-multipoint LSPs, include the **label-switched-path** statement, give the LSP a meaningful name, include the **to** statement, and specify the IP address of the PE router that is the endpoint of the LSP. Also include the **p2mp** statement and specify a pathname.

```
[edit protocols]
mpls {
   label-switched-path to-pe2 {
      to 2.2.2.2;
      p2mp vpls-GOLD;
   }
   label-switched-path to-pe3 {
      to 3.3.3.3;
      p2mp vpls-GOLD;
   }
   label-switched-path to-pe1 {
      to 1.1.1.1;
      p2mp vpls-GOLD;
   }
}
```

Configuring Point-to-Multipoint Link Protection

Step-by-Step Procedure

Point-to-multipoint LSPs only support RSVP link protection for traffic engineering. Node protection is not supported. Link protection is optional, but it is the recommended configuration for most networks.

1. To enable link protection on the core-facing interfaces, include the **link-protection** statement at the **[edit protocols rsvp interface *interface-name*]** hierarchy level.

```
[edit protocols]
rsvp {
   interface all;
   interface fxp0.0 {
      disable;
   }
   interface xe-0/3/0.0 {
      link-protection;
   }
```

```
    interface xe-0/2/0.0 {
      link-protection;
    }
    interface xe-0/1/0.0 {
      link-protection;
    }
  }
```

2. Enable the point-to-multipoint LSP to use the RSVP link protection feature. Link-protection can be configured for both static point-to-multipoint and dynamic point-to-multipoint LSPs that use a template.

   For static point-to-multipoint LSPs, configure each branch sub-LSP. To enable link protection, include the **link-protection** statement at the **[edit protocols mpls label-switched-path *label-switched-path-name*]** hierarchy level.

   ```
   [edit protocols mpls label-switched-path]
   label-switched-path to-pe2 {
     to 2.2.2.2;
     link-protection;
     p2mp vpls-GOLD;
   }
   label-switched-path to-pe3 {
     to 3.3.3.3;
     link-protection;
     p2mp vpls-GOLD;
   }
   label-switched-path to-pe1 {
     to 1.1.1.1;
     link-protection;
     p2mp vpls-GOLD;
   }
   ```

3. For dynamic point-to-multipoint LSPs using a template, only the template needs to have link protection configured. All the point-to-multipoint branch LSPs that use the template inherit this configuration.

   To enable link protection for dynamic point-to-multipoint LSPs, include the **link-protection** statement at the **[edit protocols mpls label-switched-path *label-switched-path-name*]** hierarchy level.

   ```
   [edit protocols mpls label-switched-path]
   label-switched-path vpls-GOLD-p2mp-template {
     template;
     optimize-timer 50;
     link-protection;
     p2mp;
   }
   ```

Configuring a BGP-Based VPLS Routing Instance for NG-VPLS

Step-by-Step Procedure

For NG-VPLS, the routing-instance configuration is similar to that for a regular VPLS routing instance. The routing instance defines the VPLS site and creates the VPLS connection. The following parameters are configured.

- Instance Type – VPLS.
- Interface – The interface connecting to the CE router.
- Route Distinguisher – Each routing instance you configure on a PE router must have a unique route distinguisher. The route distinguisher is used by BGP to distinguish between potentially identical network reachability information (NLRI) messages received from different VPNs. If you use a unique route distinguisher for each routing instance on each PE, you can determine which PE originated the route.
- VRF Target – Configuring a VRF target community using the **vrf-target** statement causes default VRF import and export policies to be generated that accept imported routes and tag exported routes with the specified target community.
- Protocols – Configure the VPLS protocol as described in the following procedure.

1. To configure the NG-VPLS routing instance, include the **routing-instances** statement and specify the instance name. Also include the **instance-type** statement and specify **vpls** as the type. Include the **route-distinguisher** statement and specify a route distinguisher that is unique throughout all VPNs configured on the router. Configure a VRF route target by including the **vrf-target** statement and specify the route target. The route target exported by one router must match the route target imported by another router for the same VPLS.

   ```
   [edit]
   routing-instances {
     GOLD {
       instance-type vpls;
       interface ge-1/0/0.1;
       interface ge-1/1/0.1;
       route-distinguisher 1.1.1.1:1;
       vrf-target target:65000:1;
     }
   }
   ```

2. To use a point-to-multipoint LSP for VPLS flooding, configure an LSP under the VPLS routing instance.

   To configure the point-to-multipoint LSP for VPLS flooding, include the **label-switched-path-template** statement and specify the name of the LSP template at the **[edit routing-instances *routing-instances-name* provider-tunnel rsvp-te]** hierarchy level.

   ```
   [edit]
   routing-instances {
     GOLD {
       instance-type vpls;
       interface ge-1/0/0.1;
       interface ge-1/1/0.1;
   ```

```
    route-distinguisher 1.1.1.1:1;
    provider-tunnel {
      rsvp-te {
        label-switched-path-template {
          vpls-GOLD-p2mp-template;
        }
      }
    }
    vrf-target target:65000:1;
  }
}
```

3. Configuring the VPLS protocol enables the VPLS between different sites in the VPLS domain. Multiple sites can be configured under a single VPLS routing instance, but note that the lowest site ID is used to build the VPLS pseudowire to the other PE routers, and the label block associated with the lowest site ID is advertised. The following parameters are configured for the VPLS protocol:

   - Site – Name of the VPLS site.
   - Site Range – Maximum site ID allowed in the VPLS. The site range specifies the highest-value site ID allowed within the VPLS, not the number of sites in the VPLS.
   - Site Identifier – Any number between 1 and 65,534 that uniquely identifies the VPLS site. This is also referred as the VE-ID in the relevant RFC.
   - PE-CE Interface – The interface participating in this site.
   - Tunnel services for VPLS – If you do not configure any tunnel interface at the **[edit protocol vpls tunnel-services]** hierarchy, the router uses any tunnel interface available on the router for VPLS.
   - No-tunnel-services – If you include the **no-tunnel-services** statement, the router uses a label-switched interface (LSI) for the tunnel services for that VPLS instance.
   - Mac Table Size – The size of the VPLS media access control (MAC) address table. The default is 512 addresses and the maximum is 65,536. When the table is full, new MAC addresses are no longer added to the table.

   To configure the VPLS protocol, include the **vpls** statement at the **[edit routing-instances *routing-instance-name* protocols]** hierarchy level. To configure the site range, include the **site-range** statement and specify the highest-value site ID allowed within the VPLS. To cause the router to use an LSI interface, include the **no-tunnel-services** statement. To create a VPLS site, include the **site** statement and specify a site name. Also include the **site-identifier** statement and specify the site ID. Then include the **interface** statement and specify the interface name for the interface connected to the CE device.

```
[edit]
routing-instances {
  GOLD {
    instance-type vpls;
    interface ge-1/0/0.1;
    interface ge-1/1/0.1;
    route-distinguisher 1.1.1.1:1;
```

```
    provider-tunnel {
      rsvp-te {
        label-switched-path-template {
          vpls-GOLD-p2mp-template;
        }
      }
    }
    vrf-target target:65000:1;
    protocols {
      vpls {
        site-range 8;
        no-tunnel-services;
        site CE1 {
          site-identifier 1;
          interface ge-1/0/0.1;
        }
        site Direct {
          site-identifier 2;
          interface ge-1/1/0.1;
        }
      }
    }
  }
}
```

Configuring Tunnel Services for VPLS

Step-by-Step Procedure

A tunnel interface is needed for VPLS configuration to encapsulate the originating traffic, and to de-encapsulate the traffic coming from a remote site. If the tunnel interface is not configured, the router selects one of the available tunnel interfaces on the router by default. There are three methods available in Junos OS to configure this tunnel interface.

- To specify a virtual tunnel interface to be used as the primary device for tunneling, include the **primary** statement, and specify the virtual tunnel interface to be used at the **[edit routing-instances *routing-instance-name* protocols vpls tunnel-services]** hierarchy level.

```
[edit routing-instances routing-instance-name]
protocols {
   vpls {
      site-range 8;
      tunnel-services {
         primary vt-1/2/10;
      }
   }
}
```

- To configure the router to use an LSI interface for tunnel services rather than a virtual tunnel interface, include the **no-tunnel-services** statement at the **[edit routing-instances *routing-instance-name* protocols vpls]** hierarchy level.

```
[edit routing-instances routing-instance-name]
protocols {
   vpls {
      site-range 8;
      no-tunnel-services;
   }
}
```

- In an MX Series router you must create the tunnel services interface to be used for tunnel services. To create the tunnel service interface, include the **bandwidth** statement and specify the amount of bandwidth to reserve for tunnel services in gigabits per second at the **[edit chassis fpc *slot-number* pic *slot-number* tunnel-services]** hierarchy level.

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

Verifying the Control Plane

Step-by-Step Procedure

This section describes **show** command outputs you can use to validate the control plane. It also provides methodologies for troubleshooting. Note the following:

- In this example there are six sites. Router PE1 and Router PE2 have two sites each. Router PE3 and Router PE4 have one site each. All sites are in the GOLD VPLS instance.
- In VPLS if you have multiple sites configured under a single VPLS routing instance, the label block from the site with the lowest site ID is used to establish pseudowires between remote PEs. Note that the data traffic is still sent to those PE router interfaces connected to CE devices that are in one of the following states:
  - LM – Local site ID is not the minimum designated. The local site ID is not the lowest. Therefore the local site ID is not being used to establish pseudowires or distribute VPLS label blocks.
  - RM – Remote site ID is not the minimum designated. The remote site ID is not the lowest. Therefore, the remote site ID is not being used to establish pseudowires or distribute VPLS label blocks.
- For more information about how VPLS label blocks are allocated and used, see *Understanding VPLS Label Blocks Operation*.

1. After the entire configuration is done, you can verify the VPLS connections state.

   In the following output, the VPLS connections show the **Up** state for certain sites, and the remaining sites show either the **RM** or **LM** state. This is the expected state in a VPLS implementation on multihoming sites.

   In this example, Router PE1 has site **CE1** configured with site ID **1** and site **Direct** configured with site ID **2**. The label block for site **CE1** is advertised to the remote PE routers and used for receiving the data packets from the remote PE routers. In the **show** command output, notice the following:

   - Router PE1 uses its lowest site ID, which is site ID **1**. Site ID 1 is used for Device **CE1**.
   - Router PE2 uses its lowest site ID, which is site ID **3**. Site ID 3 is used for Device **CE2**.
   - Router PE3 and Router PE4 each have a single site configured.

     For site **CE1**, connection site **3** is in the **Up** state and connection site **4** is in the **RM** state.
   - For site **Direct**, all the connections are in the **LM** state.
   - Site **Direct** has a higher site ID than site **1** on this router.

   On Router PE1, use the **show vpls connections** command to verify the VPLS connections state .

```
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: GOLD
  Local site: CE1 (1)
    connection-site           Type  St     Time last up       # Up trans
```

```
    3                       rmt   Up    Oct  6 16:27:23 2009       1
      Remote PE: 2.2.2.2, Negotiated control-word: No
      Incoming label: 262171, Outgoing label: 262145
      Local interface: lsi.1049353, Status: Up, Encapsulation: VPLS
        Description: Intf - vpls GOLD local site 1 remote site 3
    4                       rmt   RM
    5                       rmt   Up     Oct  6 16:27:27 2009       1
      Remote PE: 3.3.3.3, Negotiated control-word: No
      Incoming label: 262173, Outgoing label: 262145
      Local interface: lsi.1049354, Status: Up, Encapsulation: VPLS
        Description: Intf - vpls GOLD local site 1 remote site 5
    6                       rmt   Up     Oct  6 16:27:31 2009       1
      Remote PE: 4.4.4.4, Negotiated control-word: No
      Incoming label: 262174, Outgoing label: 800000
      Local interface: lsi.1049355, Status: Up, Encapsulation: VPLS
        Description: Intf - vpls GOLD local site 1 remote site 6
  Local site: Direct (2)
    connection-site           Type  St     Time last up       # Up trans
    3                         rmt   LM
    4                         rmt   LM
    5                         rmt   LM
    6                         rmt   LM
```

2. On Router PE4, use the **show vpls connections** command to verify the VPLS connections state.

   Verify that site **2** and site **4** are in the **RM** state. This state tells you that the sites are configured with the highest site ID on Router PE1 and Router PE2. Because Router PE4 has only one site configured, it does not have any sites in the **LM** states.

```
user@PE4> show vpls connections

...
Instance: GOLD
  Local site: Direct (6)
    connection-site           Type  St     Time last up      # Up trans
    1                         rmt   Up     Oct  6 16:28:35 2009       1
      Remote PE: 1.1.1.1, Negotiated control-word: No
      Incoming label: 800000, Outgoing label: 262174
      Local interface: vt-1/2/10.1048576, Status: Up, Encapsulation: VPLS

        Description: Intf - vpls GOLD local site 6 remote site 1
    2                         rmt   RM
    3                         rmt   Up     Oct  6 16:28:35 2009       1
      Remote PE: 2.2.2.2, Negotiated control-word: No
      Incoming label: 800002, Outgoing label: 262150
      Local interface: vt-1/2/10.1048577, Status: Up, Encapsulation: VPLS

        Description: Intf - vpls GOLD local site 6 remote site 3
    4                         rmt   RM
    5                         rmt   Up     Oct  6 16:28:35 2009       1
      Remote PE: 3.3.3.3, Negotiated control-word: No
      Incoming label: 800004, Outgoing label: 262150
      Local interface: vt-1/2/10.1048578, Status: Up, Encapsulation: VPLS

        Description: Intf - vpls GOLD local site 6 remote site 5
```

3. On each PE router, use the **show bgp summary** command to verify that the IBGP sessions between the PE routers or between the PE router and the route reflector have been established. The sessions must be operational before the PE routers can

exchange any Layer 2 VPN routes. In the example below, also notice that the output from Router PE1 shows that the **bgp.l2vpn.0** and **GOLD.l2vpn.0** routing tables have been created.

```
user@PE1> show bgp summary

Groups: 1 Peers: 1 Down peers: 0
Table    Tot Paths  Act Paths Suppressed    History Damp State    Pending
bgp.l2vpn.0      4          4          0          0          0          0
Peer            AS      InPkt     OutPkt    OutQ   Flaps Last Up/Dwn State
7.7.7.7      65000         40         39       0       1       15:45 Establ

  bgp.l2vpn.0: 4/4/4/0
  GOLD.l2vpn.0: 4/4/4/0

admin@PE2# run show bgp summary
Groups: 1 Peers: 1 Down peers: 0
Table    Tot Paths  Act Paths Suppressed    History Damp State    Pending
bgp.l2vpn.0      4          4          0          0          0          0
inet6.0          0          0          0          0          0          0
inet.0           0          0          0          0          0          0
Peer          AS      InPkt     OutPkt    OutQ   Flaps Last Up/Dwn State
7.7.7.7    65000         43         42       0       0       17:25 Establ

  bgp.l2vpn.0: 4/4/4/0
  GOLD.l2vpn.0: 4/4/4/0
```

4. On Router PE4, use the **show route table** command to verify that there is one Layer 2 VPN route to each of the other PE routers. Router PE3 should have a similar **show** command output.

```
user@PE4> show route table bgp.l2vpn.0

bgp.l2vpn.0: 5 destinations, 5 routes (5 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both

1.1.1.1:1:1:1/96
                   *[BGP/170] 00:23:18, localpref 100, from 7.7.7.7
                      AS path: I
                    > to 10.10.9.1 via xe-0/0/0.0, label-switched-path to-PE1
1.1.1.1:1:2:1/96
                   *[BGP/170] 00:23:18, localpref 100, from 7.7.7.7
                      AS path: I
                    > to 10.10.9.1 via xe-0/0/0.0, label-switched-path to-PE1
2.2.2.2:10:3:1/96
                   *[BGP/170] 00:23:18, localpref 100, from 7.7.7.7
                      AS path: I
                    > to 10.10.9.1 via xe-0/0/0.0, label-switched-path to-PE2
2.2.2.2:10:4:1/96
                   *[BGP/170] 00:23:18, localpref 100, from 7.7.7.7
                      AS path: I
                    > to 10.10.9.1 via xe-0/0/0.0, label-switched-path to-PE2
3.3.3.3:10:5:1/96
                   *[BGP/170] 00:23:18, localpref 100, from 7.7.7.7
                      AS path: I
                    > to 10.10.8.1 via xe-0/1/0.0, label-switched-path to-PE3
```

5. On the route reflector, use the **show bgp summary** command to verify that the router has an IBGP peer session with each of the PE routers.

```
user@RR> show bgp summary
```

```
Groups: 2 Peers: 5 Down peers: 1
Table    Tot Paths  Act Paths Suppressed    History Damp State  Pending
bgp.l2vpn.0      6          6          0          0          0        0
inet.0           0          0          0          0          0        0
Peer             AS     InPkt     OutPkt  OutQ   Flaps Last Up/Dwn State
1.1.1.1       65000        44        46      0       0       18:27 Establ

  bgp.l2vpn.0: 2/2/2/0
2.2.2.2       65000        43        45      0       0       18:22 Establ

  bgp.l2vpn.0: 2/2/2/0
3.3.3.3       65000        42        45      0       0       18:19 Establ

  bgp.l2vpn.0: 1/1/1/0
4.4.4.4       65000        43        45      0       0       18:15 Establ

  bgp.l2vpn.0: 1/1/1/0
```

6. In NG-VPLS, point-to-multipoint LSPs carry only unknown unicast, broadcast, and multicast packets. A full mesh of point-to-point LSPs is needed between the PE routers for NG-VPLS. The point-to-point LSPs create routes in the **inet.3** routing table. These entries are used to resolve the Layer 2 VPN routes received from the BGP peers. All other data traffic is sent over point-to-point LSPs.

   A point-to-point LSP is also created for the route reflector. This LSP creates a route in the **inet.3** routing table for BGP next-hop resolution.

   On Router PE1, use the **show mpls lsp** command to verify that the **to-PE2**, **to-PE3**, **to-PE4**, and **to-RR** LSPs are in the **Up** state.

   ```
   user@PE1> show mpls lsp ingress unidirectional

   Ingress LSP: 7 sessions
   To              From            State Rt P     ActivePath       LSPname
   2.2.2.2         1.1.1.1         Up     0 *                      to-PE2
   3.3.3.3         1.1.1.1         Up     0 *                      to-PE3
   4.4.4.4         1.1.1.1         Up     0 *                      to-PE4
   7.7.7.7         1.1.1.1         Up     0 *                      to-RR
   Total 4 displayed, Up 4, Down 0
   admin@PE2# run show mpls lsp ingress unidirectional
   Ingress LSP: 7 sessions
   To              From            State Rt P     ActivePath       LSPname
   1.1.1.1         2.2.2.2         Up     0 *                      to-PE1
   3.3.3.3         2.2.2.2         Up     0 *                      to-PE3
   4.4.4.4         2.2.2.2         Up     0 *                      to-PE4
   7.7.7.7         2.2.2.2         Up     0 *                      to-RR
   Total 4 displayed, Up 4, Down 0
   admin@PE3# run show mpls lsp ingress unidirectional
   Ingress LSP: 7 sessions
   To              From            State Rt P     ActivePath       LSPname
   1.1.1.1         3.3.3.3         Up     0 *                      to-PE1
   2.2.2.2         3.3.3.3         Up     0 *                      to-PE2
   4.4.4.4         3.3.3.3         Up     0 *                      to-PE4
   7.7.7.7         3.3.3.3         Up     0 *                      to-RR
   Total 4 displayed, Up 4, Down 0
   admin@PE4# run show mpls lsp ingress unidirectional
   Ingress LSP: 7 sessions
   To              From            State Rt P     ActivePath       LSPname
   1.1.1.1         4.4.4.4         Up     0 *                      to-PE1
   2.2.2.2         4.4.4.4         Up     0 *                      to-PE2
   ```

```
3.3.3.3         4.4.4.4         Up     0 *                      to-PE3
7.7.7.7         4.4.4.4         Up     0 *                      to-RR
Total 4 displayed, Up 4, Down 0
```

7. For each VPLS instance, a PE router creates a dedicated point-to-multipoint LSP. In this example, Router PE1 and Router PE2 are configured to use a point-to-multipoint dynamic template.

   For dynamic point-to-multipoint LSPs, whenever VPLS discovers a new Layer 2 VPN neighbor through BGP, a source-to-leaf sub-LSP is added in the VPLS instance for this neighbor PE router.

   On Router PE1, use the **show mpls lsp** command to verify that three source-to-leaf sub-LSPs are created.

   ```
   user@PE1> show mpls lsp ingress p2mp

   Ingress LSP: 1 sessions
   P2MP name: 1.1.1.1:1:vpls:GOLD, P2MP branch count: 3
   To            From          State Rt P   ActivePath     LSPname
   4.4.4.4       1.1.1.1       Up     0 *       4.4.4.4:1.1.1.1:1:vpls:GOLD
   3.3.3.3       1.1.1.1       Up     0 *       3.3.3.3:1.1.1.1:1:vpls:GOLD
   2.2.2.2       1.1.1.1       Up     0 *       2.2.2.2:1.1.1.1:1:vpls:GOLD
   Total 3 displayed, Up 3, Down 0
   ```

8. On Router PE2, use the **show mpls lsp** command to verify that three source-to-leaf sub-LSPs are created.

   ```
   user@PE2> show mpls lsp p2mp ingress

   Ingress LSP: 1 sessions
   P2MP name: 2.2.2.2:10:vpls:GOLD, P2MP branch count: 3
   To            From          State Rt P     ActivePath       LSPname
   4.4.4.4       2.2.2.2       Up     0 *       4.4.4.4:2.2.2.2:10:vpls:GOLD
   3.3.3.3       2.2.2.2       Up     0 *       3.3.3.3:2.2.2.2:10:vpls:GOLD
   1.1.1.1       2.2.2.2       Up     0 *       1.1.1.1:2.2.2.2:10:vpls:GOLD
   Total 3 displayed, Up 3, Down 0
   ```

9. In this step, Router PE3 and Router PE4 are using static point-to-multipoint LSPs. For static point-to-multipoint LSPs, the source-to-leaf sub-LSPs to all the PE routers are manually configured.

   On Router PE3, use the **show mpls lsp** command to verify that three source-to-leaf sub-LSPs have been configured.

   ```
   user@PE3> show mpls lsp p2mp ingress

   Ingress LSP: 1 sessions
   P2MP name: vpls-GOLD, P2MP branch count: 3
   To            From          State Rt P     ActivePath       LSPname
   1.1.1.1       3.3.3.3       Up     0 *                      to-pe1
   4.4.4.4       3.3.3.3       Up     0 *                      to-pe4
   2.2.2.2       3.3.3.3       Up     0 *                      to-pe2
   Total 3 displayed, Up 3, Down 0
   ```

10. On Router PE4, use the **show mpls lsp** command to verify that three source-to-leaf sub-LSPs are configured.

    ```
    user@PE4> show mpls lsp ingress p2mp
    ```

```
Ingress LSP: 1 sessions
P2MP name: vpls-GOLD, P2MP branch count: 3
To            From          State Rt P     ActivePath       LSPname
1.1.1.1       4.4.4.4       Up     0 *                      to-pe1
3.3.3.3       4.4.4.4       Up     0 *                      to-pe3
2.2.2.2       4.4.4.4       Up     0 *                      to-pe2
Total 3 displayed, Up 3, Down 0
```

11. Each point-to-multipoint LSP created by the PE router can be identified using an RSVP-TE point-to-multipoint session object. The session object is passed as a PMSI tunnel attribute by BGP when it advertises VPLS routes. Using this tunnel attribute, an incoming source-to-leaf sub LSP add request (RSVP-Path message) supports label allocation in such a way that when traffic arrives on this source-to-leaf sub-LSP the router terminates the message in the right VPLS instance and also identifies the originating PE. This supports source MAC address learning.

    On Router PE1, use the **show rsvp session** command to verify that the RSVP session for the dynamic point-to-multipoint LSP is **Up** and that link protection is configured as **desired**. Notice that the point-to-multipoint session object to be sent in BGP is **54337**.

    ```
    user@PE1> show rsvp session detail p2mp ingress

    Ingress RSVP: 7 sessions
    P2MP name: 1.1.1.1:1:vpls:GOLD, P2MP branch count: 3

    2.2.2.2
      From: 1.1.1.1, LSPstate: Up, ActiveRoute: 0
      LSPname: 2.2.2.2:1.1.1.1:1:vpls:GOLD, LSPpath: Primary
      P2MP LSPname: 1.1.1.1:1:vpls:GOLD
      Suggested label received: -, Suggested label sent: -
      Recovery label received: -, Recovery label sent: 262145
      Resv style: 1 SE, Label in: -, Label out: 262145
      Time left:    -, Since: Tue Oct  6 16:27:23 2009
      Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
      Port number: sender 2 receiver 54337 protocol 0
      Link protection desired
      Type: Protection down
      PATH rcvfrom: localclient
      Adspec: sent MTU 1500
      Path MTU: received 1500
      PATH sentto: 10.10.2.2 (xe-0/1/0.0) 371 pkts
      RESV rcvfrom: 10.10.2.2 (xe-0/1/0.0) 370 pkts
      Explct route: 10.10.2.2
      Record route: <self> 10.10.2.2
    ```

12. Router PE4 is configured for static point-to-multipoint LSPs. Link protection is not configured for these LSPs. Use the **show rsvp session** command to verify that the point-to-multipoint session object to be sent in BGP is **42873**.

    ```
    user@PE4> show rsvp session detail p2mp ingress

    Ingress RSVP: 7 sessions
    P2MP name: vpls-GOLD, P2MP branch count: 3

    1.1.1.1
      From: 4.4.4.4, LSPstate: Up, ActiveRoute: 0
      LSPname: to-pe1, LSPpath: Primary
      P2MP LSPname: vpls-GOLD
    ```

```
Suggested label received: -, Suggested label sent: -
Recovery label received: -, Recovery label sent: 390416
Resv style: 1 SE, Label in: -, Label out: 390416
Time left:    -, Since: Tue Oct  6 15:28:33 2009
Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
Port number: sender 10 receiver 42873 protocol 0
PATH rcvfrom: localclient
Adspec: sent MTU 1500
Path MTU: received 1500
PATH sentto: 10.10.9.1 (xe-0/0/0.0) 524 pkts
RESV rcvfrom: 10.10.9.1 (xe-0/0/0.0) 447 pkts
Explct route: 10.10.9.1 10.10.3.1
Record route: <self> 10.10.9.1 10.10.3.1
```

13. On Router PE1, use the **show route table** command to verify that Router PE1 received a Layer 2 VPN route to Router PE2 from the router reflector and the route includes a PMSI object that contains the point-to-multipoint tunnel identifier of **20361**.

```
user@PE1> show route table GOLD.l2vpn.0 detail

GOLD.l2vpn.0: 6 destinations, 6 routes (6 active, 0 holddown, 0 hidden)
!
!
2.2.2.2:10:3:1/96 (1 entry, 1 announced)
        *BGP    Preference: 170/-101
                Route Distinguisher: 2.2.2.2:10
                PMSI: Flags 0:RSVP-TE:label[0:0:0]:Session_13[2.2.2.2:0:20361:2.2.2.2]
                Next hop type: Indirect
                Next-hop reference count: 7
                Source: 7.7.7.7
                Protocol next hop: 2.2.2.2
                Indirect next hop: 2 no-forward
                State: <Secondary Active Int Ext>
                Local AS: 65000 Peer AS: 65000
                Age: 4:25:25    Metric2: 1
                Task: BGP_65000.7.7.7.7+63544
                Announcement bits (1): 0-GOLD-l2vpn
                AS path: I (Originator) Cluster list:  7.7.7.7
                AS path:  Originator ID: 2.2.2.2
                Communities: target:65000:1 Layer2-info: encaps:VPLS, control flags:, mtu: 0, site
preference: 100
                Import Accepted
                Label-base: 262145, range: 8
                Localpref: 100
                Router ID: 7.7.7.7
                Primary Routing Table bgp.l2vpn.0
PMSI: Flags 0:RSVP-TE:label[0:0:0]:Session_13[2.2.2.2:0:20361:2.2.2.2]
```

14. On Router PE2, use the **show rsvp session** command to verify that the PMSI tunnel identifier object of **20361** matches the PMSI tunnel identifier object displayed on Router PE1.

```
user@PE2> show rsvp session p2mp detail

Ingress RSVP: 7 sessions
P2MP name: 2.2.2.2:10:vpls:GOLD, P2MP branch count: 3

1.1.1.1
  From: 2.2.2.2, LSPstate: Up, ActiveRoute: 0
  LSPname: 1.1.1.1:2.2.2.2:10:vpls:GOLD, LSPpath: Primary
  P2MP LSPname: 2.2.2.2:10:vpls:GOLD
```

```
Suggested label received: -, Suggested label sent: -
Recovery label received: -, Recovery label sent: 262171
Resv style: 1 SE, Label in: -, Label out: 262171
Time left:    -, Since: Tue Oct  6 16:31:47 2009
Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
Port number: sender 1 receiver 20361 protocol 0
Link protection desired
Type: Protection down
PATH rcvfrom: localclient
Adspec: sent MTU 1500
Path MTU: received 1500
PATH sentto: 10.10.2.1 (xe-0/1/0.0) 379 pkts
RESV rcvfrom: 10.10.2.1 (xe-0/1/0.0) 379 pkts
Explct route: 10.10.2.1
Record route: <self> 10.10.2.1
```

Verifying the Data Plane

Step-by-Step Procedure

After the control plane is verified using the previous steps, you can verify the data plane. This section describes **show** command outputs you can use to validate the data plane.

1. On Router PE1, use the **show vpls connections extensive | match Flood** command to verify the point-to-multipoint LSP name and status of all the sites. Notice the flood next-hop identifier of **600** for the **1.1.1.1:1:vpls:GOLD** LSP.

   ```
   user@PE1> show vpls connections extensive | match Flood

   Ingress RSVP-TE P2MP LSP: 1.1.1.1:1:vpls:GOLD, Flood next-hop ID: 600
   ```

2. On Router PE1, use the **show vpls connections extensive** command to verify the point-to-multipoint LSP name and status of all the sites.

```
user@PE1> show vpls connections extensive

Instance: GOLD
  Local site: CE1 (1)
    Number of local interfaces: 1
    Number of local interfaces up: 1
    IRB interface present: no
    ge-1/0/0.1
    lsi.1049353     3       Intf - vpls GOLD local site 1 remote site 3
    lsi.1049346     4       Intf - vpls GOLD local site 1 remote site 4
        Interface flags: VC-Down
    lsi.1049354     5       Intf - vpls GOLD local site 1 remote site 5
    lsi.1049355     6       Intf - vpls GOLD local site 1 remote site 6
    Label-base        Offset     Range     Preference
    262169            1          8         100
    connection-site           Type  St     Time last up      # Up trans
    3                         rmt   Up     Oct  6 16:27:23 2009       1
      Remote PE: 2.2.2.2, Negotiated control-word: No
      Incoming label: 262171, Outgoing label: 262145
      Local interface: lsi.1049353, Status: Up, Encapsulation: VPLS
        Description: Intf - vpls GOLD local site 1 remote site 3
      RSVP-TE P2MP lsp:
        Ingress branch LSP: 2.2.2.2:1.1.1.1:1:vpls:GOLD, State: Up
        Egress branch LSP:  1.1.1.1:2.2.2.2:10:vpls:GOLD, State: Up
    Connection History:
        Oct  6 16:27:23 2009  status update timer
        Oct  6 16:27:23 2009  PE route changed
        Oct  6 16:27:23 2009  Out lbl Update                   262145
```

```
      Oct  6 16:27:23 2009  In lbl Update                    262171
      Oct  6 16:27:23 2009  loc intf up                 lsi.1049353
  4                         rmt   RM
    RSVP-TE P2MP lsp:
      Ingress branch LSP: 2.2.2.2:1.1.1.1:1:vpls:GOLD, State: Up
  5                         rmt   Up     Oct  6 16:27:27 2009         1
    Remote PE: 3.3.3.3, Negotiated control-word: No
    Incoming label: 262173, Outgoing label: 262145
    Local interface: lsi.1049354, Status: Up, Encapsulation: VPLS
      Description: Intf - vpls GOLD local site 1 remote site 5
    RSVP-TE P2MP lsp:
      Ingress branch LSP: 3.3.3.3:1.1.1.1:1:vpls:GOLD, State: Up
      Egress branch LSP:  to-pe1, State: Up
  Connection History:
      Oct  6 16:27:27 2009  status update timer
      Oct  6 16:27:27 2009  PE route changed
      Oct  6 16:27:27 2009  Out lbl Update                    262145
      Oct  6 16:27:27 2009  In lbl Update                     262173
      Oct  6 16:27:27 2009  loc intf up                 lsi.1049354
  6                         rmt   Up     Oct  6 16:27:31 2009         1
    Remote PE: 4.4.4.4, Negotiated control-word: No
    Incoming label: 262174, Outgoing label: 800000
    Local interface: lsi.1049355, Status: Up, Encapsulation: VPLS
      Description: Intf - vpls GOLD local site 1 remote site 6
    RSVP-TE P2MP lsp:
      Ingress branch LSP: 4.4.4.4:1.1.1.1:1:vpls:GOLD, State: Up
      Egress branch LSP:  to-pe1, State: Up
  Connection History:
      Oct  6 16:27:31 2009  status update timer
      Oct  6 16:27:31 2009  PE route changed
      Oct  6 16:27:31 2009  Out lbl Update                    800000
      Oct  6 16:27:31 2009  In lbl Update                     262174
      Oct  6 16:27:31 2009  loc intf up                 lsi.1049355
Local site: Direct (2)
  Number of local interfaces: 1
  Number of local interfaces up: 1
  IRB interface present: no
Interface name  Remote site ID  Description
  ge-1/1/0.1
  lsi.1049347     3       Intf - vpls GOLD local site 2 remote site 3
      Interface flags: VC-Down
  lsi.1049348     4       Intf - vpls GOLD local site 2 remote site 4
      Interface flags: VC-Down
  lsi.1049350     5       Intf - vpls GOLD local site 2 remote site 5
      Interface flags: VC-Down
  lsi.1049352     6       Intf - vpls GOLD local site 2 remote site 6
      Interface flags: VC-Down
  Label-base        Offset     Range     Preference
  262177            1          8         100
  connection-site           Type  St     Time last up
  3                         rmt   LM
    RSVP-TE P2MP lsp:
      Ingress branch LSP: 2.2.2.2:1.1.1.1:1:vpls:GOLD, State: Up
  4                         rmt   LM
    RSVP-TE P2MP lsp:
      Ingress branch LSP: 2.2.2.2:1.1.1.1:1:vpls:GOLD, State: Up
  5                         rmt   LM
    RSVP-TE P2MP lsp:
      Ingress branch LSP: 3.3.3.3:1.1.1.1:1:vpls:GOLD, State: Up
  6                         rmt   LM
    RSVP-TE P2MP lsp:
```

```
      Ingress branch LSP: 4.4.4.4:1.1.1.1:1:vpls:GOLD, State: Up
  Ingress RSVP-TE P2MP LSP: 1.1.1.1:1:vpls:GOLD, Flood next-hop ID: 600
```

3. Junos OS Release 9.0 and later identifies the flood next-hop route as a composite next hop. On Router PE1, use the **show route forwarding-table family vpls vpn GOLD detail** command to verify that three composite flood next-hop routes are installed in the Packet Forwarding Engine.

```
user@PE1> show route forwarding-table family vpls vpn GOLD detail

Routing table: GOLD.vpls
VPLS:
Destination        Type RtRef Next hop       Type Index NhRef Netif
default            perm     0                dscd   518     1
00:00:28:28:28:02/48
                   user     0                ucst   617     4 ge-1/1/0.1
00:00:28:28:28:06/48
                   user     0                indr 1048576     4
                              10.10.3.2     Push 800000, Push 390384(top)   621     2 xe-0/2/0.0
lsi.1049353        intf     0                indr 1048574     3
                              10.10.2.2     Push 262145   598     2 xe-0/1/0.0
lsi.1049354        intf     0                indr 1048575     4
                              10.10.1.2     Push 262145, Push 302272(top)   602     2 xe-0/3/0.0
lsi.1049355        intf     0                indr 1048576     4
                              10.10.3.2     Push 800000, Push 390384(top)   621     2 xe-0/2/0.0
00:14:f6:75:78:00/48
                   user     0                indr 1048575     4
                              10.10.1.2     Push 262145, Push 302272(top)   602     2 xe-0/3/0.0
00:19:e2:57:e7:c0/48
                   user     0                ucst   604     4 ge-1/0/0.1
0x30003/51         user     0                comp   613     2
0x30002/51         user     0                comp   615     2
0x30001/51         user     0                comp   582     2
ge-1/0/0.1         intf     0                ucst   604     4 ge-1/0/0.1
ge-1/1/0.1         intf     0                ucst   617     4 ge-1/1/0.1
```

You can also use the use the **show route forwarding-table family vpls extensive** command to match the flood identifier and note the flood label. To match the label out corresponding to the point-to-multipoint LSP, use the **show rsvp session ingress p2mp** command.

4. On Router PE1, use the **show route forwarding-table family vpls vpn GOLD extensive | find 0x30003/51** command to get more details about the composite next-hop route and the associated point-to-multipoint LSP labels.

```
user@PE1> show route forwarding-table family vpls vpn GOLD extensive | find
0x30003/51

Destination:  0x30003/51
  Route type: user
  Route reference: 0                    Route interface-index: 0
  Flags: sent to PFE
  Nexthop:
  Next-hop type: composite              Index: 613      Reference: 2
  Nexthop:
  Next-hop type: composite              Index: 556      Reference: 4
  Next-hop type: unicast                Index: 604      Reference: 4
  Next-hop interface: ge-1/0/0.1
  Next-hop type: unicast                Index: 617      Reference: 4
  Next-hop interface: ge-1/1/0.1
```

```
Destination:  0x30002/51
  Route type: user
  Route reference: 0                    Route interface-index: 0
  Flags: sent to PFE
  Nexthop:
  Next-hop type: composite              Index: 615      Reference: 2
  Nexthop:
  Next-hop type: composite              Index: 556      Reference: 4
  Next-hop type: unicast                Index: 604      Reference: 4
  Next-hop interface: ge-1/0/0.1
  Next-hop type: unicast                Index: 617      Reference: 4
  Next-hop interface: ge-1/1/0.1
  Nexthop:
  Next-hop type: composite              Index: 603      Reference: 3
  Next-hop type: flood                  Index: 600      Reference: 2
  Nexthop: 10.10.2.2
  Next-hop type: Push 262145            Index: 599      Reference: 1
  Next-hop interface: xe-0/1/0.0
  Nexthop: 10.10.3.2
  Next-hop type: Push 390496            Index: 622      Reference: 1
  Next-hop interface: xe-0/2/0.0
  Nexthop: 10.10.1.2
  Next-hop type: Push 302416            Index: 618      Reference: 1
  Next-hop interface: xe-0/3/0.0

Destination:  0x30001/51
  Route type: user
  Route reference: 0                    Route interface-index: 0
  Flags: sent to PFE
  Nexthop:
  Next-hop type: composite              Index: 582      Reference: 2
  Nexthop:
  Next-hop type: composite              Index: 556      Reference: 4
  Next-hop type: unicast                Index: 604      Reference: 4
  Next-hop interface: ge-1/0/0.1
  Next-hop type: unicast                Index: 617      Reference: 4
  Next-hop interface: ge-1/1/0.1
  Nexthop:
  Next-hop type: composite              Index: 603      Reference: 3
  Next-hop type: flood                  Index: 600      Reference: 2
  Nexthop: 10.10.2.2
  Next-hop type: Push 262145            Index: 599      Reference: 1
  Next-hop interface: xe-0/1/0.0
  Nexthop: 10.10.3.2
  Next-hop type: Push 390496            Index: 622      Reference: 1
  Next-hop interface: xe-0/2/0.0
  Nexthop: 10.10.1.2
  Next-hop type: Push 302416            Index: 618      Reference: 1
  Next-hop interface: xe-0/3/0.0

Destination:  ge-1/0/0.1
  Route type: interface
  Route reference: 0                    Route interface-index: 84
  Flags: sent to PFE
  Next-hop type: unicast                Index: 604      Reference: 4
  Next-hop interface: ge-1/0/0.1

Destination:  ge-1/1/0.1
  Route type: interface
  Route reference: 0                    Route interface-index: 86
```

```
  Flags: sent to PFE
  Next-hop type: unicast              Index: 617      Reference: 4
  Next-hop interface: ge-1/1/0.1
```

5. On Router PE1, use the **show vpls mac-table instance GOLD** command to verify the learned MAC addresses of CE routers connected to the VPLS domain.

```
user@PE1> show vpls mac-table instance GOLD

MAC flags (S -static MAC, D -dynamic MAC,
           SE -Statistics enabled, NM -Non configured MAC)

Routing instance : GOLD
 Bridging domain : __GOLD__, VLAN : NA
   MAC                 MAC      Logical
   address             flags    interface
   00:00:28:28:28:02   D        ge-1/1/0.1
   00:00:28:28:28:04   D        lsi.1049353
   00:14:f6:75:78:00   D        lsi.1049354
   00:19:e2:51:7f:c0   D        lsi.1049353
   00:19:e2:57:e7:c0   D        ge-1/0/0.1
```

6. On Router PE1, use the **show vpls statistics** command to verify the broadcast, multicast, and unicast traffic flow using the packet statistics for the VPLS instance.

```
user@PE1> show vpls statistics

VPLS statistics:

Instance: GOLD
   Local interface: lsi.1049347, Index: 72
     Current MAC count:                     0
   Local interface: lsi.1049348, Index: 73
     Current MAC count:                     0
   Local interface: lsi.1049346, Index: 82
     Current MAC count:                     0
   Local interface: lsi.1049353, Index: 83
   Remote PE: 2.2.2.2
     Current MAC count:                     2
   Local interface: ge-1/0/0.1, Index: 84
     Broadcast packets:                   421
     Broadcast bytes  :                 26944
     Multicast packets:                  3520
     Multicast bytes  :                261906
     Flooded packets  :             509043345
     Flooded bytes    :          130315095486
     Unicast packets  :             393836428
     Unicast bytes    :          100822118854
     Current MAC count:                     1 (Limit 1024)
   Local interface: ge-1/1/0.1, Index: 86
     Broadcast packets:                     0
     Broadcast bytes  :                     0
     Multicast packets:                     0
     Multicast bytes  :                     0
     Flooded packets  :              22889544
     Flooded bytes    :            5859702144
     Unicast packets  :                   472
     Unicast bytes    :                 30838
     Current MAC count:                     1 (Limit 1024)
   Local interface: lsi.1049354, Index: 88
   Remote PE: 3.3.3.3
     Current MAC count:                     1
```

```
    Local interface: lsi.1049350, Index: 89
      Current MAC count:                     0
    Local interface: lsi.1049355, Index: 90
    Remote PE: 4.4.4.4
      Current MAC count:                     0
    Local interface: lsi.1049352, Index: 91
      Current MAC count:                     0
```

Results The configuration, verification, and testing part of this example has been completed. The following section is for your reference.

The relevant sample configuration for Router PE1 follows.

PE1 Configuration

```
chassis {
  dump-on-panic;
  fpc 1 {
    pic 3 {
      tunnel-services {
        bandwidth 1g;
      }
    }
  }
  network-services ethernet;
}
interfaces {
  xe-0/1/0 {
    unit 0 {
      family inet {
        address 10.10.2.1/30;
      }
      family mpls;
    }
  }
  xe-0/2/0 {
    unit 0 {
      family inet {
        address 10.10.3.1/30;
      }
      family mpls;
    }
  }
  xe-0/3/0 {
    unit 0 {
      family inet {
        address 10.10.1.1/30;
      }
      family mpls;
    }
  }
  ge-1/0/0 {
    vlan-tagging;
    encapsulation vlan-vpls;
    unit 1 {
      encapsulation vlan-vpls;
      vlan-id 1000;
      family vpls;
```

```
        }
    }
    ge-1/1/0 {
        vlan-tagging;
        encapsulation vlan-vpls;
        unit 1 {
            encapsulation vlan-vpls;
            vlan-id 1000;
            family vpls;
        }
    }
    lo0 {
        unit 0 {
            family inet {
                address 1.1.1.1/32;
            }
        }
    }
}
routing-options {
    static {
        route 172.0.0.0/8 next-hop 172.19.59.1;
    }
    autonomous-system 65000;
}
protocols {
    rsvp {
        interface all;
        interface fxp0.0 {
            disable;
        }
    }
    mpls {
        label-switched-path to-RR {
            to 7.7.7.7;
        }
        label-switched-path vpls-GOLD-p2mp-template {
            template;
            optimize-timer 50;
            link-protection;
            p2mp;
        }
        label-switched-path to-PE2 {
            to 2.2.2.2;
        }
        label-switched-path to-PE3 {
            to 3.3.3.3;
        }
        label-switched-path to-PE4 {
            to 4.4.4.4;
        }
        interface all;
        interface fxp0.0 {
            disable;
        }
    }
```

```
    bgp {
      group to-RR {
        type internal;
        local-address 1.1.1.1;
        family l2vpn {
          signaling;
        }
        neighbor 7.7.7.7;
      }
    }
    ospf {
      traffic-engineering;
      area 0.0.0.0 {
        interface all;
        interface fxp0.0 {
          disable;
        }
      }
    }
  }
  routing-instances {
    GOLD {
      instance-type vpls;
      interface ge-1/0/0.1;
      interface ge-1/1/0.1;
      route-distinguisher 1.1.1.1:1;
      provider-tunnel {
        rsvp-te {
          label-switched-path-template {
            vpls-GOLD-p2mp-template;
          }
        }
      }
      vrf-target target:65000:1;
      protocols {
        vpls {
          site-range 8;
          no-tunnel-services;
          site CE1 {
            site-identifier 1;
            interface ge-1/0/0.1;
          }
          site Direct {
            site-identifier 2;
            interface ge-1/1/0.1;
          }
        }
      }
    }
  }
```

The relevant sample configuration for Router PE2 follows.

PE2 Configuration

```
  chassis {
    dump-on-panic;
    aggregated-devices {
```

```
    ethernet {
      device-count 1;
    }
  }
  fpc 1 {
    pic 3 {
      tunnel-services {
        bandwidth 1g;
      }
    }
  }
}
interfaces {
  xe-0/1/0 {
    unit 0 {
      family inet {
        address 10.10.2.2/30;
      }
      family mpls;
    }
  }
  xe-0/2/0 {
    unit 0 {
      family inet {
        address 10.10.5.1/30;
      }
      family mpls;
    }
  }
  xe-0/3/0 {
    unit 0 {
      family inet {
        address 10.10.4.1/30;
      }
      family mpls;
    }
  }
  ge-1/0/1 {
    gigether-options {
      802.3ad ae0;
    }
  }
  ge-1/0/2 {
    gigether-options {
      802.3ad ae0;
    }
  }
  ge-1/1/0 {
    vlan-tagging;
    encapsulation vlan-vpls;
    unit 1 {
      encapsulation vlan-vpls;
      vlan-id 1000;
      family vpls;
    }
  }
```

```
    ae0 {
      vlan-tagging;
      encapsulation vlan-vpls;
      unit 1 {
        encapsulation vlan-vpls;
        vlan-id 1000;
        family vpls;
      }
    }
    fxp0 {
      apply-groups [ re0 re1 ];
    }
    lo0 {
      unit 0 {
        family inet {
          address 2.2.2.2/32;
        }
      }
    }
}
routing-options {
    static {
      route 172.0.0.0/8 next-hop 172.19.59.1;
    }
    autonomous-system 65000;
}
protocols {
    rsvp {
      interface all;
      interface fxp0.0 {
        disable;
      }
    }
    mpls {
      label-switched-path to-RR {
        to 7.7.7.7;
      }
      label-switched-path vpls-GOLD-p2mp-template {
        template;
        optimize-timer 50;
        link-protection;
        p2mp;
      }
      label-switched-path to-PE1 {
        to 1.1.1.1;
      }
      label-switched-path to-PE3 {
        to 3.3.3.3;
      }
      label-switched-path to-PE4 {
        to 4.4.4.4;
      }
      interface all;
      interface fxp0.0 {
        disable;
      }
```

```
    }
    bgp {
      group to-RR {
        type internal;
        local-address 2.2.2.2;
        family l2vpn {
          signaling;
        }
        neighbor 7.7.7.7;
      }
    }
    ospf {
      traffic-engineering;
      area 0.0.0.0 {
        interface all;
        interface fxp0.0 {
          disable;
        }
      }
    }
  }
  routing-instances {
    GOLD {
      instance-type vpls;
      interface ge-1/1/0.1;
      interface ae0.1;
      route-distinguisher 2.2.2.2:10;
      provider-tunnel {
        rsvp-te {
          label-switched-path-template {
            vpls-GOLD-p2mp-template;
          }
        }
      }
      vrf-target target:65000:1;
      protocols {
        vpls {
          site-range 8;
          site CE1 {
            site-identifier 3;
            interface ae0.1;
          }
          site Direct {
            site-identifier 4;
            interface ge-1/1/0.1;
          }
        }
      }
    }
  }
```

Related Documentation

- Next-Generation VPLS Point-to-Multipoint Forwarding Overview on page 147

Next-Generation VPLS for Multicast with Multihoming Overview

VPLS emulates the broadcast domain of a LAN across an MPLS network cloud. Traditional MPLS implementations of VPLS require that all participating ingress PE routers make separate copies of each broadcast or multicast packet to send to all other PE routers that are part of the VPLS site for the same extended LAN. In a large virtual private network (VPN), replication overhead can be significant for each ingress router and its attached core-facing links.

Junos OS offers the following VPLS enhancements which provide redundancy for VPLS between PE and CE routers:

- Redundancy using BGP for multihomed links between PE and CE devices— Juniper Networks integrates the local preference and path selection capability of BGP with VPLS to allow a CE Ethernet switch to have a backup path across the network.
- Redundancy using the Spanning Tree Protocol (STP) for multihomed links between PE and CE devices— Various versions of STP can be used in the CE network to avoid loops in a multihoming environment. The provider does not have any control over this customer network configuration. The provider can also implement BGP-based loop avoidance as an additional measure to avoid loops.

The following standardized VPLS implementations are supported by the Internet Engineering Task Force (IETF):

- RFC 4761, *Virtual Private LAN Service (VPLS) Using BGP for Auto-Discovery and Signaling*
- RFC 4762, *Virtual Private LAN Service (VPLS) Using LDP Signaling*

For more information about the basic configuration of next-generation VPLS, see the Technology Overview *Next-Generation VPLS Using Point-to-Multipoint LSPs for Unicast and Multicast Forwarding*.

For a detailed technology overview of VPLS, you can refer to *LDP-BGP VPLS Interworking* at the following location:
http://www.juniper.net/us/en/local/pdf/whitepapers/2000282-en.pdf .

Redundancy Using BGP for Multihomed Links between PE and CE Routers

Juniper Networks implements a BGP-based multihoming solution to provide redundancy for VPLS between PE and CE routers.

In this implementation:

- VPLS-enabled PE routers (also called VPLS PE routers) collectively elect one of the VPLS PE routers, to which a site is multihomed, as the designated forwarder of traffic between this site and all other sites.
- All the other VPLS PE routers, to which the same site is connected, do not forward traffic to or from the site.
- Essentially all VPLS PE routers behave as if the site is singlehomed to the VPLS PE router that is the designated forwarder.

- Service providers are able to prevent well-known Layer 2 loops without relying on the customer's STP configuration.
- Customers can still run STP as a fallback strategy to prevent loops that are formed without the service provider's knowledge.

The benefits of multihoming include:

- Redundancy of the link connecting the PE router and the CE device.
- Redundancy of the directly connected PE routers.
- Faster convergence when there is a link failure between a PE router and CE device.
- The same BGP attributes are used to configure primary and backup links.

Operation of Next-Generation VPLS for Multicast with Multihoming Using BGP

VPLS provides a multipoint-to-multipoint Ethernet service that can span one or more metro areas and multiple sites. VPLS provides connectivity as if these sites are attached to the same Ethernet LAN.

VPLS uses an IP and MPLS service provider infrastructure. From the service provider's point of view, using IP and MPLS routing protocols and procedures instead of STP, and using MPLS labels instead of VLAN identifiers (IDs), significantly improves the scalability of the VPLS service.

Single CE Site Connected to Multiple VPLS PE Routers

This section describes the process used to elect a single designated forwarder for a multihomed site.

For a multihomed site, all the PE routers in the VPLS instance elect the same designated forwarder PE router using the BGP VPLS multihoming procedure. Only elected designated forwarders forward traffic to and receive traffic from the multihomed site. All other PE routers where this multihomed site is present do not participate in forwarding for that site.

All remote PE routers are aware of the designated forwarder PE router for each multihomed site and do not create a pseudowire to the PE routers that are not the designated forwarder for the multihomed site.

In Figure 20 on page 188:

- The same site ID (sometimes known as a VPLS edge identifier or VE ID) is configured on all VPLS PE routers to which a site is multihomed.
- All PE routers are aware of which sites are multihomed since they see multiple advertisements with the same site ID.
- One of the VPLS PE routers is selected as the designated forwarder for this site by all PE routers based on a deterministic algorithm.

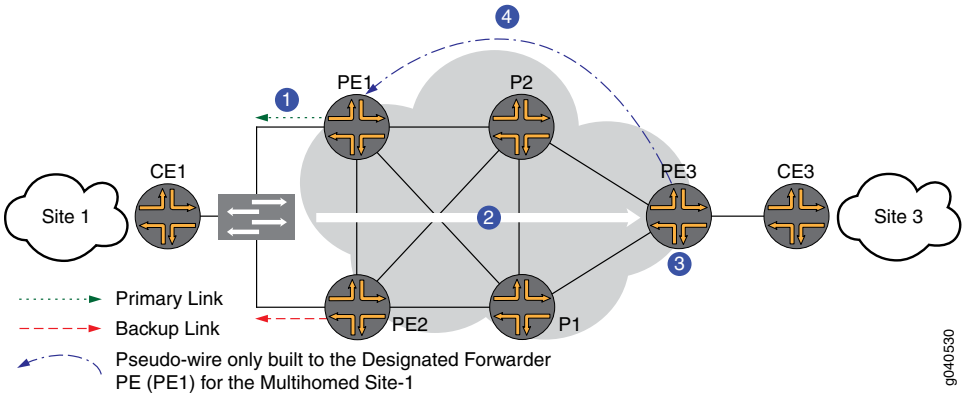
- The algorithm selects the VPLS PE router that originates the best advertisement with a particular site ID as the designated forwarder. There are two possible selection methods:
  - BGP path selection on the route reflector and the PE routers
  - VPLS site selection on the PE router only
- If multiple network layer reachability information (NLRI) advertisements have the same route distinguisher and site ID, the router uses BGP path selection rules to select the best path. The BGP rules are:
  - Always prefer advertisements that do not have the down bit set over ones that do have this bit set.
  - Prefer the advertisement with the higher local preference.
  - Use the configurable per-site site preference to set the BGP local preference in the advertisement and influence the choice of the designated forwarder.
  - Ignore the interior gateway protocol (IGP) metric while doing path selection because the choice of designated forwarder must be the same on all PE routers.
- Among advertisements with the same route distinguisher, apply VPLS site selection rules (a subset of BGP path selection rules) to pick the select advertisement.

Figure 20 on page 188 illustrates the following four-step process to select the designated forwarder and create the pseudowire:

1. Router PE1 and Router PE2 both have the same site ID (Site 1) for Router CE1.

   Router PE1 has a better local preference of 65535 and is configured as the primary router.
2. Router PE3 receives the BGP NLRI advertisement from Router PE1 and Router PE2 with the local preferences of 65535 and 1, respectively.
3. Router PE3 runs the BGP path selection algorithm and selects Router PE1 as the designated forwarder VPLS edge PE router for Site 1.
4. Router PE3 creates the pseudowire only to Router PE1, which helps to save bandwidth in the network core.

Figure 20: Single CE Site Multihomed with Two PE Routers



The resulting VPLS PE router roles for Site 1 are:

- Router PE1 is the designated forwarder VPLS edge PE router.
- Router PE2 is the non-designated forwarder VPLS edge PE router.
- Router PE3 is the remote VPLS edge PE router.

All the interfaces linking the CE and PE devices that are connected to the designated forwarder VPLS PE router, are marked **Up** and **forwarding** in **show** command output.

All the interfaces linking the CE and PE devices on the non-designated forwarder VPLS PE router, are marked **vc-down** in **show** command output. The router does not send traffic or forward received traffic on these interfaces.

Remote VPLS PE routers establish pseudowires only to the designated PE router, and tear down any pseudowires to the non-designated PE router.

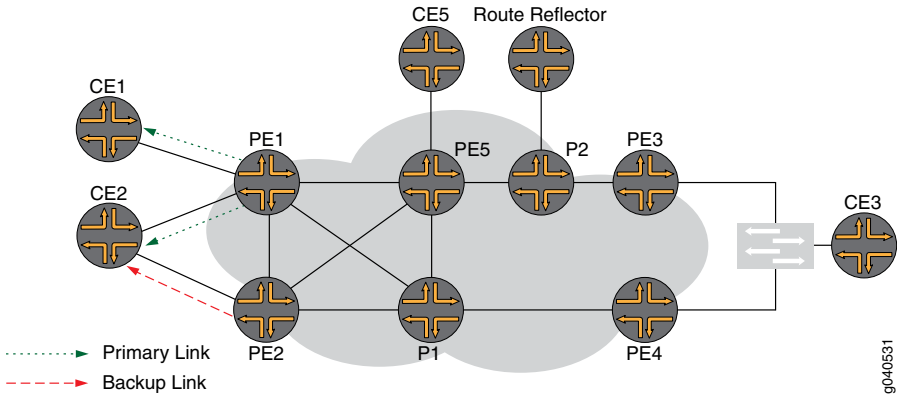
Multiple CE Sites Connected to a Single VPLS PE Router for Link Redundancy

This section describe some of the operational details of multiple CE sites connected to a single VPLS PE router.

In Figure 21 on page 189:

- Router CE2 is multihomed to Router PE1 and Router PE2.
- Router CE1 is singlehomed to Router PE1.

Figure 21: Two CE Sites Multihomed to a Single PE Router on Different Line Cards



The scenario shown in Figure 2 is common. Your network might have a single PE router in a remote area, but you would like to multihome a Layer 2 network to different Flexible PIC Concentrators (FPCs) on the same PE router. This configuration provides link redundancy on the CE devices and link redundancy on the links between the CE and PE devices, but limited link redundancy on PE devices. In this case, you need the ability to configure a site to use a single active interface for forwarding.

In this scenario:

- Path selection is done per site to determine if a PE router is the designated forwarder for that site or not.
- Only a single pseudowire is established between any two PE routers, even if one or both of them have multiple designated PE routers.

NOTE: **A pseudowire between two PE routers is always established between the designated sites with the minimum site IDs on the two PE routers.**

- Establishing a single pseudowire avoids the need to maintain multiple flooding and media access control (MAC) address tables per instance (one per site) on each PE router.
- The local interfaces are marked **vc-down** in the **show** command output where a site is connected to the non-designated forwarder router.
- When a designated site on a PE router fails, all MAC addresses from this remote PE router have to be learned again, since the router does not know the exact site where the MAC addresses were originally learned from.

Implementation of Redundancy Using VPLS Multihomed Links Between PE and CE Devices

You might need to multihome a CE device to multiple PE routers without causing a Layer 2 forwarding loop. This is not a problem if the CE device is a router, since no Layer 2 loops

can form when using a router. However, if the CE device is a Layer 2 device, like a hub or switch, multihoming it to two PE routers can cause a Layer 2 loop.

You can use one of the following methods to prevent the Layer 2 loop:

- BGP-based primary and backup link selection.
- Spanning tree protocol (STP) to prune links to the CE router. However, this method requires the service provider to trust its customer to not cause any Layer 2 loops by misconfiguration.
- Active and standby up link functionality, such as the redundant trunk groups that are supported on Juniper Networks EX Series Ethernet Switches.

The limitations of using STP on the CE site are:

- Backbone and access network bandwidth is not used efficiently.
- PE routers using STP to prevent loops with dual-homed sites receive broadcast traffic unnecessarily because the pseudowire to the standby PE router still exists.
- When the direct link between the CE and PE router fails, multihoming works fine. When a link connected downstream from the CE router fails, multihoming does not work.

The benefits and properties of the BGP-based solution are:

- BGP path selection does not have the limitations of STP.
- A CE device that is multihomed to multiple PE routers is given the same site ID on all the PE routers it is multihomed to.
- The BGP path selection algorithm selects the router that originates the best advertisement as the VPLS PE designated forwarder.
- If desired, you can set the local preference on the PE routers to control BGP path selection.
- BGP path selection occurs on the route reflector and the PE router.
- An IGP metric is not part of the selection process.
- If the route distinguisher is the same on both PE routers, the route reflector selects one PE router as the designated forwarder. If the route distinguishers are different on the PE routers, the route reflector forwards both copies of the route to the remote PE routers.

Related Documentation

- Example: Next-Generation VPLS for Multicast with Multihoming on page 191
- Example: NG-VPLS Using Point-to-Multipoint LSPs on page 152
- Next-Generation VPLS Point-to-Multipoint Forwarding Overview on page 147

Example: Next-Generation VPLS for Multicast with Multihoming

This example shows how to configure next-generation VPLS for multicast with multihoming. It is organized in the following sections:

Requirements

The following table lists the hardware and software requirements for this configuration.

Table 10: Hardware and Software Used

Equipment	Components	Software
Four MX Series 3D Universal Edge Routers	DPC40X-1GE -X, DPC 4X-10GE-X, DPC40x-1GE-R, DPC 4X-10GE-R	Junos OS Release 9.3 or later
Two M320 Multiservice Edge Routers and T Series Core Routers	FPC 3, 10GE Xenpak	Junos OS Release 9.3 or later
Five EX Series Ethernet Switches	EX4200, EX3200	Junos OS Release 9.4 or later

Overview and Topology

Figure 22 on page 192 shows the physical topology used in this next-generation VPLS multihoming example.

Figure 22: Physical Topology of Next-Generation VPLS for Multicast with Multihoming

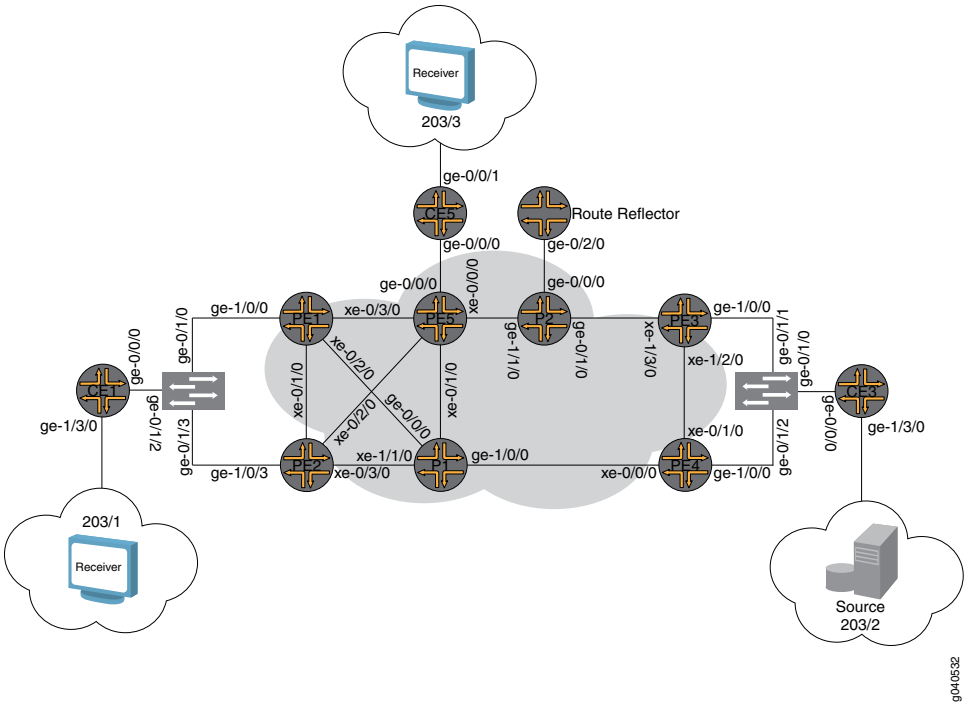
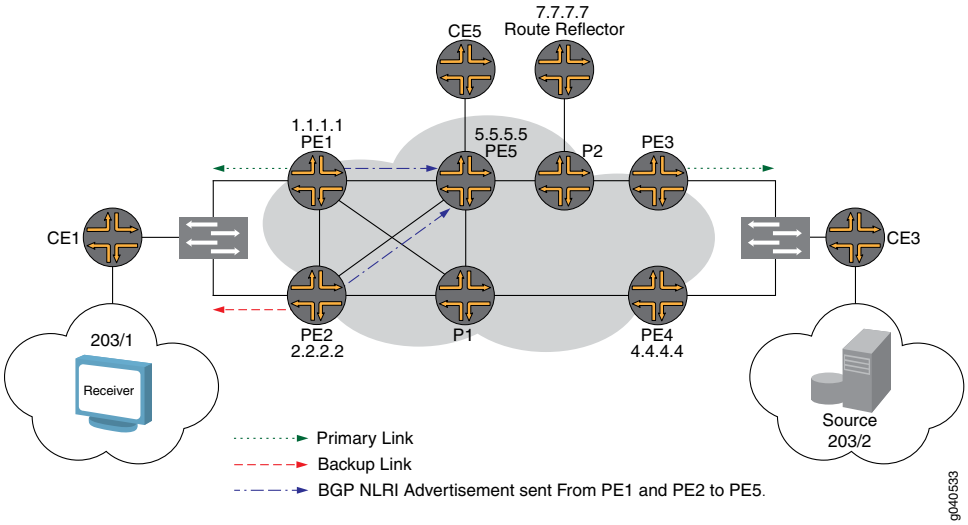


Figure 23 on page 192 show the logical topology of the next-generation VPLS multihoming example.

Figure 23: Logical Topology of Next-Generation VPLS for Multicast with Multihoming



The network state and configuration before the implementation is as follows:

- Five PE routers participating in the next-generation VPLS domain named GOLD.
- OSPF, BGP, and RSVP are configured on the MPLS core interfaces.
- The **no-tunnel-services** statement is included in the VPLS routing instance. This statement supports the use of label-switched interface (LSI) tunnel interfaces for VPLS.
- Router PE1 and Router PE2 are configured with a dynamic point-to-multipoint LSP using the **vpls-GOLD-p2mp-template** template.
- Router PE3 and Router PE4 are configured to use static point-to-multipoint LSPs.

NOTE: **Single-hop point-to-multipoint LSPs are not supported, so single-hop point-to-multipoint LSPs are down.**

- Router CE1 is multihomed to Router PE1 and Router PE2 through an EX4200 Layer 2 switch.
- Router CE3 is multihomed to Router PE3 and Router PE4 through an EX4200 Layer 2 switch.
- Router CE5 is singlehomed to Router PE5.
- The off-path route reflector is configured for BGP. The **family l2vpn** statement is included in the route reflector configuration.
- Router CE3 is connected to test equipment through port 203/2. The test equipment generates multicast traffic to groups 230.1.1.1 through 230.1.1.10 at the rate of 10,000 pps.
- Router CE1 and Router CE5 are configured with static Internet Group Management Protocol (IGMP) joins so they can receive the multicast traffic from Router CE3.
- The Layer 2 switches are configured with truck ports to the PE routers and access ports to the test equipment.

Here is a summary of the steps necessary to complete the configuration successfully:

1. Configure a unique route distinguisher for the VPLS routing instance named GOLD on Router PE1, Router PE2, Router PE3, and Router PE4.
2. Configure the same site ID for the multihomed PE routers. Configure both Router PE1 and Router PE2 with a site ID value of 1. Configure both Router PE3 and Router PE4 with a site ID value of 3.
3. Configure multihoming under the CE1 site configuration.
4. Configure the site-preference **Primary** on Router PE1 and configure the site-preference **Backup** on Router PE2. In this case, Router PE1 has the primary link to Router CE1 and Router PE2 has the backup link to Router CE1.
5. Configure the site preference on Router PE3 and Router PE4. Configure Router PE3 as the primary and Router PE4 as the backup.

Configuration

This section provides a step-by-step procedure to configure next-generation VPLS for multicast with multihoming.

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

This example is organized in the following sections:

Configuring Next-Generation VPLS Multihoming

Step-by-Step Procedure

1. In BGP-based VPLS multihoming, it is recommended 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 the other backup PE routers to maintain additional state information for faster convergence.

   There are two levels of path selection:

   - The first is BGP: BGP uses a combination of route distinguisher, site ID, and VE block offset for BGP path selection.
   - The second is in VPLS: VPLS uses the site ID for VPLS path selection.

   By configuring unique route distinguishers, the prefixes for BGP path selection are all unique. Therefore, BGP path selection is skipped and VPLS path selection is used, which only looks at the site ID.

   On Router PE1, Router PE2, Router PE3, and Router PE4 configure a unique router distinguisher for the **GOLD** routing instance.

   ```
   user@PE1# set routing-instance GOLD route-distinguisher 1.1.1.1:1

   user@PE2# set routing-instance GOLD route-distinguisher 2.2.2.2:10

   user@PE3# set routing-instance GOLD route-distinguisher 3.3.3.3:1

   user@PE4# set routing-instance GOLD route-distinguisher 4.4.4.4:10
   ```

2. Configure site ID **1** on Routers PE1 and PE2 for Router CE1. Configure site ID **3** on Routers PE3 and PE4 for Router CE3.

   ```
   user@PE1# set routing-instance GOLD protocols vpls site CE1 site-identifier 1

   user@PE2# set routing-instance GOLD protocols vpls site CE1 site-identifier 1
   ```

```
user@PE3# set routing-instance GOLD protocols vpls site CE3 site-identifier 3

user@PE4# set routing-instance GOLD protocols vpls site CE3 site-identifier 3
```

3. Enable multihoming by including the **multi-homing** statement under the multihomed site configuration on Router PE1, Router PE2, Router PE3, and Router PE4.

```
user@PE1# set routing-instance GOLD protocols vpls site CE1 multi-homing

user@PE2# set routing-instance GOLD protocols vpls site CE1 multi-homing

user@PE3# set routing-instance GOLD protocols vpls site CE3 multi-homing

user@PE4# set routing-instance GOLD protocols vpls site CE3 multi-homing
```

4. Include the **site-preference primary** statement on Router PE1 and Router PE3, and include the **site-preference backup** statement on Router PE2 and Router PE4. The **site-preference primary** statement sets the local preference to the highest value (65535) and the **site-preference backup** statement sets the BGP local preference to 1. Since the site ID is the same, the routers select the highest local preference value as the designated forwarder.

```
user@PE1# set routing-instance GOLD protocols vpls site CE1 site-preference primary

user@PE2# set routing-instance GOLD protocols vpls site CE1 site-preference backup

user@PE3# set routing-instance GOLD protocols vpls site CE3 site-preference
  primary

user@PE4# set routing-instance GOLD protocols vpls site CE3 site-preference
  backup
```

Validating the VPLS Control Plane

Step-by-Step Procedure

This section presents show commands that you can use to verify the operation of the example configuration.

In this example the traffic patterns are:

- The source is connected to Router CE3 and sends 10,000 pps for the groups 230.1.1.1 to 230.1.1.10. Router CE3 is configured as a rendezvous point.
- Multicast receivers are connected to both Router CE1 and Router CE5. Protocol Independent Multicast (PIM) join messages are generated by the test equipment.
- The link between Router PE3 and Router CE3 and the link between Router PE1 and Router CE1 are configured as primaries for VPLS multihoming.
- All PE routers have a BGP session with the route reflector.
- All PE routers have a label-switched path (LSP) that is created to the route reflector so that the PE routers have a route to the route reflector in the **inet.3** table for route resolution.

1. On Router PE1, use the **show vpls connections** command to verify that the VPLS connections are **Up** between Router PE1 and Router PE3 and between Router PE1 and PE5. Router PE1 is the primary link selected by the VPLS multihoming configuration.

```
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: GOLD
  Local site: CE1 (1)
    connection-site           Type  St     Time last up          # Up trans
    1                         rmt   RN
    3                         rmt   Up     Nov 16 11:22:44 2009           1
      Remote PE: 3.3.3.3, Negotiated control-word: No
      Incoming label: 262147, Outgoing label: 262145
      Local interface: lsi.1048835, Status: Up, Encapsulation: VPLS
        Description: Intf - vpls GOLD local site 1 remote site 3
    5                         rmt   Up     Nov 16 11:22:46 2009           1
      Remote PE: 5.5.5.5, Negotiated control-word: No
      Incoming label: 262149, Outgoing label: 262161
      Local interface: lsi.1048836, Status: Up, Encapsulation: VPLS
        Description: Intf - vpls GOLD local site 1 remote site 5
```

2. On Router PE2, use the **show vpls connections** command to verify that the VPLS connections to Router PE3 and Router PE5 are in the **LN** state, meaning the local router is not the designated forwarder. Router PE2 is configured to be the backup link for Router CE1.

```
user@PE2# show vpls connections

...

Instance: GOLD
  Local site: CE1 (1)
    connection-site           Type  St     Time last up          # Up trans
    1                         rmt   LN
    3                         rmt   LN
    5                         rmt   LN
```

3. On Router PE3, use the **show vpls connections** command to verify that the VPLS connections to Router PE1 and Router PE5 are **Up**. Router PE3 is configured to be the primary link for Router CE3.

```
user@PE3# show vpls connections

...

Instance: GOLD
  Local site: CE3 (3)
    connection-site           Type  St     Time last up          # Up trans
    1                         rmt   Up     Nov 16 11:22:01 2009           1
      Remote PE: 1.1.1.1, Negotiated control-word: No
      Incoming label: 262145, Outgoing label: 262147
      Local interface: lsi.1048832, Status: Up, Encapsulation: VPLS
        Description: Intf - vpls GOLD local site 3 remote site 1
    3                         rmt   RN
    5                         rmt   Up     Nov 16 11:22:56 2009           1
      Remote PE: 5.5.5.5, Negotiated control-word: No
      Incoming label: 262149, Outgoing label: 262163
      Local interface: lsi.1048834, Status: Up, Encapsulation: VPLS
        Description: Intf - vpls GOLD local site 3 remote site 5
```

4. On Router PE4, use the **show vpls connections** command to verify that the VPLS connections are in the **LN** state, meaning the local site is not designated. Router PE4 is configured to be the backup link for Router CE3.

```
user@PE4# show vpls connections

...

Instance: GOLD
  Local site: CE3 (3)
    connection-site           Type  St     Time last up          # Up trans
    1                         rmt   LN
    3                         rmt   SC
    5                         rmt   LN
```

5. On Router PE1, use the **show route advertising-protocol** command to verify that Router PE1 (the multihoming primary router) is sending the BGP Layer 2 VPN route advertisement to the route reflector with the local preference value of **65535**. The local preference is used by Router PE3 to select Router PE1 as the designated forwarder, rather than selecting Router PE2 that has a local preference of **1**.

```
user@PE1# show route advertising-protocol bgp 7.7.7.7 extensive

GOLD.l2vpn.0: 5 destinations, 5 routes (5 active, 0 holddown, 0 hidden)
* 1.1.1.1:1:1:1/96 (1 entry, 1 announced)
 BGP group to-RR type Internal
     Route Distinguisher: 1.1.1.1:1
     Label-base: 262145, range: 8
     Nexthop: Self
     Flags: Nexthop Change
     Localpref: 65535
     AS path: [65000] I
    Communities: target:65000:1 Layer2-info: encaps:VPLS, control flags:, mtu: 0, site preference: 65535

     PMSI: Flags 0:RSVP-TE:label[0:0:0]:Session_13[1.1.1.1:0:9519:1.1.1.1]
```


6. On Router PE2, use the **show route advertising-protocol** command to verify that Router PE2 is configured as the multihoming backup with a local preference of **1**.

```
user@PE2# show route advertising-protocol bgp 7.7.7.7 extensive

GOLD.l2vpn.0: 5 destinations, 5 routes (5 active, 0 holddown, 0 hidden)
* 2.2.2.2:10:1:1/96 (1 entry, 1 announced)
 BGP group to-RR type Internal
     Route Distinguisher: 2.2.2.2:10
     Label-base: 262145, range: 8
     Nexthop: Self
     Flags: Nexthop Change
     Localpref: 1
     AS path: [65000] I
     Communities: target:65000:1 Layer2-info: encaps:VPLS, control flags:, mtu: 0, site preference: 1
```

7. On Router PE3, use the **show route receive-protocol** command to verify that Router PE3 receives the Layer 2 VPN route from the route reflector for Router PE1 and Router PE2 with different local preference values.

   BGP route selection is based on the received **l2vpn** routes for the VPLS site connected to multihomed PE routers. Since the route distinguishers are different on Router PE1 and Router PE2, Router PE3 and Router PE4 consider the received routes from Router PE1 and Router PE2 as different routes. Router PE3 and Router PE4 run the BGP path selection algorithm and select Router PE1, the router advertising the route with the higher local preference value, as the designated forwarder.

   ```
   user@PE3# show route receive-protocol bgp 7.7.7.7

   bgp.l2vpn.0: 4 destinations, 4 routes (4 active, 0 holddown, 0 hidden)
     Prefix                  Nexthop              MED     Lclpref    AS path

     1.1.1.1:1:1:1/96
   *                         1.1.1.1                      65535      I
     2.2.2.2:10:1:1/96
   *                         2.2.2.2                      1          I
     4.4.4.4:10:3:1/96
   *                         4.4.4.4                      1          I
     5.5.5.5:10:5:1/96
   *                         5.5.5.5                      100        I

   GOLD.l2vpn.0: 5 destinations, 5 routes (5 active, 0 holddown, 0 hidden)
     Prefix                  Nexthop              MED     Lclpref    AS path

     1.1.1.1:1:1:1/96
   *                         1.1.1.1                      65535      I
     2.2.2.2:10:1:1/96
   *                         2.2.2.2                      1          I
     4.4.4.4:10:3:1/96
   *                         4.4.4.4                      1          I
     5.5.5.5:10:5:1/96
   *                         5.5.5.5                      100        I
   ```

8. On Router PE3, use the **show route table** command to verify that Router PE3 has selected the static point-to-multipoint LSP from Router PE3 to Router PE1 for forwarding.

Notice that Router PE2 does not have any provider multicast service interface (PMSI) flags because PMSI attributes are not attached.

```
user@PE3# show route table GOLD.l2vpn.0 extensive

GOLD.l2vpn.0: 5 destinations, 5 routes (5 active, 0 holddown, 0 hidden)
1.1.1.1:1:1:1/96 (1 entry, 1 announced)
        *BGP    Preference: 170/-65536
                Route Distinguisher: 1.1.1.1:1
                PMSI: Flags 0:RSVP-TE:label[0:0:0]:Session_13[1.1.1.1:0:9519:1.1.1.1]
                Next hop type: Indirect
                Next-hop reference count: 4
                Source: 7.7.7.7
                Protocol next hop: 1.1.1.1
                Indirect next hop: 2 no-forward
                State: <Secondary Active Int Ext>
                Local AS: 65000 Peer AS: 65000
                Age: 2:30:44    Metric2: 1
                Task: BGP_65000.7.7.7.7+179
                Announcement bits (1): 0-GOLD-l2vpn
                AS path: I (Originator) Cluster list:  7.7.7.7
                AS path:  Originator ID: 1.1.1.1
                Communities: target:65000:1 Layer2-info: encaps:VPLS, control flags:, mtu: 0, site
preference: 65535
                Import Accepted
                Label-base: 262145, range: 8
                Localpref: 65535
                Router ID: 7.7.7.7
                Primary Routing Table bgp.l2vpn.0
                Indirect next hops: 1
                        Protocol next hop: 1.1.1.1 Metric: 3
                        Indirect next hop: 2 no-forward
                        Indirect path forwarding next hops: 1
                                Next hop type: Router
                                Next hop: 10.10.8.2 via xe-0/1/0.0 weight 0x1
                        1.1.1.1/32 Originating RIB: inet.3
                          Metric: 3                     Node path count: 1
                          Forwarding nexthops: 1
                                Nexthop: 10.10.8.2 via xe-0/1/0.0

2.2.2.2:10:1:1/96 (1 entry, 1 announced)
        *BGP    Preference: 170/-2
                Route Distinguisher: 2.2.2.2:10
                Next hop type: Indirect
                Next-hop reference count: 3
                Source: 7.7.7.7
                Protocol next hop: 2.2.2.2
                Indirect next hop: 2 no-forward
                State: <Secondary Active Int Ext>
                Local AS: 65000 Peer AS: 65000
                Age: 2:30:44    Metric2: 1
                Task: BGP_65000.7.7.7.7+179
                Announcement bits (1): 0-GOLD-l2vpn
                AS path: I (Originator) Cluster list:  7.7.7.7
                AS path:  Originator ID: 2.2.2.2
                Communities: target:65000:1 Layer2-info: encaps:VPLS, control flags:, mtu: 0, site
preference: 1
                Import Accepted
                Label-base: 262145, range: 8
                Localpref: 1
                Router ID: 7.7.7.7
```



```
                Primary Routing Table bgp.l2vpn.0
                Indirect next hops: 1
                        Protocol next hop: 2.2.2.2 Metric: 3
                        Indirect next hop: 2 no-forward
                        Indirect path forwarding next hops: 1
                                Next hop type: Router
                                Next hop: 10.10.8.2 via xe-0/1/0.0 weight 0x1
                        2.2.2.2/32 Originating RIB: inet.3
                          Metric: 3                       Node path count: 1
                          Forwarding nexthops: 1
                                Nexthop: 10.10.8.2 via xe-0/1/0.0
```

9. On Router PE3, use the **show vpls connections** command to verify that the VPLS connection is in the **Up** state.

   Notice the display also shows the local interface and the incoming and outgoing label values used.

```
user@PE3# show vpls connections extensive

...

Instance: GOLD
  Local site: CE3 (3)
    Number of local interfaces: 1
    Number of local interfaces up: 1
    IRB interface present: no
    ge-1/0/0.1
    lsi.1048832         1         Intf - vpls GOLD local site 3 remote site 1
    lsi.1048833         2         Intf - vpls GOLD local site 3 remote site 2
        Interface flags: VC-Down
    lsi.1048834         5         Intf - vpls GOLD local site 3 remote site 5
        Interface flags: VC-Down
    Label-base        Offset     Range     Preference
    262145            1          8         65535
    connection-site           Type  St     Time last up          # Up trans
    1                         rmt   Up     Nov 16 11:22:01 2009           1
      Remote PE: 1.1.1.1, Negotiated control-word: No
      Incoming label: 262145, Outgoing label: 262147
      Local interface: lsi.1048832, Status: Up, Encapsulation: VPLS
        Description: Intf - vpls GOLD local site 3 remote site 1
      RSVP-TE P2MP lsp:
        Egress branch LSP:  3.3.3.3:1.1.1.1:1:vpls:GOLD, State: Up
    Connection History:
        Nov 16 11:22:54 2009  PE route changed
        Nov 16 11:22:01 2009  status update timer
        Nov 16 11:22:01 2009  PE route changed
        Nov 16 11:22:01 2009  Out lbl Update                   262147
        Nov 16 11:22:01 2009  In lbl Update                    262145
        Nov 16 11:22:01 2009  loc intf up                 lsi.1048832
    3                         rmt   RN
    5                         rmt   RD
  Ingress RSVP-TE P2MP LSP: vpls-GOLD, Flood next-hop ID: 616
```

Verifying the VPLS Data Plane

Step-by-Step Procedure

After the control plane is verified using the previous steps, you can verify the data plane. The data plane operation in the VPLS multihoming scenario is the same as the regular next-generation VPLS operation. This section describes the **show** command outputs that you can use to validate the data plane.

1. On Router PE3, use the **show mpls lsp** command to verify the state of the static LSPs and sub-LSPs.

   Router PE2 is configured with static point-to-multipoint LSPs and sub-LSPs with link protection. Point to multipoint LSPs are not supported for single-hop LSPs. In the following output notice that the single-hop point-to-multipoint LSP from Router PE3 to Router PE4 is **down**.

   ```
   user@PE3# show mpls lsp p2mp ingress

   Ingress LSP: 1 sessions
   P2MP name: vpls-GOLD, P2MP branch count: 4
   To              From            State Rt P     ActivePath       LSPname
   5.5.5.5         3.3.3.3         Up     0 *                      to-pe5
   1.1.1.1         3.3.3.3         Up     0 *                      to-pe1
   4.4.4.4         3.3.3.3         Dn     0 *                      to-pe4
   2.2.2.2         3.3.3.3         Up     0 *                      to-pe2
   Total 4 displayed, Up 3, Down 1
   ```

2. On Router PE1, use the **show mpls lsp** command to verify the state of the dynamic LSPs.

   Router PE1 is using a dynamic point-to-multipoint LSP template configured with link protection. Notice that the LSP state is **Up** and that link protection is **desired**.

```
user@PE1# show mpls lsp p2mp ingress extensive

Ingress LSP: 1 sessions
P2MP name: 1.1.1.1:1:vpls:GOLD, P2MP branch count: 1

3.3.3.3
  From: 1.1.1.1, State: Up, ActiveRoute: 0, LSPname: 3.3.3.3:1.1.1.1:1:vpls:GOLD
  ActivePath:  (primary)
  P2MP name: 1.1.1.1:1:vpls:GOLD
  Link protection desired
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary                    State: Up
    Priorities: 7 0
    OptimizeTimer: 50
    SmartOptimizeTimer: 180
    Reoptimization in 45 second(s).
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 3)
 10.10.3.2 S 10.10.9.2 S 10.10.8.1 S
    Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node 10=SoftPreempt):
         10.10.3.2(Label=488645) 4.4.4.4(flag=0x21) 10.10.9.2(flag=1 Label=299936) 10.10.8.1(Label=262145)

   12 Nov 16 15:38:08.116 CSPF: computation result ignored[314 times]
   11 Nov 16 11:23:44.856 Link-protection Up
   10 Nov 16 11:23:32.696 CSPF: computation result ignored[3 times]
    9 Nov 16 11:22:47.859 Record Route:  10.10.3.2(Label=488645) 4.4.4.4(flag=0x21) 10.10.9.2(flag=1
Label=299936) 10.10.8.1(Label=262145)
```

```
   8 Nov 16 11:22:44.910 Record Route:  10.10.3.2(Label=488645) 4.4.4.4(flag=0x20) 10.10.9.2(Label=299936)
 10.10.8.1(Label=262145)
    7 Nov 16 11:22:44.910 Up
    6 Nov 16 11:22:44.910 10.10.3.1: Down
    5 Nov 16 11:22:44.866 Selected as active path
   4 Nov 16 11:22:44.864 Record Route:  10.10.3.2(Label=488629) 4.4.4.4(flag=0x20) 10.10.9.2(Label=299920)
 10.10.8.1(Label=3)
    3 Nov 16 11:22:44.864 Up
    2 Nov 16 11:22:44.852 Originate Call
    1 Nov 16 11:22:44.852 CSPF: computation result accepted  10.10.3.2 10.10.9.2 10.10.8.1
  Created: Mon Nov 16 11:22:45 2009
Total 1 displayed, Up 1, Down 0
```

3. On Router PE3, use the **monitor interface traffic** command to verify the multicast replication behavior for the point-to-multipoint LSP on the designated forwarder Router PE3.

   The output shows that **10,000** pps are received on interface **ge-1/0/0** from Router CE3. The traffic has been forwarded to the provider (P) Router P2 and Router PE4 through xe-0/0/0 and xe-0/1/0, respectively. Based on the output, you can determine that a single copy of the packet is being sent to Router P2 and Router PE4.

```
user@PE3> monitor interface traffic

PE3                        Seconds: 8                  Time: 11:58:40

Interface    Link  Input packets        (pps)     Output packets        (pps)
 lc-0/0/0      Up              0                             0
 xe-0/0/0      Up       13570505          (0)       4507338866      (10000)
 lc-0/1/0      Up              0                             0
 xe-0/1/0      Up         292843          (1)        628972219      (10000)
 lc-0/2/0      Up              0                             0
 xe-0/2/0      Up         343292          (0)           206808          (1)
 lc-0/3/0      Up              0                             0
 xe-0/3/0    Down              0          (0)                0          (0)
 ge-1/0/0      Up     2703709733       (9999)         13203544          (1)
 lc-1/0/0      Up              0                             0
 ge-1/0/1    Down     50380341937          (0)       60024542111          (0)
 ge-1/0/2    Down     60652323068          (0)       84480825838          (0)
 ge-1/0/3    Down     81219536264          (0)       84614255165          (0)
 ge-1/0/4    Down     54379241112          (0)       83656815208          (0)
```

4. On Router P2, use the **monitor interface traffic** command to verify that the multicast packet replication happens close to the PE routers connected to the receivers.

   Router PE1 and Router PE5 are connected to receivers that have joined this multicast group. Notice that incoming multicast packets from Router PE3 on the **ge-0/1/0** interface are replicated twice and sent out on the **ge-1/1/0** interface.

```
user@P2> monitor interface traffic

P2                         Seconds: 6                  Time: 12:07:58

Interface    Link  Input packets        (pps)     Output packets        (pps)
 ge-0/1/0      Up       661459806      (10000)          116236          (0)
 ge-1/1/0      Up          115956          (0)       1322690473      (20000)
 gr-2/1/0      Up               0          (0)                0          (0)
 ip-2/1/0      Up               0          (0)                0          (0)
```

5. On Router PE3, use the **show vpls flood** command to verify information about the flood next-hop route.

   Junos OS Release 9.0 and later identifies the flood next-hop route as a composite next hop. Notice that the interface is **ge-1/0/0.1**, the next-hop type is **composite**, and that the flood composition is **flood-to-all**. This means the traffic is flooded to all the PE routers.

```
user@PE3# show vpls flood extensive

Name: GOLD
CEs: 1
VEs: 1
  Flood route prefix: 0x30002/51
  Flood route type: FLOOD_GRP_COMP_NH
  Flood route owner: __ves__
  Flood group name: __ves__
  Flood group index: 0
  Nexthop type: comp
  Nexthop index: 606
    Flooding to:
    Name             Type          NhType          Index
    __all_ces__      Group          comp            603
        Composition: split-horizon
        Flooding to:
        Name             Type          NhType          Index
        ge-1/0/0.1       CE             ucst            578

  Flood route prefix: 0x30003/51
  Flood route type: FLOOD_GRP_COMP_NH
  Flood route owner: __all_ces__
  Flood group name: __all_ces__
  Flood group index: 1
  Nexthop type: comp
  Nexthop index: 611
    Flooding to:
    Name             Type          NhType          Index
    __ves__          Group          comp            594
        Composition: flood-to-all
    Component p2mp NH (for all core facing interfaces):
    Index
    616
    Flooding to:
    Name             Type          NhType          Index
    __all_ces__      Group          comp            603
        Composition: split-horizon
        Flooding to:
        Name             Type          NhType          Index
        ge-1/0/0.1       CE             ucst            578

  Flood route prefix: 0x30001/51
  Flood route type: FLOOD_GRP_COMP_NH
  Flood route owner: __re_flood__
  Flood group name: __re_flood__
  Flood group index: 65534
  Nexthop type: comp
  Nexthop index: 598
    Flooding to:
    Name             Type          NhType          Index
    __ves__          Group          comp            594
        Composition: flood-to-all
```

```
    Component p2mp NH (for all core facing interfaces):
    Index
    616
    Flooding to:
    Name             Type          NhType          Index
    __all_ces__      Group          comp            603
        Composition: split-horizon
        Flooding to:
        Name             Type          NhType          Index
        ge-1/0/0.1       CE             ucst            578
Name: __juniper_private1__
CEs: 0
VEs: 0
```

6. On Router PE3, use the **show vpls mac-table** command to verify that the MAC address of the PE router at the remote end of the VPLS has been learned and added to the MAC address table.

   Notice that the MAC address is learned on the **ge-1/0/0.1** interface.

```
user@PE3# show vpls mac-table

MAC flags (S -static MAC, D -dynamic MAC,
           SE -Statistics enabled, NM -Non configured MAC)

Routing instance : GOLD
 Bridging domain : __GOLD__, VLAN : NA
   MAC                 MAC      Logical
   address             flags    interface
   00:14:f6:75:78:00  D    ge-1/0/0.1
```

7. On Router PE3, use the **show route forwarding-table** command to verify that the forwarding table has the required entries with two labels: one for the VPLS service and the other for the next-hop interface.

```
user@PE3> show route forwarding-table family vpls vpn GOLD

Routing table: GOLD.vpls
VPLS:
Destination        Type RtRef Next hop           Type Index NhRef Netif
default            perm     0                    dscd   574     1
lsi.1048832        intf     0                    indr 1048575     4
                              10.10.7.1         Push 262147, Push 309680(top)   596     2 xe-0/0/0.0
lsi.1048836        intf     0                    indr 1048574     4
                              10.10.7.1         Push 262179, Push 299856(top)   589     2 xe-0/0/0.0
00:10:db:e9:4e:b6/48
                   user     0                    indr 1048574     4
                              10.10.7.1         Push 262179, Push 299856(top)   589     2 xe-0/0/0.0
00:12:1e:c6:98:00/48
                   user     0                    indr 1048575     4
                              10.10.7.1         Push 262147, Push 309680(top)   596     2 xe-0/0/0.0
00:14:f6:75:78:00/48
                   user     0                    ucst   578     4 ge-1/0/0.1
0x30002/51         user     0                    comp   606     2
ge-1/0/0.1         intf     0                    ucst   578     4 ge-1/0/0.1
0x30003/51         user     0                    comp   611     2
0x30001/51         user     0                    comp   598     2
```

Results The configuration and verification parts of this example have been completed. The following section is for your reference.

The relevant sample configuration for Router PE1 follows:

Router PE1

```
chassis {
    dump-on-panic;
    fpc 1 {
        pic 3 {
            tunnel-services {
                bandwidth 1g;
            }
        }
    }
    network-services ethernet;
}
interfaces {
    xe-0/1/0 {
        unit 0 {
            family inet {
                address 10.10.2.1/30;
            }
            family mpls;
        }
    }
    xe-0/2/0 {
        unit 0 {
            family inet {
                address 10.10.3.1/30;
            }
            family mpls;
        }
    }
    xe-0/3/0 {
        unit 0 {
            family inet {
                address 10.10.1.1/30;
            }
            family mpls;
        }
    }
    ge-1/0/0 {
        vlan-tagging;
        encapsulation vlan-vpls;
        unit 1 {
            encapsulation vlan-vpls;
            vlan-id 1000;
            family vpls;
        }
    }
    lo0 {
        unit 0 {
            family inet {
                address 1.1.1.1/32;
            }
        }
    }
}
routing-options {
```

```
    static {
        route 172.0.0.0/8 next-hop 172.19.59.1;
    }
    autonomous-system 65000;
}
protocols {
    rsvp {
        interface all;
        interface fxp0.0 {
            disable;
        }
        interface xe-0/3/0.0 {
            link-protection;
        }
        interface xe-0/2/0.0 {
            link-protection;
        }
        interface xe-0/1/0.0 {
            link-protection;
        }
    }
    mpls {
        label-switched-path to-RR {
            to 7.7.7.7;
        }
        label-switched-path vpls-GOLD-p2mp-template {
            template;
            optimize-timer 50;
            link-protection;
            p2mp;
        }
        label-switched-path to-PE2 {
            to 2.2.2.2;
        }
        label-switched-path to-PE3 {
            to 3.3.3.3;
        }
        label-switched-path to-PE4 {
            to 4.4.4.4;
        }
        label-switched-path to-PE5 {
            to 5.5.5.5;
        }
        interface all;
        interface fxp0.0 {
            disable;
        }
    }
    bgp {
        group to-RR {
            type internal;
            local-address 1.1.1.1;
            family l2vpn {
                signaling;
            }
            neighbor 7.7.7.7;
```

```
        }
      }
      ospf {
        traffic-engineering;
        area 0.0.0.0 {
          interface all;
          interface fxp0.0 {
            disable;
          }
        }
      }
    }
    routing-instances {
      GOLD {
        instance-type vpls;
        interface ge-1/0/0.1;
        route-distinguisher 1.1.1.1:1;
        provider-tunnel {
          rsvp-te {
            label-switched-path-template {
              vpls-GOLD-p2mp-template;
            }
          }
        }
        vrf-target target:65000:1;
        protocols {
          vpls {
            site-range 8;
            no-tunnel-services;
            site CE1 {
              site-identifier 1;
              multi-homing;
              site-preference primary;
              interface ge-1/0/0.1;
            }
          }
        }
      }
    }
```

The relevant sample configuration for Router PE2 follows.

PE2 Router

```
    chassis {
      dump-on-panic;
      fpc 1 {
        pic 3 {
          tunnel-services {
            bandwidth 1g;
          }
        }
      }
      network-services ethernet;
    }
    interfaces {
      xe-0/1/0 {
        unit 0 {
```

```
        family inet {
          address 10.10.2.2/30;
        }
        family mpls;
      }
    }
    xe-0/2/0 {
      unit 0 {
        family inet {
          address 10.10.5.1/30;
        }
        family mpls;
      }
    }
    xe-0/3/0 {
      unit 0 {
        family inet {
          address 10.10.4.1/30;
        }
        family mpls;
      }
    }
    ge-1/0/1 {
      vlan-tagging;
      encapsulation vlan-vpls;
    }
    ge-1/0/3 {
      vlan-tagging;
      encapsulation vlan-vpls;
      unit 1 {
        encapsulation vlan-vpls;
        vlan-id 1000;
        family vpls;
      }
    }
    fxp0 {
      apply-groups [ re0 re1 ];
    }
    lo0 {
      unit 0 {
        family inet {
          address 2.2.2.2/32;
        }
      }
    }
  }
  routing-options {
    static {
      route 172.0.0.0/8 next-hop 172.19.59.1;
    }
    autonomous-system 65000;
  }
  protocols {
    rsvp {
      interface all;
      interface fxp0.0 {
```

```
            disable;
        }
    }
    mpls {
        label-switched-path to-RR {
            to 7.7.7.7;
        }
        label-switched-path vpls-GOLD-p2mp-template {
            template;
            optimize-timer 50;
            link-protection;
            p2mp;
        }
        label-switched-path to-PE1 {
            to 1.1.1.1;
        }
        label-switched-path to-PE3 {
            to 3.3.3.3;
        }
        label-switched-path to-PE4 {
            to 4.4.4.4;
        }
        label-switched-path to-PE5 {
            to 5.5.5.5;
        }
        interface all;
        interface fxp0.0 {
            disable;
        }
    }
    bgp {
        group to-RR {
            type internal;
            local-address 2.2.2.2;
            family l2vpn {
                signaling;
            }
            neighbor 7.7.7.7;
        }
    }
    ospf {
        traffic-engineering;
        area 0.0.0.0 {
            interface all;
            interface fxp0.0 {
                disable;
            }
        }
    }
}
routing-instances {
    GOLD {
        instance-type vpls;
        interface ge-1/0/3.1;
        route-distinguisher 2.2.2.2:10;
        provider-tunnel {
```

```
        rsvp-te {
            label-switched-path-template {
                vpls-GOLD-p2mp-template;
            }
        }
    }
    vrf-target target:65000:1;
    protocols {
        vpls {
            site-range 8;
            no-tunnel-services;
            site CE1 {
                site-identifier 1;
                multi-homing;
                site-preference backup;
                interface ge-1/0/3.1;
            }
        }
    }
}
```

Related Documentation

- Example: NG-VPLS Using Point-to-Multipoint LSPs on page 152
- Next-Generation VPLS Point-to-Multipoint Forwarding Overview on page 147
- Next-Generation VPLS for Multicast with Multihoming Overview on page 185

Example: Configuring BGP-Based H-VPLS Using Different Mesh Groups for Each Spoke Router

This example shows how to configure hierarchical virtual private LAN service (H-VPLS) using different mesh groups to provide H-VPLS functionality and provides steps for verifying and troubleshooting the configuration. This is one type of H-VPLS configuration possible in the Juniper Networks implementation. For information about the alternate type of configuration see "Example: Configuring LDP-Based H-VPLS Using a Single Mesh Group to Terminate the Layer 2 Circuits" on page 227.

Using mesh groups improves LDP-based VPLS control plane scalability and avoids the requirement for a full mesh of LDP sessions. This example uses BGP-based VPLS.

This example is organized into the following sections:

Requirements

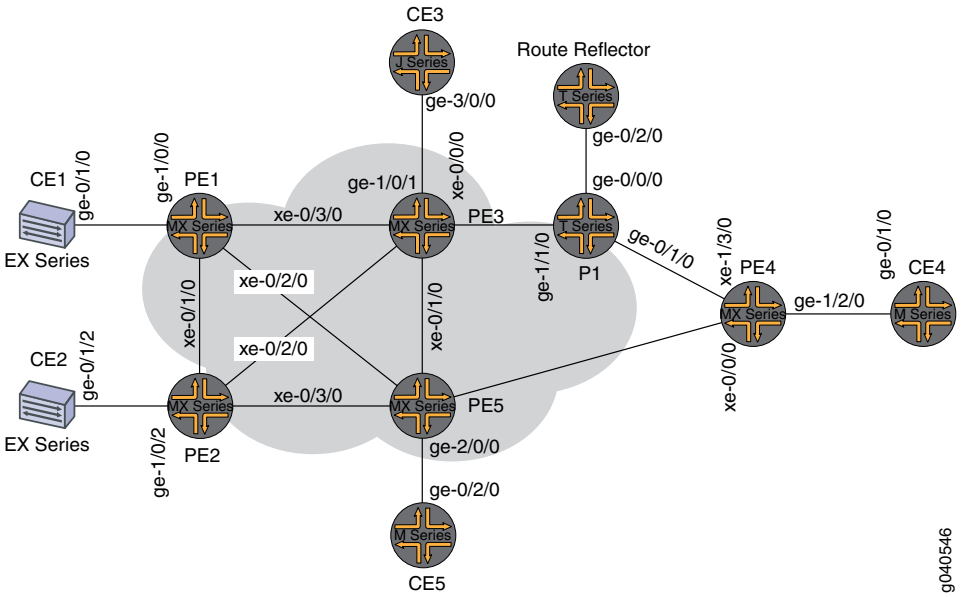
This example uses the following hardware components:

- Four MX Series 3D Universal Edge Routers for Router PE1, Router PE2, Router PE3, and Router PE4
- Two M Series Multiservice Edge Routers for Router CE4 and Router PE5
- Two EX Series Ethernet Switches for Device CE1 and Device CE2
- Two T Series Core Routers for Routers P1 and the route reflector
- One J Series Services Router for Router CE3

Overview and Topology

Figure 2 shows the physical topology used in this example.

Figure 24: Physical Topology of H-VPLS



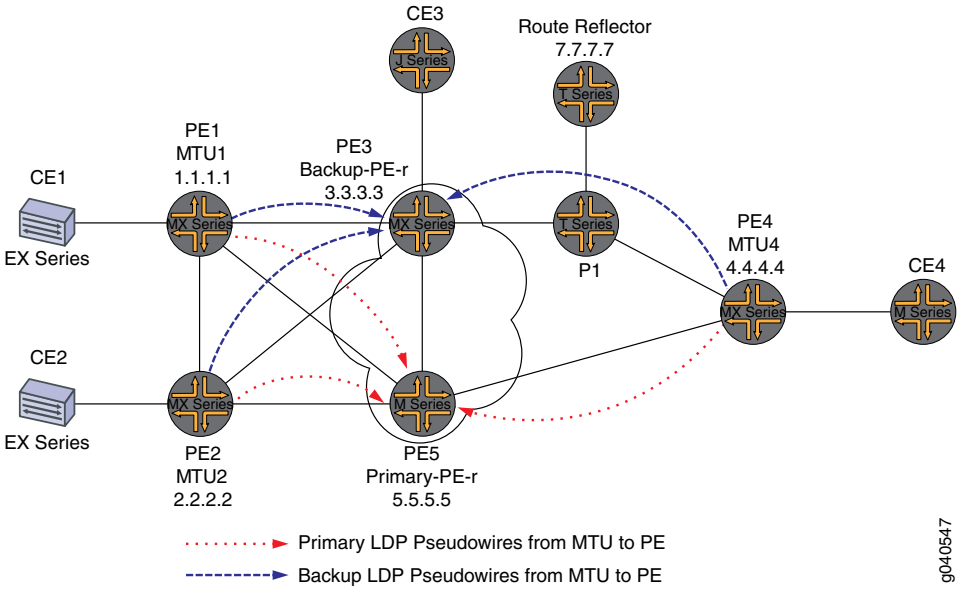
The following describes the base configuration used in this example:

- Router PE1, Router PE2, and Router PE4 are configured as MTU devices.
- Router PE3 and Router PE5 are configured as PE-r routers, each using an LDP-based VPLS routing instance.
- The LDP and OSPF protocols are configured on all of the MTU devices and PE-r routers.
- Core-facing interfaces are enabled with the MPLS address family.
- The VPLS routing instance is configured on PE-r routers with the **no-tunnel-interface** statement. This allows the MX Series routers to use a label-switched interface (LSI).
- The M320 router has a tunnel PIC installed.

- All of the routers are configured with loopback IP addresses and the autonomous system number is 65000.
- BGP is configured on the PE-r routers and the route reflector. The BGP configuration includes the **signaling** statement at the **[edit protocols bgp group group-name family l2vpn]** hierarchy level to support Layer 2 VPN signaling using BGP.

Figure 3 shows the logical topology used in this example.

Figure 25: Logical Topology of H-VPLS



In Figure 25 on page 213:

- Router PE1, Router PE2, and Router PE4 are configured as MTU devices. All of the MTU devices have Layer 2 circuit connections to the PE-r routers. For redundancy, a backup neighbor is configured for the Layer 2 circuit connections to the PE-r routers.
- It is not necessary to enable VPLS on the MTU devices.
- The VPLS routing instance is only configured on the PE-r routes.
- On the PE-r routers, a mesh group is created under the **H-VPLS** routing instance to terminate the Layer 2 circuit connections.
- It is not necessary to include the **l2circuit** statement in the **[edit protocols]** hierarchy on the PE-r routers. The mesh group configuration under the VPLS routing instance terminates the Layer 2 circuit pseudowires from all MTU devices in the VPLS domain.
- Each MTU device can be configured with a different virtual circuit ID or the same ID, within a single VPLS domain. The mesh groups configuration allows you to use different VPLS ID values for each mesh group.

Configuration

To configure H-VPLS with different mesh groups for each spoke PE router using BGP-based VPLS, perform the following tasks:

Configuring the Spoke PE Routers

Step-by-Step Procedure

1. On Router PE1, configure the Gigabit Ethernet interface connected to Router CE1. Include the **encapsulation** statement and specify the **ethernet-ccc** option. Also configure the logical interface by including the **family** statement and specifying the **ccc** option.

```
[edit interfaces]
ge-1/0/0 {
   encapsulation ethernet-ccc;
   unit 0 {
      family ccc;
   }
}
```

2. On Router PE1, configure the Layer 2 circuit by including the **neighbor** statement and specifying the IP address of Router PE5 as the neighbor. Configure the Gigabit Ethernet logical interface by including the **virtual-circuit-id** statement and specifying **100** as the ID. Also configure a backup neighbor for the Layer 2 circuit by including the **backup-neighbor** statement, specifying the IP address of Router PE3 as the backup neighbor, and including the **standby** statement.

```
[edit protocols]
l2circuit {
   neighbor 5.5.5.5 {
      interface ge-1/0/0.0 {
         virtual-circuit-id 100;
         backup-neighbor 3.3.3.3 { # Backup H-VPLS PE router
         standby;
      }
   }
}
```

3. On Router PE2, configure the Gigabit Ethernet interface connected to Router CE2. Include the **encapsulation** statement and specify the **ethernet-ccc** option. Also configure the logical interface by including the **family** statement and specifying the **ccc** option.

```
[edit interfaces]
ge-1/0/2 {
   encapsulation ethernet-ccc;
   unit 0 {
      family ccc;
   }
}
```

4. On Router PE2, configure the Layer 2 circuit by including the **neighbor** statement and specifying the IP address of Router PE5 as the neighbor. Configure the Gigabit Ethernet logical interface by including the **virtual-circuit-id** statement and specifying **200** as the ID. Configure the encapsulation by including the **encapsulation-type** statement and specifying the **ethernet** option. Also configure a backup neighbor for the Layer 2 circuit by including the **backup-neighbor** statement, specifying the IP address of Router PE3 as the backup neighbor, and including the **standby** statement.

```
[edit protocols]
l2circuit {
  neighbor 5.5.5.5 {
    interface ge-1/0/2.0 {
      virtual-circuit-id 200; # different VC-ID
      encapsulation-type ethernet; # default encapsulation
      backup-neighbor 3.3.3.3 {
        standby;
      }
    }
  }
}
```

5. On Router PE4, configure the Gigabit Ethernet interface connected to Router CE4. Include the **encapsulation** statement and specify the **ethernet-ccc** option. Also configure the logical interface by including the **family** statement and specifying the **ccc** option.

```
ge-1/2/0 {
  encapsulation ethernet-ccc;
  unit 0 {
    family ccc;
  }
}
```

6. On Router PE4, configure the Layer 2 circuit by including the **neighbor** statement and specifying the IP address of Router PE5 as the neighbor. Configure the Gigabit Ethernet logical interface by including the **virtual-circuit-id** statement and specifying **400** as the ID. Also configure a backup neighbor for the Layer 2 circuit by including the **backup-neighbor** statement, specifying the IP address of Router PE3 as the backup neighbor, and including the **standby** statement.

```
[edit protocols]
l2circuit {
  neighbor 5.5.5.5 {
    interface ge-1/2/0.0 {
      virtual-circuit-id 400;
      backup-neighbor 3.3.3.3 {
        standby;
      }
    }
  }
}
```

Configuring the Hub PE (PE-r)

Step-by-Step Procedure

1. On Router PE5 (the primary hub), configure the Gigabit Ethernet interface connected to Router CE5. Include the **encapsulation** statement and specify the **ethernet-vpls** option. Also configure the logical interface by including the **family inet** statement and specifying the IPv4 address for the interface.

```
[edit interfaces]
ge-2/0/0 {
   encapsulation ethernet-vpls;
   unit 0 {
      family vpls;
   }
}
lo0 {
   unit 0 {
      family inet {
         address 5.5.5.5/32;
      }
   }
}
```

2. On PE-r Router PE5. configure the BGP-based VPLS routing instance by including the **instance-type** statement at the **[edit routing-instances H-VPLS]** hierarchy level and specifying the **vpls** option. Include the interface statement and specify the Gigabit Ethernet interface connected to Router CE5. Configure a route distinguisher to ensure that the route advertisement is unique by including the **route-distinguisher** statement and specifying **7.7.7.7:77** as the value. Also configure the VPN routing and forwarding (VRF) route target to be included in the route advertisements to the other routers participating in the VPLS. To configure the VRF route target, include the **vrf-target** statement and specify **target:65000:2** as the value.

```
[edit]
routing-instances {
   H-VPLS {
      instance-type vpls;
      interface ge-2/0/0.0;
      route-distinguisher 7.7.7.7:77;
      vrf-target target:65000:2;
   }
}
```

3. On PE-r Router PE5, configure a provider tunnel that makes use of dynamic point-to-multipoint LSPs by including the **provider-tunnel** statement at the **[edit routing-instances H-VPLS]** hierarchy level. Configure a dynamic label switched path that uses resource reservation protocol (RSVP) signaling to dynamically create the LSP. To configure the LSP, include the **label-switched-path-template** statement at the **[edit routing-instances H-VPLS provider-tunnel]** hierarchy level and specify **vpls-GOLD-p2mp-template** as the name of the template to use.

   The configuration of the **vpls-GOLD-p2mp-template** template is shown in the results section of this example.

```
[edit]
routing-instances {
```

```
    H-VPLS {
      provider-tunnel {
        rsvp-te {
          label-switched-path-template {
            vpls-GOLD-p2mp-template;
          }
        }
      }
    }
  }
```

4. On PE-r Router PE5, configure the VPLS protocol and the mesh groups for each of the spoke PE routers. It is not necessary to configure the Layer 2 circuit (L2-circuit) protocol on the hub PE. Configuring mesh groups under the VPLS instance terminates the Layer 2 circuit into the VPLS instance without the use of a logical tunnel interface.

   To configure the VPLS protocol, include the **vpls** statement at the **[edit routing-instances H-VPLS protocols]** hierarchy level. Include the **site-range** statement and specify **8** as the value. Include the **no-tunnel-services** statement to enable the use of LSI interfaces. Include the **site** statement and specify **CE5** as the name of the site. Include the **interface** statement and specify the Gigabit Ethernet interface connected to CE5.

   To configure each mesh group, include the **mesh-group** statement and specify the mesh group name. In this example, the mesh group name is the name of the spoke PE router associated with each mesh group. Include the **vpls-id** statement and specify the site ID that matches the virtual circuit ID configured in the *Configuring the Spoke PE Routers* section of this example. Also include the **neighbor** statement and specify the IP address of the spoke PE router associated with each mesh group. For the mesh group for Router PE2, include the **encapsulation-type** statement and specify the **ethernet** option.

```
[edit routing-instances H-VPLS]
protocols {
  vpls {
    site-range 8;
    site CE5 {
      site-identifier 5;
      interface ge-2/0/0.0;
    }
    mesh-group pe4 {
      vpls-id 400;
      neighbor 4.4.4.4;
    }
    mesh-group pe2 {
      vpls-id 200;
      neighbor 2.2.2.2 {
        encapsulation-type ethernet;
      }
    }
    mesh-group pe1 {
      vpls-id 100;
      neighbor 1.1.1.1;
    }
  }
```

```
}
```

5. On Router PE3 (the backup hub), configure the Gigabit Ethernet interface connected to Router CE3 by including the **encapsulation** statement and specifying the **ethernet-ccc** option. Also configure the logical interface. Include the **family inet** statement and specify the IP address for the interface.

```
[edit interfaces]
ge-1/0/1 {
    encapsulation ethernet-vpls;
    unit 0 {
        family vpls;
    }
}
lo0 {
    unit 0 {
        family inet {
            address 3.3.3.3/32;
        }
    }
}
```

6. On PE-r Router PE3, configure the BGP-based VPLS routing instance by including the **instance-type** statement at the **[edit routing-instances H-VPLS]** hierarchy level and specifying the **vpls** option. Include the interface statement and specify the Gigabit Ethernet interface connected to Router CE3. Configure a route distinguisher to ensure that the route advertisement is unique. To configure the route distinguisher, include the **route-distinguisher** statement and specify **3.3.3.3:33** as the value. Also configure the VPN routing and forwarding (VRF) route target to be included in the route advertisements to the other routers participating in the VPLS. To configure the VRF route target, include the **vrf-target** statement and specify **target:65000:2** as the value.

```
[edit routing-instances]
H-VPLS {
    instance-type vpls;
    interface ge-1/0/1.0;
    route-distinguisher 3.3.3.3:33;
    vrf-target target:65000:2;
}
```

7. On PE-r Router PE3, configure a provider tunnel that makes use of dynamic point-to-multipoint LSPs by including the **provider-tunnel** statement at the **[edit routing-instances H-VPLS]** hierarchy level. Configure a dynamic LSP that uses resource reservation protocol (RSVP) signaling to dynamically create the LSP. To configure the LSP, include the **label-switched-path-template** statement at the **[edit routing-instances H-VPLS provider-tunnel]** hierarchy level and specify **vpls-GOLD-p2mp-template** as the name of the template to use.

   The configuration of the **vpls-GOLD-p2mp-template** template is shown in the results section of this example.

```
[edit routing-instances H-VPLS]
provider-tunnel {
    rsvp-te {
```



```
        label-switched-path-template {
          vpls-GOLD-p2mp-template;
        }
      }
    }
```

8. On PE-r Router PE3, configure the VPLS protocol and the mesh groups for each of the spoke PE routers. It is not necessary to configure the Layer 2 circuit (L2-circuit) protocol on the Hub PE. Configuring mesh groups under the VPLS instance terminates the Layer 2 circuit into the VPLS instance without the use of a logical tunnel interface.

   To configure the VPLS protocol, include the vpls statement at the **[edit routing-instances H-VPLS protocols]** hierarchy level. Include the **site-range** statement and specify **8** as the value. Include the **no-tunnel-services** statement to enable the use of LSI interfaces. Include the **site** statement and specify **mtu-pe4** as the name of the site. Include the **interface** statement and specify the Gigabit Ethernet interface connected to CE3.

   To configure each mesh group, include the **mesh-group** statement and specify the mesh group name. In this example, the mesh group name is the name of the spoke PE router associated with each mesh group. Include the **vpls-id** statement and specify the site ID that matches the virtual circuit ID configured in the *Configuring the Spoke PE Routers* section of this example. Also include the **neighbor** statement and specify the IP address of the spoke PE router associated with each mesh group.

```
[edit routing-instances H-VPLS]
protocols {
  vpls {
    site-range 8;
    no-tunnel-services;
    site mtu-pe4 {
      site-identifier 3;
      interface ge-1/0/1.0;
    }
    mesh-group pe4 {
      vpls-id 400;
      neighbor 4.4.4.4;
    }
    mesh-group pe2 {
      vpls-id 200;
      neighbor 2.2.2.2;
    }
    mesh-group pe1 {
      vpls-id 100;
      neighbor 1.1.1.1;
    }
  }
}
```

Verifying the H-VPLS Operation

Step-by-Step Procedure

This section describes the show commands you can use to validate that the H-VPLS is working as expected.

1. On Router PE1, use the **show l2circuit connections** command to verify that the Layer 2 circuit to Router PE5 is **Up** and the Layer 2 circuit to Router PE3 is in **standby** mode.

   The output also shows the assigned label, virtual circuit ID, and the **ETHERNET** encapsulation type .

```
user@PE1# show l2circuit connections

Layer-2 Circuit Connections:

Legend for connection status (St)
EI -- encapsulation invalid      NP -- interface h/w not present
MM -- mtu mismatch               Dn -- down
EM -- encapsulation mismatch     VC-Dn -- Virtual circuit Down
CM -- control-word mismatch      Up -- operational
VM -- vlan id mismatch           CF -- Call admission control failure
OL -- no outgoing label          IB -- TDM incompatible bitrate
NC -- intf encaps not CCC/TCC    TM -- TDM misconfiguration
BK -- Backup Connection          ST -- Standby Connection
CB -- rcvd cell-bundle size bad  XX -- unknown
SP -- Static Pseudowire

Legend for interface status
Up -- operational
Dn -- down
Neighbor: 3.3.3.3
    Interface                 Type  St     Time last up          # Up trans
    ge-1/0/0.0(vc 100)        rmt   ST
Neighbor: 5.5.5.5
    Interface                 Type  St     Time last up          # Up trans
    ge-1/0/0.0(vc 100)        rmt   Up     Jan  2 14:52:20 2010           1
      Remote PE: 5.5.5.5, Negotiated control-word: No
      Incoming label: 301296, Outgoing label: 800005
      Local interface: ge-1/0/0.0, Status: Up, Encapsulation: ETHERNET
```

2. On Router PE1, use the **show ldp neighbor** command to verify that the targeted LDP sessions have been created between the loopback interface to the primary and backup H-VPLS hub neighbors.

```
user@PE1# show ldp neighbor

Address            Interface          Label space ID         Hold time
3.3.3.3            lo0.0              3.3.3.3:0                40
5.5.5.5            lo0.0              5.5.5.5:0                37
```

3. On Router PE5, use the **show vpls connections** command to verify that the VPLS connection status is **Up** for both the LDP-based VPLS and the BGP-based VPLS Layer 2 circuits that are terminated.

```
user@PE5# show vpls connections

Instance: H-VPLS
  BGP-VPLS State    <<<Local CE connected through BGP-based VPLS PE router
  Local site: mtu-pe4 (3)
    connection-site           Type  St     Time last up          # Up trans
```

```
  5                       rmt   Up     Jan  2 21:27:20 2010          1
    Remote PE: 5.5.5.5, Negotiated control-word: No
    Incoming label: 262165, Outgoing label: 800258
    Local interface: lsi.1057801, Status: Up, Encapsulation: VPLS
      Description: Intf - vpls H-VPLS local site 3 remote site 5
LDP-VPLS State    <<<Layer 2 circuit terminated in VPLS using mesh groups
Mesh-group connections: pe4    <<<mesh group
  Neighbor                Type  St     Time last up          # Up trans
  4.4.4.4(vpls-id 400)    rmt   Up     Jan  2 15:47:13 2010          1
    Remote PE: 4.4.4.4, Negotiated control-word: No
    Incoming label: 262409, Outgoing label: 301088
    Local interface: lsi.1057796, Status: Up, Encapsulation: ETHERNET
      Description: Intf - vpls H-VPLS neighbor 4.4.4.4 vpls-id 400
Mesh-group connections: pe2
  Neighbor                Type  St     Time last up          # Up trans
  2.2.2.2(vpls-id 200)    rmt   Up     Jan  2 21:04:40 2010          1
    Remote PE: 2.2.2.2, Negotiated control-word: No
    Incoming label: 262410, Outgoing label: 301488
    Local interface: lsi.1057797, Status: Up, Encapsulation: ETHERNET
      Description: Intf - vpls H-VPLS neighbor 2.2.2.2 vpls-id 200
Mesh-group connections: pe1
  Neighbor                Type  St     Time last up          # Up trans
  1.1.1.1(vpls-id 100)    rmt   Up     Jan  2 15:47:13 2010          1
    Remote PE: 1.1.1.1, Negotiated control-word: No
    Incoming label: 262411, Outgoing label: 301328
    Local interface: lsi.1057798, Status: Up, Encapsulation: ETHERNET
      Description: Intf - vpls H-VPLS neighbor 1.1.1.1 vpls-id 100
```

4. On Router PE5, use the **show ldp neighbor** command to verify that a targeted LDP session has been created to each of the spoke PE routers (MTUs).

```
user@PE5# show ldp neighbor

Address            Interface          Label space ID         Hold time
1.1.1.1            lo0.0              1.1.1.1:0                41
2.2.2.2            lo0.0              2.2.2.2:0                44
4.4.4.4            lo0.0              4.4.4.4:0                32
```

5. On Router PE5, use the **show vpls mac-table** command to verify that MAC addresses of Router CE1, Router CE2, and Router CE3 have been learned.

```
user@PE5# show vpls mac-table

MAC flags (S -static MAC, D -dynamic MAC,
           SE -Statistics enabled, NM -Non configured MAC)

Routing instance : H-VPLS
 Bridging domain : __H-VPLS__, VLAN : NA
   MAC                 MAC      Logical
   address             flags    interface
   00:10:db:e9:4e:b6   D        ge-1/0/1.0         <<<Local Site MAC
   00:12:1e:c6:98:3e   D        lsi.1057801        <<<CE1 MAC
   00:14:f6:75:78:1f   D        lsi.1057801        <<<CE3 MAC
   00:1f:12:32:b1:d8   D        lsi.1057801        <<<CE2 MAC
```

Results The configuration and verification parts of this example have been completed. The following section is for your reference.

The relevant sample configuration for the spoke Router PE1 follows.

Router PE1

```
interfaces {
    xe-0/1/0 {
        unit 0 {
            family inet {
                address 10.10.2.1/30;
            }
            family mpls;
        }
    }
    xe-0/2/0 {
        unit 0 {
            family inet {
                address 10.10.3.1/30;
            }
            family mpls;
        }
    }
    xe-0/3/0 {
        unit 0 {
            family inet {
                address 10.10.1.1/30;
            }
            family mpls;
        }
    }
    ge-1/0/0 {
        encapsulation ethernet-ccc;
        unit 0 {
            family ccc;
        }
    }
    lo0 {
        unit 0 {
            family inet {
                address 1.1.1.1/32;
            }
        }
    }
}
routing-options {
    static {
        route 172.0.0.0/8 next-hop 172.19.59.1;
    }
    autonomous-system 65000;
}
protocols {
    mpls {
        interface all;
        interface fxp0.0 {
            disable;
        }
    }
    ospf {
        traffic-engineering;
        area 0.0.0.0 {
            interface all;
```

```
        interface fxp0.0 {
          disable;
        }
      }
    }
    ldp {
      interface all;
      interface fxp0.0 {
        disable;
      }
    }
    l2circuit {
      neighbor 5.5.5.5 {
        interface ge-1/0/0.0 {
          virtual-circuit-id 100;
          backup-neighbor 3.3.3.3 {
            standby;
          }
        }
      }
    }
  }
```

The relevant sample configuration for Router PE3 follows.

Router PE3

```
interfaces {
  xe-0/0/0 {
    unit 0 {
      family inet {
        address 10.10.20.2/30;
      }
      family mpls;
    }
  }
  xe-0/1/0 {
    unit 0 {
      family inet {
        address 10.10.6.1/30;
      }
      family mpls;
    }
  }
  xe-0/2/0 {
    unit 0 {
      family inet {
        address 10.10.5.2/30;
      }
      family mpls;
    }
  }
  xe-0/3/0 {
    unit 0 {
      family inet {
        address 10.10.1.2/30;
      }
      family mpls;
```

```
        }
    }
    ge-1/0/1 {
        encapsulation ethernet-vpls;
        unit 0 {
            family vpls;
        }
    }
    lo0 {
        unit 0 {
            family inet {
                address 3.3.3.3/32;
            }
        }
    }
}
routing-options {
    static {
        route 172.0.0.0/8 next-hop 172.19.59.1;
    }
    autonomous-system 65000;
}
protocols {
    rsvp {
        interface all;
        interface fxp0.0 {
            disable;
        }
        interface xe-0/0/0.0 {
            link-protection;
        }
        interface xe-0/1/0.0 {
            link-protection;
        }
        interface xe-0/3/0.0 {
            link-protection;
        }
        interface xe-0/2/0.0 {
            link-protection;
        }
    }
    mpls {
        label-switched-path to-RR {
            to 7.7.7.7;
        }
        label-switched-path vpls-GOLD-p2mp-template {
            template;
            optimize-timer 50;
            link-protection;
            p2mp;
        }
        label-switched-path to-PE2 {
            to 2.2.2.2;
        }
        label-switched-path to-PE3 {
            to 3.3.3.3;
```

```
        }
        label-switched-path to-PE4 {
            to 4.4.4.4;
        }
        label-switched-path to-PE1 {
            to 1.1.1.1;
        }
        interface all;
        interface fxp0.0 {
            disable;
        }
    }
    bgp {
        group RR {
            type internal;
            local-address 3.3.3.3;
            family l2vpn {
                signaling;
            }
            neighbor 7.7.7.7;
        }
    }
    ospf {
        traffic-engineering;
        area 0.0.0.0 {
            interface all;
            interface fxp0.0 {
                disable;
            }
        }
    }
    ldp {
        interface all;
        interface fxp0.0 {
            disable;
        }
    }
}
routing-instances {
    H-VPLS {
        instance-type vpls;
        interface ge-1/0/1.0;
        route-distinguisher 3.3.3.3:33;
        provider-tunnel {
            rsvp-te {
                label-switched-path-template {
                    vpls-GOLD-p2mp-template;
                }
            }
        }
        vrf-target target:65000:2;
        protocols {
            vpls {
                site-range 8;
                no-tunnel-services;
                site mtu-pe4 {
```

```
            site-identifier 3;
            interface ge-1/0/1.0;
          }
          mesh-group pe4 {
            vpls-id 400;
            neighbor 4.4.4.4;
          }
          mesh-group pe2 {
            vpls-id 200;
            neighbor 2.2.2.2;
          }
          mesh-group pe1 {
            vpls-id 100;
            neighbor 1.1.1.1;
          }
        }
      }
    }
  }
```

Verification

To confirm that the complete configuration is working properly, perform these tasks:

- Verifying VPLS Connections From Router CE1 on page 226
- Verifying VPLS Connections From Router CE3 on page 226

Verifying VPLS Connections From Router CE1

Purpose To verify the CE-to-CE VPLS connections from Router CE1.

Action Use the **ping** command to verify connectivity from Router CE1 to Router CE2, Router CE3, Router CE4, and Router CE5.

```
user@CE1# ping 40.40.40.2
PING 40.40.40.2 (40.40.40.2): 56 data bytes
64 bytes from 40.40.40.2: icmp_seq=0 ttl=64 time=2.513 ms
64 bytes from 40.40.40.2: icmp_seq=1 ttl=64 time=1.940 ms

user@CE1# ping 40.40.40.3
PING 40.40.40.3 (40.40.40.3): 56 data bytes
64 bytes from 40.40.40.3: icmp_seq=0 ttl=64 time=0.943 ms
64 bytes from 40.40.40.3: icmp_seq=1 ttl=64 time=0.868 ms

user@CE1# ping 40.40.40.5
PING 40.40.40.5 (40.40.40.5): 56 data bytes
64 bytes from 40.40.40.5: icmp_seq=0 ttl=64 time=1.196 ms
64 bytes from 40.40.40.5: icmp_seq=1 ttl=64 time=17.260 ms

user@CE1# ping 40.40.40.11
PING 40.40.40.11 (40.40.40.11): 56 data bytes
64 bytes from 40.40.40.11: icmp_seq=0 ttl=64 time=1.027 ms
64 bytes from 40.40.40.11: icmp_seq=1 ttl=64 time=1.013 ms
```

Verifying VPLS Connections From Router CE3

Purpose To verify the CE-to-CE VPLS connections from Router CE3.

Action Use the **ping** command to verify connectivity from Router CE3 to Router CE1, Router CE2, Router CE4, and Router CE5.

```
user@CE3> ping 40.40.40.1
PING 40.40.40.1 (40.40.40.1): 56 data bytes
64 bytes from 40.40.40.1: icmp_seq=0 ttl=64 time=1.999 ms
64 bytes from 40.40.40.1: icmp_seq=1 ttl=64 time=1.175 ms

user@CE3> ping 40.40.40.2
PING 40.40.40.2 (40.40.40.2): 56 data bytes
64 bytes from 40.40.40.2: icmp_seq=0 ttl=64 time=3.483 ms
64 bytes from 40.40.40.2: icmp_seq=1 ttl=64 time=1.170 ms

user@CE3> ping 40.40.40.5
PING 40.40.40.5 (40.40.40.5): 56 data bytes
64 bytes from 40.40.40.5: icmp_seq=0 ttl=64 time=2.813 ms
64 bytes from 40.40.40.5: icmp_seq=1 ttl=64 time=1.170 ms

user@CE3> ping 40.40.40.11
PING 40.40.40.11 (40.40.40.11): 56 data bytes
64 bytes from 40.40.40.11: icmp_seq=0 ttl=64 time=2.125 ms
64 bytes from 40.40.40.11: icmp_seq=2 ttl=64 time=124.979 ms
```

Related Documentation

- Example: Configuring LDP-Based H-VPLS Using a Single Mesh Group to Terminate the Layer 2 Circuits on page 227
- VPLS Versions Overview

Example: Configuring LDP-Based H-VPLS Using a Single Mesh Group to Terminate the Layer 2 Circuits

This example shows how to configure a single mesh group to terminate the Layer 2 circuits into an LDP-based VPLS. This is one type of hierarchical virtual private LAN service (H-VPLS) configuration possible in the Juniper Networks implementation. For information about the alternate type of configuration see "Example: Configuring BGP-Based H-VPLS Using Different Mesh Groups for Each Spoke Router" on page 211.

This example provides step-by-step configuration instructions and also provides steps for verifying and troubleshooting the configuration.

This example is organized into the following sections:

Requirements

This example uses the following hardware components:

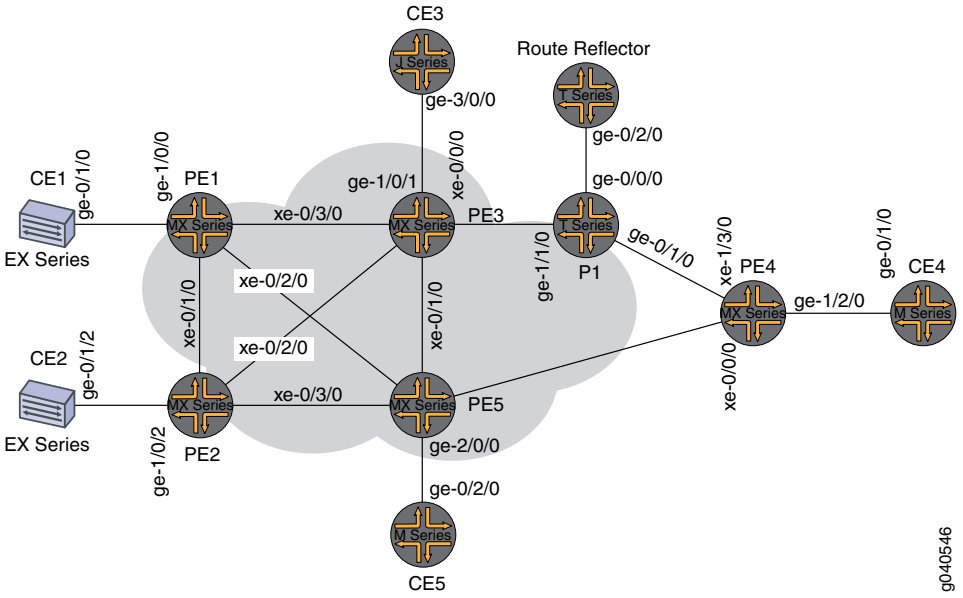
- Four MX Series 3D Universal Edge Routers for Routers PE1, PE2, PE3, and PE4
- Two M Series Multiservice Edge Routers for Routers CE4 and PE5
- Two EX Series Ethernet Switches for Devices CE1 and CE2

- Two T Series Core Routers for Routers P1 and the route reflector
- One J Series Services Router for Router CE3

Overview and Topology

Figure 26 on page 228 shows the physical topology used in this example.

Figure 26: Physical Topology of H-VPLS using a Single Mesh Group



In Figure 26 on page 228:

- Local switching is used to switch traffic between Layer 2 circuit pseudowires from the different spoke PE routers.
- The spoke PE routers are configured with the same virtual circuit ID and VPLS ID pair in a mesh group.
- The spoke PE routers are configured in an LDP-signaled VPLS routing instance.
- The layer 2 circuits are terminated into the LDP-based VPLS.

Configuration

To configure a single mesh group to terminate the Layer 2 circuits into an LDP-based VPLS, perform the following tasks:

- Configuring the Spoke PE Routers on page 229
- Configuring the Hub PE Router on page 230
- Verification on page 231

Configuring the Spoke PE Routers

Step-by-Step Procedure

Configure a single mesh group to terminate all the Layer 2 circuit pseudowires and enable local switching between the pseudowires.

1. On Router PE1, configure the Layer 2 circuit by including the **l2circuit** statement at the **[edit protocols]** hierarchy level. Include the **neighbor** statement and specify the IPv4 address of the hub PE router. Also configure the logical interface by including the **interface** statement and specify the interface connected to Router CE1.

   Configure the virtual circuit ID by including the **virtual-circuit-id** statement and specifying **100** as the ID value at the **[edit protocols l2circuit neighbor 5.5.5.5 interface ge-1/0/0.0]** hierarchy level.

   Configure the backup neighbor by including the **backup-neighbor** statement and specifying the IPv4 address of the backup hub PE router. Router PE3 is the backup neighbor in this example. Also include the **standby** statement at the **[edit protocols l2circuit neighbor 5.5.5.5 interface ge-1/0/0.0 backup-neighbor 3.3.3.3]** hierarchy level.

   ```
   [edit protocols]
   l2circuit {
     neighbor 5.5.5.5 {
       interface ge-1/0/0.0 {
         virtual-circuit-id 100;
         backup-neighbor 3.3.3.3 {
           standby;
         }
       }
     }
   }
   ```

2. On Router PE2, configure the Layer 2 circuit by including the **l2circuit** statement at the **[edit protocols]** hierarchy level. Include the **neighbor** statement and specify the IPv4 address of the hub PE router. Configure the logical interface by including the **interface** statement and specifying the interface connected to Router CE2.

   Configure the virtual circuit ID by including the **virtual-circuit-id** statement and specifying **100** as the ID value at the **[edit protocols l2circuit neighbor 5.5.5.5 interface ge-1/0/2.0]** hierarchy level. Include the **encapsulation** statement and specify **ethernet** as the type.

   Configure the backup neighbor by including the **backup-neighbor** statement and specifying the IPv4 address of the backup hub PE router. Router PE3 is the backup neighbor in this example. Also include the **standby** statement at the **[edit protocols l2circuit neighbor 5.5.5.5 interface ge-1/0/0.0 backup-neighbor 3.3.3.3]** hierarchy level.

   ```
   [edit protocols]
   l2circuit {
     neighbor 5.5.5.5 {
       interface ge-1/0/2.0 {
         virtual-circuit-id 100;
         encapsulation-type ethernet;
   ```

```
        backup-neighbor 3.3.3.3 {
          standby;
        }
      }
    }
  }
```

3. On Router PE4, configure the Layer 2 circuit by including the **l2circuit** statement at the **[edit protocols]** hierarchy level. Include the **neighbor** statement and specify the IPv4 address of the hub PE router. Configure the logical interface by including the **interface** statement and specify the interface connected to Router CE4.

   Configure the virtual circuit ID by including the **virtual-circuit-id** statement and specifying **100** as the ID value at the **[edit protocols l2circuit neighbor 5.5.5.5 interface ge-1/2/0.0]** hierarchy level.

   Configure the backup neighbor by including the **backup-neighbor** statement and specifying the IPv4 address of the backup hub PE router. Router PE3 is the backup neighbor in this example. Also include the **standby** statement at the **[edit protocols l2circuit neighbor 5.5.5.5 interface ge-1/2/0.0 backup-neighbor 3.3.3.3]** hierarchy level.

```
[edit protocols]
l2circuit {
  neighbor 5.5.5.5 {
    interface ge-1/2/0.0 {
      virtual-circuit-id 100;
      backup-neighbor 3.3.3.3 {
        standby;
      }
    }
  }
}
```

Configuring the Hub PE Router

Step-by-Step Procedure

Configure a single mesh group to terminate all the Layer 2 circuit pseudowires and enable local switching between the pseudowires.

1. On Router PE3, configure the Gigabit Ethernet interface connected to Router CE3 by including the **encapsulation** statement and specifying the **ethernet-vpls** option. Also configure the logical interface by including the **family** statement and specifying the **vpls** option.

```
[edit interfaces]
ge-1/0/1 {
  encapsulation ethernet-vpls;
  unit 0 {
    family vpls;
  }
}
```

2. On Router PE3, configure the logical loopback interface by including the **family** statement and specifying the **inet** option. Include the **address** statement and specify the IPv4 address for the interface.

```
[edit interfaces]
lo0 {
  unit 0 {
    family inet {
      address 3.3.3.3/32;
    }
  }
}
```

3. On Router PE3, configure the LDP-based VPLS routing instance by including the **instance-type** statement at the **[edit routing-instances H-VPLS]** hierarchy level and specifying the **vpls** option. Include the **interface** statement and specify the Gigabit Ethernet interface connected to Router CE3.

   Configure the VPLS protocol by including the **vpls** statement at the **[edit routing-instances H-VPLS protocols]** hierarchy level. Include the **no-tunnel-services** statement to enable the router to use an LSI interface.

```
[edit routing-instances]
H-VPLS {
  instance-type vpls;
  interface ge-1/0/1.0;
  protocols {
    vpls {
      no-tunnel-services;
    }
  }
}
```

4. On Router PE3, configure the mesh group by including the **mesh-group** statement at the **[edit routing-instances H-VPLS protocols vpls]** hierarchy level and specifying **L2-Circuits** as the name of the group. Include the **vpls-id** statement and specify **100** as the ID value. Include the **local-switching** statement to enable the router to switch traffic between the pseudowires.

   For each neighbor in the mesh group, include the **neighbor** statement and specify the IPv4 address of the spoke PE router.

```
[edit routing-instances H-VPLS protocols vpls]
mesh-group L2-Circuits {
  vpls-id 100;   <<< Same VPLS ID on all MTUs
  local-switching;   << Local-switching enabled
  neighbor 1.1.1.1;   <<MTU IP addresses
  neighbor 2.2.2.2;
  neighbor 4.4.4.4;
}
```

Verification

Step-by-Step Procedure

1. On Router PE5, use the **show ldp neighbor** command to verify that LDP sessions have been created to each of the spoke PE routers.

```
user@PE5# show ldp neighbor

Address            Interface          Label space ID         Hold time
1.1.1.1            lo0.0              1.1.1.1:0                33
```

```
2.2.2.2             lo0.0               2.2.2.2:0                37
4.4.4.4             lo0.0               4.4.4.4:0                39
```

2. On Router PE5, use the **show vpls connections extensive** command to verify that the mesh group neighbor session is **Up**, that inbound and outbound labels have been assigned, that the VPLS ID is correct, and that the virtual tunnel interface is being used.

```
user@PE5# show vpls connections extensive

...
Instance: H-VPLS
    Number of local interfaces: 1
    Number of local interfaces up: 1
    Number of VE mesh-groups: 2
    Number of VE mesh-groups up: 1
    ge-2/0/0.0
    Mesh-group interfaces: L2-Circuits
      State: Up      ID: 2
      vt-2/1/0.1048848    Intf - vpls H-VPLS neighbor 4.4.4.4 vpls-id 100
      vt-2/1/0.1048849    Intf - vpls H-VPLS neighbor 2.2.2.2 vpls-id 100
      vt-2/1/0.1048850    Intf - vpls H-VPLS neighbor 1.1.1.1 vpls-id 100
    Mesh-group interfaces: __ves__
      State: Dn      ID: 0
  Mesh-group connections: L2-Circuits
    Neighbor                Type  St     Time last up          # Up trans
    4.4.4.4(vpls-id 100)    rmt   Up     Jan  3 16:46:26 2010           1
      Remote PE: 4.4.4.4, Negotiated control-word: No
      Incoming label: 800011, Outgoing label: 301088
      Local interface: vt-2/1/0.1048848, Status: Up, Encapsulation: ETHERNET
        Description: Intf - vpls H-VPLS neighbor 4.4.4.4 vpls-id 100
    Connection History:
        Jan  3 16:46:26 2010  status update timer
        Jan  3 16:46:26 2010  PE route changed
        Jan  3 16:46:26 2010  In lbl Update                   800011
        Jan  3 16:46:26 2010  Out lbl Update                  301088
        Jan  3 16:46:26 2010  In lbl Update                   800011
        Jan  3 16:46:26 2010  loc intf up             vt-2/1/0.1048848
    2.2.2.2(vpls-id 100)    rmt   Up     Jan  3 16:46:26 2010           1
      Remote PE: 2.2.2.2, Negotiated control-word: No
      Incoming label: 800010, Outgoing label: 301488
      Local interface: vt-2/1/0.1048849, Status: Up, Encapsulation: ETHERNET
        Description: Intf - vpls H-VPLS neighbor 2.2.2.2 vpls-id 100
    Connection History:
        Jan  3 16:46:26 2010  status update timer
        Jan  3 16:46:26 2010  PE route changed
        Jan  3 16:46:26 2010  In lbl Update                   800010
        Jan  3 16:46:26 2010  Out lbl Update                  301488
        Jan  3 16:46:26 2010  In lbl Update                   800010
        Jan  3 16:46:26 2010  loc intf up             vt-2/1/0.1048849
    1.1.1.1(vpls-id 100)    rmt   Up     Jan  3 16:46:26 2010           1
      Remote PE: 1.1.1.1, Negotiated control-word: No
      Incoming label: 800009, Outgoing label: 301296
      Local interface: vt-2/1/0.1048850, Status: Up, Encapsulation: ETHERNET
        Description: Intf - vpls H-VPLS neighbor 1.1.1.1 vpls-id 100
    Connection History:
        Jan  3 16:46:26 2010  status update timer
        Jan  3 16:46:26 2010  PE route changed
        Jan  3 16:46:26 2010  In lbl Update                   800009
        Jan  3 16:46:26 2010  Out lbl Update                  301296
```



```
Jan  3 16:46:26 2010  In lbl Update                    800009
Jan  3 16:46:26 2010  loc intf up             vt-2/1/0.1048850
```

Related Documentation

- Example: Configuring BGP-Based H-VPLS Using Different Mesh Groups for Each Spoke Router on page 211
- VPLS Versions Overview

PART 3

Administration

CHAPTER 6

VPLS Reference

Supported Platforms and PICs

Virtual private LAN service (VPLS) is supported on all M Series routers except the M160.

VPLS is supported on all J Series, MX Series, and T Series routers.

VPLS is supported on the following SRX Services Gateways for the branch:

- SRX100
- SRX210
- SRX240
- SRX650

VPLS is supported on the following PICs:

- All ATM2 IQ PICs
- 4-port Fast Ethernet PIC with 10/100 Base-TX interfaces PIC
- 1-port, 2-port, and 10-port Gigabit Ethernet PICs
- 1-port, 2-port, and 4-port Gigabit Ethernet PICs with SFP
- 1-port 10-Gigabit Ethernet PIC
- 1-port and 2-port Gigabit Ethernet Intelligent Queuing (IQ) PICs
- 4-port and 8-port Gigabit Ethernet IQ2 PICs with SFP
- 1-port 10-Gigabit Ethernet IQ2 PIC with XFP
- 4-port, quad-wide Gigabit Ethernet PIC
- 10-port 10-Gigabit OSE PIC

Supported VPLS Standards

The Junos OS substantially supports the following following RFCs, which define standards for virtual private LAN service (VPLS).

- RFC 4761, *Virtual Private LAN Service (VPLS) Using BGP for Auto-Discovery and Signaling*
- RFC 4762, *Virtual Private LAN Service (VPLS) Using Label Distribution Protocol (LDP) Signaling*

  FEC 128, FEC 129, control bit **0**, the Ethernet pseudowire type **0x0005**, and the Ethernet tagged mode pseudowire type **0x0004** are supported.

Related Documentation

- Supported Carrier-of-Carriers and Interprovider VPN Standards
- Supported Layer 2 Circuit Standards
- Supported Layer 2 VPN Standard
- Supported Layer 3 VPN Standards
- Supported Multicast VPN Standards
- Accessing Standards Documents on the Internet

CHAPTER 7

Configuring VPLS Reference

Configuring Port Mirroring for VPLS Traffic

You can configure port mirroring for VPLS traffic on the M7, M10i, M120, M320, and the MX Series routers. VPLS port mirroring is supported only M7i and M0i routers with the Enhanced Compact Forwarding Engine Board (CFEB-E). In addition, on M320 routers, VPLS port mirroring is supported only on Enhanced III Flexible PIC Concentrators (FPCs).

To configure port mirroring for VPLS include the **port-mirroring** statement at the **[edit forwarding-options]** hierarchy level. For more information about configuring port mirroring for VPLS for all platforms supported, see the *Junos OS Policy Framework Configuration Guide*. For information about configuring port mirroring for VPLS for MX Series routers, see the *JUNOS MX Series Ethernet Services Routers Layer 2 Configuration Guide*.

CHAPTER 8

Summary of VPLS Configuration Statements

active-interface

Syntax

```
active-interface {
    any;
    primary interface-name;
}
```

Hierarchy Level

[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls site *site-name*],
[edit routing-instances *routing-instance-name* protocols vpls site *site-name*]

Release Information

Statement introduced in Junos OS Release 7.5.

Description

Specify a multihomed interface as the primary interface for the VPLS site. If there are multiple interfaces, the remaining interfaces are activated only when the primary interface goes down. 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.

Options

any—One configured interface is randomly designated as the active interface for the VPLS site.

primary *interface-name*—Specify the name of the multihomed interface to be used as the primary interface by the VPLS site.

Required Privilege Level

routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- Specifying an Interface as the Active Interface on page 65

automatic-site-id

Syntax

```
automatic-site-id {
  collision-detect-time seconds;
  new-site-wait-time seconds;
  reclaim-wait-time minimum seconds maximum seconds;
  startup-wait-time seconds;
}
```

Hierarchy Level

[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls site *site-name*],
[edit routing-instances *routing-instance-name* protocols vpls site *site-name*]

Release Information

Statement introduced in Junos OS Release 9.1.

Description

Enable automatic site identifiers for VPLS routing instances.

Options

collision-detect-time—The time in seconds to wait after a claim advertisement is sent to the other routers in a VPLS instance before a PE router can begin using a site identifier. If the PE router receives a competing claim advertisement for the same site identifier during this time period, it initiates the collision resolution procedure for site identifiers.

new-site-wait-time—The time in seconds to wait to receive VPLS information for a newly configured routing instance or a new site. This time interval is also applied whenever the automatic site identifier feature is activated on a VPLS routing instance other than at startup. Effectively, this timer indicates how long to wait before an attempt is made to allocate a site identifier. This timer is also triggered whenever a VPLS routing instance is enabled.

reclaim-wait-time—The time in seconds to wait to receive VPLS information for a newly configured routing instance or a new site. This time interval is also applied whenever the automatic site identifier feature is activated on a VPLS routing instance other than at startup. Effectively, this timer indicates how long to wait before an attempt is made to allocate a site identifier. This timer is also triggered whenever a VPLS routing instance is enabled. You can configure two values for this option: the **minimum** wait time and the **maximum** wait time.

startup-wait-time—The time in seconds to wait at startup to receive all the VPLS information for the route targets configured on the other PE routers included in the VPLS routing instance.

Required Privilege Level

routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- Configuring Automatic Site Identifiers for VPLS on page 30

connectivity-type

Syntax connectivity-type (ce | irb | permanent);

Hierarchy Level [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls],
[edit routing-instances *routing-instance-name* protocols vpls]

Release Information Statement introduced in Junos OS Release 9.1.
irb option introduced in Junos OS Release 9.3.
permanent option introduced in Junos OS Release 10.4.

Description Specify when a VPLS connection is taken down depending on whether or not the interface for the VPLS routing instance is customer-facing or integrated routing and bridging (IRB).

Default ce

Options

ce—Require that for the VPLS connection to be up, the customer-facing interface for the VPLS routing instance must also be up. If the customer-facing interface fails, the VPLS connection is taken down.

irb—Allow a VPLS connection to remain up so long as an IRB interface is configured for the VPLS routing instance.

permanent—Allow a VPLS connection to remain up until specifically taken down. This option is reserved for use in configuring Layer 2 Wholesale subscriber networks. See the *Broadband Subscriber Management Solutions Guide* for details about configuring a Layer 2 Wholesale network.

NOTE: **To specifically take down a VPLS routing instance that is using the permanent option, all associated static logical interfaces must also be down.**

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- Configuring VPLS Routing Instance and VPLS Interface Connectivity on page 36
- Configuring Separate NNI Routing Instances for Layer 2 Wholesale Service Retailers

encapsulation

Syntax encapsulation (ethernet-vpls | ether-vpls-over-atm-llc | extended-vlan-vpls | vlan-vpls);

Hierarchy Level [edit interfaces *interface-name*],
[edit logical-systems *logical-system-name* interfaces *interface-name*]

Release Information Statement introduced before Junos OS Release 7.4.

Description Physical link-layer encapsulation type for VPLS interfaces. This statement summary for the **encapsulation** statement describes encapsulations supported for VPLS only. For a full description of the **encapsulation-type** statement, see encapsulation-type.

Options

ethernet-vpls—Use Ethernet VPLS encapsulation on Ethernet interfaces that have VPLS enabled and that must accept packets carrying standard Tag Protocol ID (TPID) values. On M Series routers, except the M320 router, the 4-port Fast Ethernet TX PIC and the 1-port, 2-port, and 4-port, 4-slot Gigabit Ethernet PICs can use the Ethernet VPLS encapsulation type.

ether-vpls-over-atm-llc—For ATM intelligent queuing (IQ) interfaces only, use the Ethernet virtual private LAN service (VPLS) over ATM LLC encapsulation to bridge Ethernet interfaces and ATM interfaces over a VPLS routing instance (as described in RFC 2684, *Multiprotocol Encapsulation over ATM Adaptation Layer 5*). Packets from the ATM interfaces are converted to standard ENET2/802.3 encapsulated Ethernet frames with the frame check sequence (FCS) field removed.

extended-vlan-vpls—Use extended virtual local area network (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. On M Series routers, except the M320 router, the 4-port Fast Ethernet TX PIC and the 1-port, 2-port, and 4-port, 4-slot Gigabit Ethernet PICs can use the Ethernet VPLS encapsulation type.

vlan-vpls—Use VLAN VPLS encapsulation on Ethernet interfaces with VLAN tagging and VPLS enabled. Interfaces with VLAN VPLS encapsulation accept packets carrying standard TPID values only. On M Series routers, except the M320 router, the 4-port Fast Ethernet TX PIC and the 1-port, 2-port, and 4-port, 4-slot Gigabit Ethernet PICs can use the Ethernet VPLS encapsulation type.

NOTE: Label-switched interfaces (LSIs) do not support VLAN VPLS encapsulation. Therefore, you can only use VLAN VPLS encapsulation on a PE-router-to-CE-router interface and not a core-facing interface.

Required Privilege Level interface—To view this statement in the configuration.
interface-control—To add this statement to the configuration.

Related Documentation

- Configuring the VPLS Interface Encapsulation on page 43

encapsulation-type

Syntax encapsulation-type (atm-aal5 | atm-cell | atm-cell-port-mode | atm-cell-vc-mode | atm-cell-vp-mode | cesop | cisco-hdlc | ethernet | ethernet-vlan | frame-relay | frame-relay-port-mode | interworking | ppp | satop-e1 | satop-e3 | satop-t1 | satop-t3);

Hierarchy Level [edit logical-systems *logical-system-name* protocols l2circuit neighbor *address* interface *interface-name*],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols l2vpn],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols l2vpn neighbor *address*],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls],
[edit protocols l2circuit neighbor *address* interface *interface-name*],
[edit routing-instances *routing-instance-name* protocols l2vpn],
[edit routing-instances *routing-instance-name* protocols l2vpn neighbor *address*],
[edit routing-instances *routing-instance-name* protocols vpls]

Release Information Statement introduced in Junos OS Release 9.2.
Statement introduced in Junos OS Release 11.1 for EX Series switches.

Description Specify the type of Layer 2 traffic originating from the CE device. Only the **ethernet** and **ethernet-vlan** encapsulation types are supported for VPLS. Not all encapsulation types are supported on the switches. See the switch CLI.

Options **atm-aal5**—ATM Adaptation Layer (AAL/5)

atm-cell—ATM cell relay

atm-cell-port-mode—ATM cell relay port promiscuous mode

atm-cell-vc-mode—ATM VC cell relay nonpromiscuous mode

atm-cell-vp-mode—ATM virtual path (VP) cell relay promiscuous mode

cesop—CESOP-based Layer 2 VPN

cisco-hdlc—Cisco Systems–compatible HDLC

ethernet—Ethernet

ethernet-vlan—Ethernet VLAN

frame-relay—Frame Relay

frame-relay-port-mode—Frame Relay port mode

interworking—Layer 2.5 interworking VPN

ppp—PPP

satsop-e1—SATSOP-E1–based Layer 2 VPN

satsop-e3—SATSOP-E3–based Layer 2 VPN

satsop-t1—SATSOP-T1–based Layer 2 VPN

satsop-t3—SATSOP-T3–based Layer 2 VPN

Default: For VPLS networks, the default encapsulation type is **ethernet**.

Required Privilege Level

routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- Configuring the Local Site on PE Routers in Layer 2 VPNs
- Configuring VPLS Routing Instances on page 28
- Configuring Interfaces for Layer 2 Circuits
- Configuring an MPLS-Based Layer 2 VPN (CLI Procedure)

family multiservice

Syntax

```
family multiservice {
  destination-mac;
  label-1;
  label-2;
  payload {
    ip {
      layer-3 {
        (destination-ip-only | source-ip-only);
      }
      layer-3-only;
      layer-4;
    }
  }
  source-mac;
  symmetric-hash {
    complement;
  }
}
```

Hierarchy Level [edit forwarding-options hash-key]

Release Information Statement introduced in Junos OS Release 8.0.
ip, **label-1**, **label-2**, **layer-3-only**, and **payload** statements introduced in Junos OS Release 9.4.
layer-3, **layer-**. **source-address-only**, and **destination-address-only** statements introduced in Junos OS Release 9.5.
symmetric-hash statement and the **complement** option introduced in Junos OS Release 9.6.

Description (M Series, MX Series, and T Series routers only) Configure load balancing based on Layer 2 media access control information. On MX Series routers, configure VPLS load balancing. On M120 and M320 routers only, configure VPLS load balancing based on MPLS labels and IP information. For IPv4 traffic, only the IP source and destination addresses are included in the hash key. For MPLS and IPv4 traffic, one or two MPLS labels and IPv4 source and destination addresses are included. For MPLS Ethernet pseudowires, only one or two MPLS labels are included in the hash key.

Options You can configure one or more options to load-balance using the packet information that you specify.

destination-mac—Configure this when you want to include the destination-address MAC information in the hash key for Layer 2 load balancing.

source-mac—Configure this when you want to include the source-address MAC information in the hash key.

label-1 (M120 and M320 routers only)—Configure this when you want to include the first MPLS label in the hash key. Used for including a one-label packet for per-flow load balancing of IPv4 VPLS traffic based on IP information and MPLS labels.

label-2 (M120 and M320 routers only)—Configure this when you want to include the second MPLS label in the hash key. If both **label-1** and **label-2** are specified, the entire first label and the first 16 bits of the second label are hashed.

payload (MX Series, M120, and M320 routers only)—Use this to include the packets' IP payload in the hash key.

ip (MX Series, M120, and M320 routers only)—Use this to include the IP address of the IPv4 or IPv6 payload in the hash key.

layer-3-only (M120, and M320 routers only)—Use this to include only the Layer 3 information from the packets' IP payload in the hash key.

layer-3 (MX Series routers only)—Use this to include Layer 3 information from the packets' IP payload in the hash key.

source-address-only (MX Series routers only)—Use this to include only the source IP address in the payload in the hash key.

destination-address-only (MX Series routers only)—Use this to include only the destination IP address in the payload in the hash key.

NOTE: You can include either the **source-address-only** or the **destination-address-only** statement, not both. They are mutually exclusive.

layer-4 (MX Series routers only)—Include Layer 4 information from the packets' IP payload in the hash key.

NOTE: On MX Series routers only, you can configure either Layer 3 or Layer 4 load balancing, or both at the same time.

NOTE: On I chip platforms, an unknown Layer 4 header is excluded from load balance hashing to avoid undesired packet reordering.

symmetric-hash (MX Series 3D Universal Edge Routers only)—Configure the symmetric hash or symmetric hash complement for configuring symmetrical load balancing on an 802.3ad Link Aggregation Group.

complement (MX Series 3D Universal Edge Routers only)—Include the complement of the symmetric hash in the hash key.

Required Privilege Level

interface—To view this statement in the configuration.
interface-control—To add this statement to the configuration.

Related Documentation

- Configuring Load Balancing Based on MAC Addresses
- Configuring VPLS Load Balancing Based on IP and MPLS Information
- Configuring VPLS Load Balancing on MX Series 3D Universal Edge Routers
- Configuring VPLS Load Balancing on page 47

fast-reroute-priority

Syntax fast-reroute-priority (high | low | medium);

Hierarchy Level [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* forwarding-options],
[edit routing-instances *routing-instance-name* forwarding-options]

Release Information Statement introduced in Junos OS Release 9.5.

Description Specify the fast reroute priority for a VPLS routing instance. You can configure **high**, **medium**, or **low** fast reroute priority to prioritize specific VPLS routing instances for faster convergence and traffic restoration. Because the router repairs next hops for high-priority VPLS routing instances first, the traffic traversing a VPLS routing instance configured with **high** fast reroute priority is restored faster than the traffic for VPLS routing instances configured with **medium** or **low** fast reroute priority.

Default low

Options

high—Set the fast reroute priority for a VPLS routing instance to high. During a fast reroute event, the router repairs next hops for high-priority VPLS routing instances first.

low—Set the fast reroute priority for a VPLS routing instance to low, which is the default. During a fast reroute event, the router repairs next hops for low-priority VPLS routing instances last.

medium—Set the fast reroute priority for a VPLS routing instance to medium. During a fast reroute event, the router repairs next hops for medium-priority VPLS instances after high-priority VPLS routing instances but before low-priority VPLS routing instances.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- Configuring VPLS Fast Reroute Priority on page 48

interface

Syntax

```
interface interface-name {
    interface-mac-limit limit;
}
```

Hierarchy Level

[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls site *site-name*],
[edit routing-instances *routing-instance-name* protocols vpls site *site-name*]

Release Information

Statement introduced before Junos OS Release 7.4.

Description

Configure the Layer 2 circuit pseudowires for a VPLS site as logical interfaces within the VPLS site configuration.

Options

interface-name—Specify the name of the interface used by the VPLS site.

The other option is explained separately.

Required Privilege Level

routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- Configuring the VPLS Site Interfaces on page 33

interface-mac-limit

Syntax

```
interface-mac-limit limit;
```

Hierarchy Level

[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 site *site-name* interfaces *interface-name*]

Release Information

Statement introduced before Junos OS Release 7.4.

Description

Specify the maximum number of media access control (MAC) addresses that can be learned by the VPLS routing instance. You can configure the same limit for all interfaces configured for a routing instance. You can also configure a limit for a specific interface.

Options

limit—Specify the number of MAC addresses that can be learned from each interface.

Range: 16 through 65,536 MAC addresses

Default: 512 addresses

Required Privilege Level

routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- Limiting the Number of MAC Addresses Learned from an Interface on page 38
- mac-table-size on page 256

l2vpn-id

Syntax l2vpn-id (*as-number:id* | *ip-address:id*);

Hierarchy Level [edit logical-systems *logical-system-name* routing-instances *instance-name*],
[edit routing-instances *instance-name*]

Release Information Statement introduced in Junos OS Release 10.4R2.

Description Specify a globally unique Layer 2 VPN community identifier for the instance.

Options ***as-number:id***—Autonomous system number (**l2vpn-id:*as-number:2-byte-number***. For example: **l2vpn-id l2vpn-id:100:200**. The AS number can be in the range from 1 through 65,535.

ip-address:id—IP address (**l2vpn-id:*ip-address:2-byte-number***. For example: **l2vpn-id l2vpn-id:10.1.1.1:2**. The IP address can be any globally unique unicast address.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- Example: Configuring BGP Autodiscovery for LDP VPLS on page 89
- Example: Configuring BGP Autodiscovery for LDP VPLS with User-Defined Mesh Groups on page 106

label-block-size

Syntax label-block-size *size*;

Hierarchy Level [edit logical-systems *profile-name* routing-instances *instance-name* protocols vpls],
[edit routing-instances *instance-name* protocols vpls]

Release Information Statement introduced in Junos OS Release 10.0.

Description Configure the label block size for VPLS labels.

Default 8

Options

- 2—Allocate the label blocks in increments of 2. For a VPLS domain that has only two sites with no future expansion plans.
- 4—Allocate the label blocks in increments of 4.
- 8 (default)—Allocate the label blocks in increments of 8.
- 16—Allocate the label blocks in increments of 16. A label block size of 16 enables you to minimize the number of routes in the VPLS domain. Use this setting only if the number of routes is the most important concern.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- Configuring the Label Block Size on page 81

label-switched-path-template

Syntax

```
label-switched-path-template {
    (default-template | lsp-template-name);
}
```

Hierarchy Level

[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* provider-tunnel],
[edit routing-instances *routing-instance-name* provider-tunnel]

Release Information

Statement introduced in Junos OS Release 8.3.

Description

Enables dynamic point-to-multipoint LSPs to be used for flooding VPLS traffic. There is no default setting for the **label-switched-path-template** statement, so you must configure either the default template using the **default-template** option or you must specify the name of your preconfigured point-to-multipoint LSP template.

Options

default-template—Create a point-to-multipoint LSP with the default parameters.

p2mp-lsp-template-name—Name of the point-to-multipoint LSP template.

Required Privilege Level

routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- Configuring Dynamic Point-to-Multipoint Flooding LSPs on page 68

local-switching

Syntax

```
local-switching;
```

Hierarchy Level

[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls mesh-group *mesh-group-name*],
[edit routing-instances *routing-instance-name* protocols vpls mesh-group *mesh-group-name*]

Release Information

Statement introduced in Junos OS Release 9.3.

Description

Allows you to terminate multiple Layer 2 circuit pseudowires at a single VPLS mesh group.

Required Privilege Level

routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- Configuring Switching Between Pseudowires Using VPLS Mesh Groups on page 72

mac-flush

Syntax mac-flush [*explicit-mac-flush-message-options*];

Hierarchy Level [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 mesh-group *mesh-group-name*],
[edit routing-instances *routing-instance-name* protocols vpls],
[edit routing-instances *routing-instance-name* protocols vpls mesh-group *mesh-group-name*]

Release Information Statement introduced in Junos OS Release 10.0.

Description Enable media access control (MAC) flush processing for the virtual private LAN service (VPLS) routing instance or for the mesh group under a VPLS routing instance. MAC flush processing removes MAC addresses from the MAC address database that have been learned dynamically. With the dynamically learned MAC addresses removed, MAC address convergence requires less time to complete.

For certain cases where MAC flush processing is not initiated by default, you can also specify ***explicit-mac-flush-message-options*** that additionally configure the router to send explicit MAC flush messages. To configure the router to send explicit MAC flush messages under specific conditions, include ***explicit-mac-flush-message-options*** with the statement.

Options *explicit-mac-flush-message-options*—(Optional) You can specify one or more of the following explicit MAC flush message options:

- **any-interface**—(Optional) Send a MAC flush message when any customer-facing attachment circuit interface goes down.
- **any-spoke**—(Optional) Send a MAC FLUSH-FROM-ME flush message to all provider edge (PE) routers in the core when one of the spoke pseudowires between the multitenant unit switch and the other network-facing provider edge (NPE) router goes down, causing the multitenant unit switch to switch to this NPE router.

  NOTE: This option has a similar effect in a VPLS multihoming environment with multiple multitenant unit switches connected to NPE routers, where both multitenant unit switches have pseudowires that terminate in a mesh group with local-switching configured. If the any-spoke option is enabled, then both PE routers send MAC FLUSH-FROM-ME flush messages to all PEs in the core.

- **propagate**—(Optional) Propagate MAC flush to the core.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- Configuring VPLS Routing Instances on page 28
- Configuring Interoperability Between BGP Signaling and LDP Signaling in VPLS on page 70

mac-table-aging-time

Syntax mac-table-aging-time *time*;

Hierarchy Level [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls],
[edit routing-instances *routing-instance-name* protocols vpls]

Release Information Statement introduced in Junos OS Release 7.4.

Description Modify the timeout interval for the VPLS table.

Options *time*—Specify the number of seconds to wait between VPLS table clearings.

Range: 10 through 1,000,000 seconds

Default: 300 seconds

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- Configuring the VPLS MAC Table Timeout Interval on page 37

mac-table-size

Syntax mac-table-size *size*;

Hierarchy Level [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls],
[edit routing-instances *routing-instance-name* protocols vpls]

Release Information Statement introduced before Junos OS Release 7.4.

Description Modify the size of the VPLS MAC address table.

Options *size*—Specify the size of the MAC address table.

Range: (M Series and T Series) 16 through 65,536 MAC addresses
(MX Series) 16 through 1,048,575 MAC addresses

Default: 512 MAC addresses

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- Configuring the Size of the VPLS MAC Address Table on page 37

mesh-group

Syntax

```
mesh-group mesh-group-name {
  l2vpn-id (as-number:id | ip-address:id);
  local-switching;
  mac-flush [ explicit-mac-flush-message-options ];
  neighbor address {...}
  peer-as all;
  pseudowire-status-tlv;
  route-distinguisher (as-number:id | ip-address:id);
  vpls-id number;
  vrf-export [ policy-names ];
  vrf-import [ policy-names ];
  vrf-target {
    community;
    import community-name;
    export community-name;
  }
}
}
```

Hierarchy Level

[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls],
[edit routing-instances *routing-instance-name* protocols vpls]

Release Information

Statement introduced in Junos OS Release 9.0.
local-switching, **mac-tlv-receive**, **mac-tlv-send**, and **peer-as** optionsintroduced in Junos OS Release 9.3.
pseudowire-status-tlv and **mac-flush** options introduced in Junos OS Release 10.0.
route-distinguisher option introduced in Junos OS Release 11.2.

Description

Specify the virtual private LAN service (VPLS) mesh group. The statement options allow you to specify each provider edge (PE) router that is a member of the mesh group. This statement is also used in the configuration of inter-autonomous system (AS) VPLS with media access control (MAC) operations.

Options

mesh-group-name—Name of the VPLS mesh group.

The remaining statements are explained separately.

Required Privilege Level

routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- Configuring VPLS Routing Instances on page 28
- Configuring Interoperability Between BGP Signaling and LDP Signaling in VPLS on page 70
- Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 73

multi-homing

Syntax multi-homing;

Hierarchy Level [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls site *site-name*],
[edit routing-instances *routing-instance-name* protocols vpls site *site-name*]

Release Information Statement introduced in Junos OS Release 7.5.

Description Specify the PE router as being a part of a multihomed site. Include this statement on all PE routers associated with a particular site. Configuration of this statement tracks BGP peers. If no BGP peer is available, all active interfaces for a site are deactivated.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- Configuring Multihoming on the PE Router on page 65

neighbor

Syntax

```
neighbor neighbor-id {
    backup-neighbor {...}
    community community-name;
    encapsulation-type type;
    ignore-encapsulation-mismatch;
    pseudowire-status-tlv;
    psn-tunnel-endpoint address;
    switchover-delay milliseconds;
}
```

Hierarchy Level

[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls],
[edit logical-systems *logical-system-name* routing-instances *instance-name* protocols vpls mesh-group *mesh-group-name*],
[edit routing-instances *routing-instance-name* protocols vpls],
[edit routing-instances *instance-name* protocols vpls mesh-group *mesh-group-name*]

Release Information

Statement introduced in Junos OS Release 8.4. The **pseudowire-status-tlv** option was added in Junos OS Release 10.0.

Description

Specify each of the PE routers participating in the VPLS domain. Configuring this statement enables LDP for signaling VPLS.

Options

neighbor-id—Specify the neighbor identifier for each PE router participating in the VPLS domain.

The other options are explained separately.

Required Privilege Level

routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- Configuring LDP Signaling for VPLS on page 34

no-local-switching

Syntax no-local-switching;

Hierarchy Level [edit bridge-domains *bridge-domain-name*]

Release Information Statement introduced in Junos OS Release 8.5.

Description Prevents CE devices from communicating directly with each other. If the **no-local-switching** statement is configured, frames arriving on a CE interface are sent to a VPLS edge (VE) device or core-facing interfaces only.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- Configuring VPLS and Integrated Routing and Bridging on page 70

no-tunnel-services

Syntax no-tunnel-services;

Hierarchy Level [edit logical-systems *logical-system-name* protocols vpls static-vpls],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls],
[edit protocols vpls static-vpls],
[edit routing-instances *routing-instance-name* protocols vpls]

Release Information Statement introduced in Junos OS Release 7.6. Support for static VPLS added in Junos OS Release 10.2.

Description Configure VPLS on a router without a Tunnel Services PIC. Configuring the **no-tunnel-services** statement creates a label-switched interface (LSI) to provide VPLS functionality. An LSI MPLS label is used as the inner label for VPLS. This label maps to a VPLS routing instance. On the PE router, the LSI label is stripped and then mapped to a logical LSI interface. The Layer 2 Ethernet frame is then forwarded using the LSI interface to the correct VPLS routing instance.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- Configuring VPLS Without a Tunnel Services PIC on page 49
- Configuring Static Pseudowires for VPLS on page 39
- Configuring EXP-Based Traffic Classification for VPLS on page 40

peer-as

Syntax

```
peer-as {
    all;
}
```

Hierarchy Level

[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls mesh-group *mesh-group-name*],
[edit routing-instances *routing-instance-name* protocols vpls mesh-group *mesh-group-name*]

Release Information

Statement introduced in Junos OS Release 9.3.

Description

Enable the autonomous system border router (ASBR) to establish a single pseudowire to each of the other ASBRs interconnected using inter-AS VPLS with MAC processing at the ASBR.

Options

all—This option is required. All peer routers, the ASBRs, are placed within the same VPLS mesh group.

Required Privilege Level

routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- Configuring Inter-AS VPLS with MAC Processing at the ASBR on page 73

rsvp-te

Syntax

```
rsvp-te {
  label-switched-path-template {
    (default-template | lsp-template-name);
  }
  static-lsp lsp-name;
}
```

Hierarchy Level

[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* provider-tunnel],
[edit routing-instances *routing-instance-name* provider-tunnel]

Release Information

Statement introduced in Junos OS Release 8.3.

Description

Configure VPLS unknown unicast, broadcast, and multicast traffic flooding using point-to-multipoint LSPs.

Options

static-lsp *lsp-name*—Create a static point-to-multipoint LSP and automatically include all of the neighbors in the VPLS routing instance.

The remaining option is explained separately.

Required Privilege Level

routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- Flooding Unknown Traffic Using Point-to-Multipoint LSPs on page 66

site

Syntax

```
site site-name {
  interface interface-name {
    interface-mac-limit limit;
  }
  site-identifier identifier;
  site-preference preference-value;
}
```

Hierarchy Level

[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls],
[edit routing-instances *routing-instance-name* protocols vpls]

Release Information

Statement introduced before Junos OS Release 7.4.

Description

Specify the site name and site identifier for a site. Allows you to configure a remote site ID for remote sites.

Options

site-name—Name of the site.

The remaining statements are explained separately.

Required Privilege Level

routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- Configuring the VPLS Site Name and Site Identifier on page 30

site-identifier

Syntax

site-identifier *identifier*;

Hierarchy Level

[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls site *site-name*],
[edit routing-instances *routing-instance-name* protocols vpls site *site-name*]

Release Information

Statement introduced before Junos OS Release 7.4.

Description

Specify the numerical identifier for the local VPLS site.

Options

identifier—Specify the numerical identifier for the local VPLS site. The identifier must be an unsigned 16-bit number greater than zero.

Required Privilege Level

routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- Configuring the VPLS Site Name and Site Identifier on page 30

site-preference

Syntax

```
site-preference preference-value {
    backup;
    primary;
}
```

Hierarchy Level

[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols l2vpn site *site-name*],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls site *site-name*],
[edit routing-instances *routing-instance-name* protocols l2vpn site *site-name*],
[edit routing-instances *routing-instance-name* protocols vpls site *site-name*]

Release Information

Statement introduced before Junos OS Release 7.4.

Description

Specify the preference value advertised for a particular Layer 2 VPN or VPLS site. The site preference value is encoded in the BGP local preference attribute. When a PE router receives multiple advertisements with the same VE identifier, the advertisement with the highest local preference value is preferred.

Options

preference-value—Specify the preference value advertised for a Layer 2 VPN or VPLS site.

Range: 1 through 65,535

backup—Set the preference value to 1.

primary—Set the preference value to 65,535.

Required Privilege Level

routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- Configuring the VPLS Site Preference on page 33

site-range

Syntax site-range *number*;

Hierarchy Level [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls],
[edit routing-instances *routing-instance-name* protocols vpls]

Release Information Statement introduced before Junos OS Release 7.4.

Description Specify an upper limit on the maximum site identifier that can be accepted to allow a pseudowire to be brought up. Pseudowires cannot be established to sites with site identifiers greater than the configured site range. If you issue the **show vpls connections** command, such sites are displayed as OR (out of range). You must specify a value from 1 through 65,534. We recommend using the default.

Default 65,534

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- Configuring the Site Range on page 31

static

Syntax

```
static {
    incoming-label label;
    outgoing-label label;
}
```

Hierarchy Level

[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls mesh-group *mesh-group-name* neighbor *address*],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls neighbor *address*],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls neighbor *address* backup-neighbor *address*],
[edit routing-instances *routing-instance-name* protocols vpls mesh-group *mesh-group-name* neighbor *address*],
[edit routing-instances *routing-instance-name* protocols vpls neighbor *address*],
[edit routing-instances *routing-instance-name* protocols vpls neighbor *address* backup-neighbor *address*]

Release Information

Statement introduced in Junos OS Release 10.2.

Description

Specifies a static pseudowire for a VPLS domain. By configuring static pseudowires for the VPLS domain, you do not need to configure the LDP or BGP protocols that would normally be used for signaling. Static pseudowires require that you configure a set of in and out labels for each pseudowire configured for the VPLS domain. You can configure both static and dynamic neighbors within the same VPLS routing instance. You can also configure a static pseudowire for a backup neighbor (if you configure the neighbor as static the backup must also be static) and for a mesh group.

Options

incoming-label *label*—You must configure an incoming label for the static pseudowire.

Range: 29,696 through 41,983 and 1,000,000 through 1,048,575

outgoing-label *label*—You must configure an outgoing label for the static pseudowire.

Range: 16 through 1,048,575

Required Privilege Level

routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- See Configuring Static Pseudowires for VPLS on page 39.

template

Syntax template;

Hierarchy Level [edit logical-systems *logical-system-name* protocols mpls label-switched-path *p2mp-lsp-template-name*],
[edit protocols mpls label-switched-path *p2mp-lsp-template-name*]

Release Information Statement introduced in Junos OS Release 8.3.

Description Specify a template for the dynamically generated point-to-multipoint LSPs used for VPLS flooding.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- Configuring Dynamic Point-to-Multipoint Flooding LSPs with a Preconfigured Template on page 69

traceoptions

Syntax

```
traceoptions {
    file filename <files number> <size size> <world-readable | no-world-readable>;
    flag flag <flag-modifier> <disable>;
}
```

Hierarchy Level

[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls],
[edit routing-instances *routing-instance-name* protocols vpls]

Release Information

Statement introduced before Junos OS Release 7.4.

Description

Trace traffic flowing through a VPLS routing instance.

Options

disable—(Optional) Disable the tracing operation. You can use this option to disable a single operation when you have defined a broad group of tracing operations, such as **all**.

file *filename*—Name of the file to receive the output of the tracing operation. Enclose the name in quotation marks (" ").

files *number*—(Optional) Maximum number of trace files. When a trace file named ***trace-file*** reaches this size, it is renamed ***trace-file*.0**. When ***trace-file*** again reaches its maximum size, ***trace-file*.0** is renamed ***trace-file*.1** and ***trace-file*** is renamed ***trace-file*.0**. This renaming scheme continues until the maximum number of trace files is reached. Then the oldest trace file is overwritten.

If you specify a maximum number of files, you also must specify a maximum file size with the **size** option.

Range: 2 through 1000 files

Default: 2 files

flag *flag*—Tracing operation to perform. To specify more than one tracing operation, include multiple **flag** statements. You can specify the following tracing flags:

- **all**—All VPLS tracing options
- **connections**—VPLS connections (events and state changes)
- **error**—Error conditions
- **nlri**—VPLS advertisements received or sent by means of the BGP
- **route**—Routing information
- **topology**—VPLS topology changes caused by reconfiguration or advertisements received from other provider edge (PE) routers using BGP

flag-modifier—(Optional) Modifier for the tracing flag. You can specify the following modifiers:

- **detail**—Provide detailed trace information.

- **disable**—Disable the tracing flag.
- **receive**—Trace received packets.
- **send**—Trace sent packets.

no-world-readable—Do not allow any user to read the log file.

size ***size***—(Optional) Maximum size of each trace file, in kilobytes (KB), megabytes (MB), or gigabytes (GB). When a trace file named ***trace-file*** reaches this size, it is renamed ***trace-file*****.0**. When ***trace-file*** again reaches its maximum size, ***trace-file*****.0** is renamed ***trace-file*****.1** and ***trace-file*** is renamed ***trace-file*****.0**. This renaming scheme continues until the maximum number of trace files is reached. Then the oldest trace file is overwritten.

If you specify a maximum file size, you also must specify a maximum number of trace files with the **files** option.

Syntax: ***x*****k** to specify kilobytes, ***x*****m** to specify megabytes, or ***x*****g** to specify gigabytes

Range: 10 KB through the maximum file size supported on your system

Default: 1 MB

world-readable—Allow any user to read the log file.

Required Privilege Level

routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- Tracing VPLS Traffic and Operations on page 79

tunnel-services

Syntax

```
tunnel-services {
    devices device-names;
    primary primary-device-name;
}
```

Hierarchy Level

[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vpls]
[edit routing-instances *routing-instance-name* protocols vpls]

Release Information

Statement introduced before Junos OS Release 7.4.

Description

Specify that traffic for particular VPLS routing instances be forwarded to specific virtual tunnel (VT) interfaces, allowing you to load-balance VPLS traffic among all the available VT interfaces on the router.

Options

devices *device-names*—Specify the VT interfaces acceptable for use by the VPLS routing instance. If you do not configure this option, all VT interfaces available to the router can be used for de-encapsulating traffic for this instance.

primary *primary-device-name*—Specify the primary VT interface to be used by the VPLS routing instance. The VT interface specified is used to de-encapsulate all VPLS traffic from the MPLS core network for this routing instance. If the VT interface specified is unavailable, then one of the other acceptable VT interfaces is used for handling the VPLS traffic. If you do not configure this option, any acceptable VT interface can be used to de-encapsulate VPLS traffic from the core.

Required Privilege Level

routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation

- Specifying the VT Interfaces Used by VPLS Routing Instances on page 63

vlan-id

Syntax vlan-id *number*;

Hierarchy Level [edit interfaces *interface-name* unit *logical-unit-number*],
[edit logical-systems *logical-system-name* interfaces *interface-name* unit *logical-unit-number*]

Release Information Statement introduced before Junos OS Release 7.4.

Description For Fast Ethernet and Gigabit Ethernet interfaces only, bind an 802.1Q VLAN tag ID to a logical interface.

Options *number*—A valid VLAN identifier.

Range: For 4-port Fast Ethernet PICs configured to handle VPLS traffic, 512 through 1023. For 1-port and 10-port Gigabit Ethernet PICs configured to handle VPLS traffic, 512 through 4094.

Required Privilege Level interface—To view this statement in the configuration.
interface-control—To add this statement to the configuration.

Related Documentation
- Enabling VLAN Tagging on page 44

vlan-id-list (Interface in VPLS)

Syntax vlan-id-list [*numbers number–number*];

Hierarchy Level [edit interfaces *interface-name* unit *logical-unit-number*],
[edit logical-systems *logical-system-name* interfaces *interface-name* unit *logical-unit-number*]

Release Information Statement introduced for VPLS in Junos OS Release 10.2.

Description Configure a logical interface to forward packets and learn MAC addresses within each VPLS routing instance configured with a VLAN ID that matches a VLAN ID specified in the list. VLAN IDs can be entered individually using a space to separate each ID, entered as an inclusive list separating the starting VLAN ID and ending VLAN ID with a hyphen, or a combination of both.

Options *number number*—Individual VLAN IDs separated by a space.

number-number—Starting VLAN ID and ending VLAN ID in an inclusive range.

Range: 1 through 4095

Required Privilege Level interface—To view this statement in the configuration.
interface-control—To add this statement to the configuration.

Related Documentation
- Configuring Interfaces for VPLS Routing on page 41

vlan-tagging

Syntax vlan-tagging;

Hierarchy Level [edit interfaces *interface-name*],
[edit logical-systems *logical-system-name* interfaces *interface-name*]

Release Information Statement introduced before Junos OS Release 7.4.

Description For Fast Ethernet and Gigabit Ethernet interfaces only, enable the reception and transmission of 802.1Q VLAN-tagged frames on the interface.

Required Privilege Level interface—To view this statement in the configuration.
interface-control—To add this statement to the configuration.

Related Documentation
- Enabling VLAN Tagging on page 44

vpls (Interfaces)

Syntax vpls;

Hierarchy Level [edit interfaces *interface-name* unit *logical-unit-number* family],
[edit logical-systems *logical-system-name* interfaces *interface-name* unit *logical-unit-number* family]

Release Information Statement introduced before Junos OS Release 7.4.

Description Specify the VPLS protocol family information for the logical interface.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- Configuring Interfaces for VPLS Routing on page 41

vpls (Routing Instance)

Syntax

```
vpls {
  active-interface {
    any;
    primary interface-name;
  }
  connectivity-type (ce | irb);
  interface-mac-limit limit;
  label-block-size size;
  mac-flush [ explicit-mac-flush-message-options ];
  mac-table-aging-time time;
  mac-table-size size;
  mesh-group mesh-group-name {
    l2vpn-id (as-number:id | ip-address:id);
    local-switching;
    mac-flush [ explicit-mac-flush-message-options ];
    neighbor address {...}
    peer-as all;
    pseudowire-status-tlv;
    route-distinguisher (as-number:id | ip-address:id);
    vpls-id number;
    vrf-export [ policy-names ];
  vrf-import [ policy-names ];
    vrf-target {
      community;
      import community-name;
      export community-name;
    }
  no-tunnel-services;
  site site-name {
    interface interface-name {
      interface-mac-limit limit;
    }
    multi-homing;
    site-identifier identifier;
    site-preference preference-value;
  }
  site-range number;
  traceoptions {
    file filename <files number> <size size> <world-readable | no-world-readable>;
    flag flag <flag-modifier> <disable>;
  }
  tunnel-services {
    devices device-names;
    primary primary-device-name;
  }
}
```

Hierarchy Level

[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols],
[edit routing-instances *routing-instance-name* protocols]

Release Information Statement introduced before Junos OS Release 7.4. The **mac-flush** option was added in Junos OS Release 10.0.

Description Configure a virtual private LAN service (VPLS) routing instance.

The remaining statements are explained separately.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- Configuring VPLS Routing Instances on page 28

vpls-id

Syntax vpls-id *vpls-id*;

Hierarchy Level
[edit logical-systems *logical-system-name* routing-instances *instance-name* protocols l2vpn],
[edit logical-systems *logical-system-name* routing-instances *instance-name* protocols l2vpn mesh-group *mesh-group-name*],
[edit logical-systems *logical-system-name* routing-instances *instance-name* protocols vpls],
[edit logical-systems *logical-system-name* routing-instances *instance-name* protocols vpls mesh-group *mesh-group-name*],
[edit routing-instances *instance-name* protocols l2vpn],
[edit routing-instances *instance-name* protocols l2vpn mesh-group *mesh-group-name*],
[edit routing-instances *instance-name* protocols vpls],
[edit routing-instances *instance-name* protocols vpls mesh-group *mesh-group-name*]

Release Information Statement introduced in Junos OS Release 8.4.

Description Identify the virtual circuit identifier used for the VPLS routing instance or mesh group. This statement is a part of the configuration to enable LDP signaling for VPLS.

Options ***vpls-id***—Specify a valid identifier for the VPLS routing instance.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Documentation
- Configuring LDP Signaling for VPLS on page 34

PART 4

Index

Index

Symbols

A

B

C

D

E

F

I

L

M

N

P

R

S

T

V

Y