Network Configuration Example

Interconnecting a Layer 2 Circuit with a Layer 2 VPN

Release

12.3

Published: 2012-11-14

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

Network Configuration Example Interconnecting a Layer 2 Circuit with a Layer 2 VPN
Release 12.3

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

Table of Contents

Introduction

This document describes how to configure and verify a Layer 2 circuit to Layer 2 VPN interconnection using a Layer 2 Interworking (iw0) interface.

Layer 2 Circuit Overview

A Layer 2 circuit is a point-to-point Layer 2 connection transported using Multiprotocol Label Switching (MPLS) or other tunneling technology on the service provider's network. A Layer 2 circuit is similar to a circuit cross-connect (CCC), except that multiple virtual circuits (VCs) are transported over a single shared label-switched path (LSP) tunnel between two provider edge (PE) routers. In contrast, each CCC requires a separate dedicated LSP.

To establish a Layer 2 circuit, the Link Integrity Protocol (LIP) is used as the signaling protocol to advertise the ingress label to the remote PE routers. For this purpose, a targeted remote LDP neighbor session is established using the extended discovery mechanism described in LDP, and the session is brought up to the remote PE loopback IP address. Because LDP looks at the Layer 2 circuit configuration and initiates extended neighbor discovery for all the Layer 2 circuit neighbors (the remote PEs), no new configuration is necessary in LDP. Each Layer 2 circuit is represented by the logical interface connecting the local PE router to the local customer edge (CE) router. Note that LDP must be enabled on the lo0.0 interface for extended neighbor discovery to function correctly.

Packets are sent to remote CE routers over an egress VPN label advertised by the remote PE router, using a targeted LDP session. The VPN label is sent over an LDP LSP to the remote PE router connected to the remote CE router. Return traffic from the remote CE router destined to the local CE router is sent using an ingress VPN label advertised by the local PE router, which is also sent over the LDP LSP to the local PE router from the remote PE router.

Related Documentation

- Layer 3 VPN Overview
- Layer 2 VPN Overview on page 2
- Layer 2 VPN Applications on page 2
- Applications for Interconnecting a Layer 2 Circuit with a Layer 2 Circuit
- Applications for Interconnecting a Layer 2 Circuit with a Layer 3 VPN
- Example: Interconnecting a Layer 2 Circuit with a Layer 2 Circuit
- Example: Interconnecting a Layer 2 Circuit with a Layer 3 VPN
- Example: Interconnecting a Layer 2 Circuit with a Layer 2 VPN on page 4

Layer 2 VPN Overview

As the need to link different Layer 2 services to one another for expanded service offerings grows, Layer 2 Multiprotocol Label Switching (MPLS) VPN services are increasingly in demand.

Implementing a Layer 2 VPN on a router is similar to implementing a VPN using a Layer 2 technology, such as Asynchronous Transfer Mode (ATM). However, for a Layer 2 VPN on a router, traffic is forwarded to the router in a Layer 2 format. It is carried by MPLS over the service provider's network, and then converted back to Layer 2 format at the receiving site. You can configure different Layer 2 formats at the sending and receiving sites. The security and privacy of an MPLS Layer 2 VPN are equal to those of an ATM or Frame Relay VPN. The service provisioned with Layer 2 VPNs is also known as Virtual Private Wire Service (VPWS).

On a Layer 2 VPN, routing typically occurs on the customer edge (CE) router. The CE router connected to a service provider on a Layer 2 VPN must select the appropriate circuit on which to send traffic. The provider edge (PE) router receiving the traffic sends the traffic across the service provider's network to the PE router connected to the receiving site. The PE routers do not need to store or process the customer's routes; they only need to be configured to send data to the appropriate tunnel. For a Layer 2 VPN, customers need to configure their own routers to carry all Layer 3 traffic. The service provider needs to know only how much traffic the Layer 2 VPN will need to carry. The service provider's routers carry traffic between the customer's sites using Layer 2 VPN interfaces. The VPN topology is determined by policies configured on the PE routers.

Because Layer 2 VPNs use BGP as the signaling protocol, they have a simpler design and require less overhead than traditional VPNs over Layer 2 circuits. BGP signaling also enables autodiscovery of Layer 2 VPN peers. Layer 2 VPNs are similar to BGP or MPLS VPNs and VPLS in many respects; all three types of services employ BGP for signaling.

Related Documentation

- Layer 2 VPN Applications on page 2
- Using the Layer 2 Interworking Interface to Interconnect a Layer 2 Circuit to a Layer 2 VPN on page 3
- Using the Layer 2 Interworking Interface to Interconnect a Layer 2 VPN to a Layer 2 VPN
- Interconnecting Layer 2 VPNs with Layer 3 VPNs Overview
- Example: Interconnecting a Layer 2 VPN with a Layer 2 VPN
- Example: Interconnecting a Layer 2 Circuit with a Layer 2 VPN on page 4
- Example: Interconnecting a Layer 2 VPN with a Layer 3 VPN

Layer 2 VPN Applications

Implementing a Layer 2 VPN includes the following benefits:

- Terminating a Layer 2 VPN into a Layer 2 VPN using the interworking (iw0) software interface eliminates the limitation of bandwidth on the tunnel interfaces used for these configuration scenarios. Instead of using a physical Tunnel PIC for looping the packet received from the Layer 2 VPN to another Layer 2 VPN, Junos OS is used to link both the Layer 2 VPN routes.
- Layer 2 VPNs enable the sharing of a provider's core network infrastructure between IP and Layer 2 VPN services, reducing the cost of providing those services. A Layer 2 MPLS VPN allows you to provide Layer 2 VPN service over an existing IP and MPLS backbone.
- From a service provider's point of view, a Layer 2 MPLS VPN allows the use of a single Layer 3 VPN (such as RFC 2547bis), MPLS traffic engineering, and Differentiated Services (DiffServ).
- Service providers do not have to invest in separate Layer 2 equipment to provide Layer 2 VPN service. You can configure the PE router to run any Layer 3 protocol in addition to the Layer 2 protocols. Customers who prefer to maintain control over most of the administration of their own networks might want Layer 2 VPN connections with their service provider instead of a Layer 3 VPN.

Related Documentation

- Layer 2 VPN Overview on page 2
- Using the Layer 2 Interworking Interface to Interconnect a Layer 2 Circuit to a Layer 2 VPN on page 3
- Using the Layer 2 Interworking Interface to Interconnect a Layer 2 VPN to a Layer 2 VPN
- Example: Interconnecting a Layer 2 Circuit with a Layer 2 VPN on page 4
- Example: Interconnecting a Layer 2 VPN with a Layer 2 VPN
- Example: Interconnecting a Layer 2 VPN with a Layer 3 VPN

Using the Layer 2 Interworking Interface to Interconnect a Layer 2 Circuit to a Layer 2 VPN

Instead of using a physical Tunnel PIC for looping the packet received from the Layer 2 circuit, the Layer 2 interworking interface uses Junos OS to stitch together both Layer 2 VPN routes.

To configure the interworking interface, include the **iw0** statement. The **iw0** statement is configured at the **[edit interfaces]** hierarchy level. This specifies the peering between two logical interfaces. This configuration is similar to the configuration for a logical tunnel interface. The logical Interfaces must be associated with the endpoints of a Layer 2 circuit and Layer 2 VPN connections.

```
[edit interfaces]
iw0 {
  unit 0 {
    peer-unit 1;
  }
  unit 1 {
```

```
        peer-unit 0;
    }
}
```

Configure the Layer 2 circuit protocol by including the **l2circuit** statement at the **[edit protocols]** hierarchy level and specifying the **neighbor** and **iw0** interface.

```
[edit protocols]
l2circuit {
    neighbor 1.2.3.4 {
        interface iw0.0;
    }
}
```

Configure the Layer 2 VPN connection, by including the ***routing-instance-name*** statement at the **[edit routing-instances]** hierarchy level and specifying the **instance-type l2vpn** option.

```
[edit routing-instances]
routing-instance-name {
    instance-type l2vpn;
    interface iw0.1;
    ...
    protocols {
        l2vpn {
            <l2vpn configuration>;
        }
    }
}
```

In addition to the **iw0** interface configuration, Layer 2 interworking **l2iw** protocols must be enabled. Without the **l2iw** configuration, the **l2iw** routes will not be formed, regardless of whether any **iw** interfaces are present. Within the l2iw protocols, only trace options can be configured in the standard fashion. The minimum configuration necessary for the feature to work is shown below:

```
[edit]
protocols {
    l2iw;
}
```

Related Documentation

- Layer 2 Circuit Overview on page 1
- Layer 2 VPN Overview on page 2
- Example: Interconnecting a Layer 2 Circuit with a Layer 2 VPN on page 4

Example: Interconnecting a Layer 2 Circuit with a Layer 2 VPN

This example provides a step-by-step procedure and commands for configuring and verifying a Layer 2 circuit to a Layer 2 VPN. It contains the following sections:

- Requirements on page 5
- Overview and Topology on page 5
- Configuration on page 6

Requirements

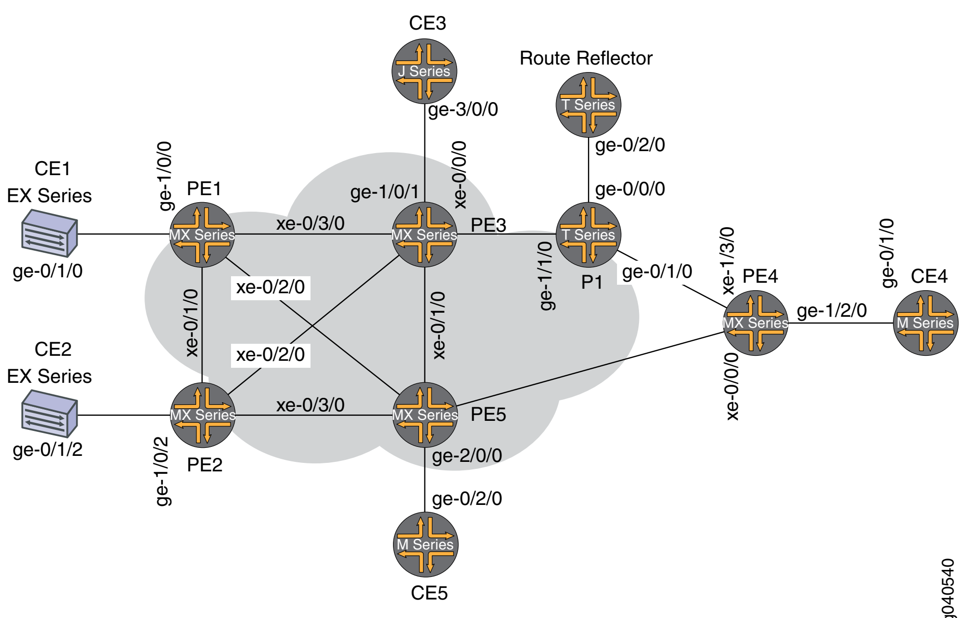
This example uses the following hardware and software components:

- Junos OS Release 9.3 or later
- 2 MX Series 3D Universal Edge Routers
- 2 M Series Multiservice Edge Router
- 1 T Series Core Router
- 1 EX Series Ethernet Switch
- 1 J Series Services Routers

Overview and Topology

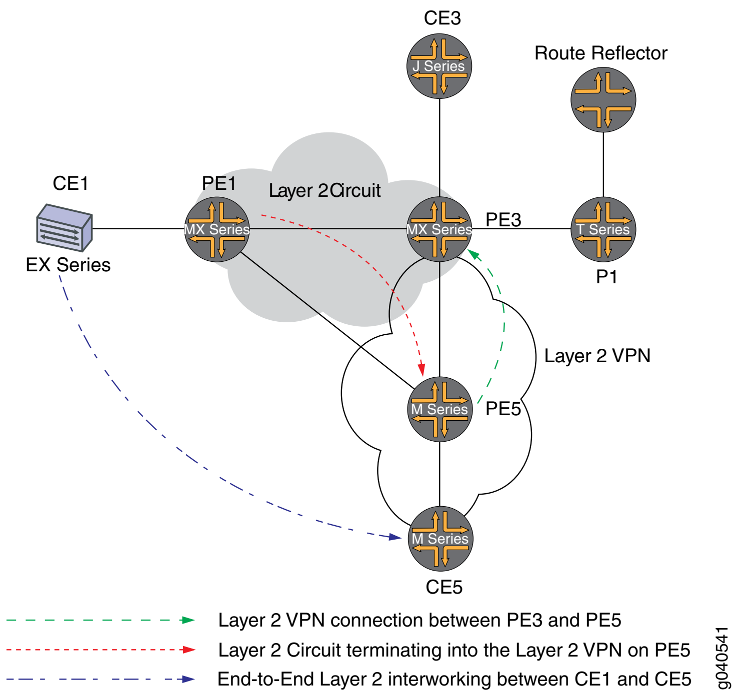
The physical topology of a Layer 2 circuit to a Layer 2 VPN connection is shown in Figure 1 on page 5.

Figure 1: Physical Topology of a Layer 2 Circuit to a Layer 2 VPN Connection



The logical topology of a Layer 2 circuit to a Layer 2 VPN connection is shown in Figure 2 on page 6.

Figure 2: Logical Topology of a Layer 2 Circuit to a Layer 2 VPN Connection



Configuration

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

In this example, the router being configured is identified using the following command prompts:

- **CE1** identifies the customer edge 1 (CE1) router
- **PE1** identifies the provider edge 1 (PE1) router
- **CE3** identifies the customer edge 3 (CE3) router
- **PE3** identifies the provider edge 3 (PE3) router
- **CE5** identifies the customer edge 5 (CE5) router
- **PE5** identifies the provider edge 5 (PE5) router

This example is organized in the following sections:

- Configuring Protocols on the PE and P Routers on page 7
- Verification on page 11

Configuring Protocols on the PE and P Routers

Step-by-Step Procedure

In this example, all of the PE routers and P routers are configured with OSPF as the IGP protocol. The MPLS, LDP, and BGP protocols are enabled on all of the interfaces except **fxp.0**. Core-facing interfaces are enabled with the MPLS address and inet address.

1. Configure all the PE and P routers with OSPF as the IGP. Enable the MPLS, LDP, and BGP protocols on all interfaces except **fxp.0**. LDP is used as the signaling protocol on Router PE1 for the Layer 2 circuit. The following configuration snippet shows the protocol configuration for Router PE1:

```
[edit]
protocols {
  mpls {
    interface all;
    interface fxp0.0 {
      disable;
    }
  }
  bgp {
    group 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;
      }
    }
  }
  ldp {
    interface all;
    interface fxp0.0 {
      disable;
    }
  }
}
```

2. Configure the PE and P routers with OSPF as the IGP. Enable the MPLS, LDP, and BGP protocols on all interfaces except **fxp.0**. BGP is used as the signaling protocol on Router PE3 for the Layer 2 VPN. The following configuration snippet shows the protocol configuration for Router PE3:

```
[edit]
protocols {
  mpls {
    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;
            }
        }
    }
```

Step-by-Step Procedure

Configuring Interfaces

1. On Router PE1, configure the **ge-1/0/0** interface encapsulation. To configure the interface encapsulation, include the **encapsulation** statement and specify the **ethernet-ccc** option (vlan-ccc encapsulation is also supported). Configure the **ge-1/0/0.0** logical interface family for circuit cross-connect functionality. To configure the logical interface family, include the **family** statement and specify the **ccc** option. The encapsulation should be configured the same way for all routers in the Layer 2 circuit domain.

```
[edit interfaces]
ge-1/0/0 {
    encapsulation ethernet-ccc;
    unit 0 {
        family ccc;
    }
}
lo0 {
    unit 0 {
        family inet {
            address 1.1.1.1/32;
        }
    }
}
```

2. Router PE5 is the router that is *stitching* the Layer 2 circuit to the Layer 2 VPN using the interworking interface. The configuration of the peer unit interfaces is what makes the interconnection.

   On Router PE5, configure the **iw0** interface with two logical interfaces. To configure the **iw0** interface, include the **interfaces** statement and specify **iw0** as the interface name. For the unit 0 logical interface, include the **peer-unit** statement and specify the logical interface **unit 1** as the peer interface. For the unit 1 logical interface, include the **peer-unit** statement and specify the logical interface **unit 0** as the peer interface.

```
[edit interfaces]
iw0 {
   unit 0 {
      encapsulation ethernet-ccc;
      peer-unit 1;
   }
   unit 1 {
      encapsulation ethernet-ccc;
      peer-unit 0;
   }
}
```

3. On Router PE5, configure the logical loopback interface. The loopback interface is used to establish the targeted LDP sessions to Routers PE1 and PE5.

```
[edit interfaces]
lo0 {
   unit 0 {
      family inet {
         address 5.5.5.5/32;
      }
   }
}
```

Step-by-Step Procedure

Configuring the Layer 2 circuit protocol

1. On Router PE1, configure the IP address of the remote PE router with the **neighbor** statement. The loopback address and router ID of the PE neighbor is commonly the neighbor's IP address. To allow a Layer 2 circuit to be established even though the maximum transmission unit (MTU) configured on the PE router does not match the MTU configured on the remote PE router, include the **ignore-mtu-mismatch** statement.

```
[edit]
protocols {
   l2circuit {
      neighbor 5.5.5.5 {
         interface ge-1/0/0.0 {
            virtual-circuit-id 100;
            no-control-word;
            ignore-mtu-mismatch;
         }
      }
   }
}
```

2. On Router PE5, configure the IP address of the remote PE router. To configure the IP address of the remote PE router, include the **neighbor** statement and specify the IP address of the loopback interface on Router PE1. Configure the virtual circuit ID to be the same as the virtual circuit ID on the neighbor router. To allow a Layer 2 circuit to be established even though the MTU configured on the local PE router does not match the MTU configured on the remote PE router, include the **ignore-mtu-mismatch** statement. Also disable the use of the control word for demultiplexing by including the **no-control-word** statement.

```
[edit protocols]
l2circuit {
  neighbor 1.1.1.1 {
    interface iw0.0 {
      virtual-circuit-id 100;
      no-control-word;
      ignore-mtu-mismatch;
    }
  }
}
```

3. On Router PE5, configure the Layer 2 VPN protocols by including the **l2vpn** statement at the **[edit routing-instances *routing-instances-name* protocols]** hierarchy level. To configure the **iw0** interface, include the **interfaces** statement and specify **iw0** as the interface name. The **iw0** interface is configured under the Layer 2 VPN protocols to receive the looped packet from the **iw0.1** logical interface. The **l2vpn** protocol is configured on Router PE5 with site CE5, which is configured in the BGP L2VPN routing instance. Router CE1 has communication to Router CE5, through the Layer 2 interworking configuration on Router PE5.

```
[edit]
routing-instances {
  L2VPN {
    instance-type l2vpn;
    interface ge-2/0/0.0;
    interface iw0.1;
    route-distinguisher 65000:5;
    vrf-target target:65000:2;
    protocols {
      l2vpn {
        encapsulation-type ethernet;
        site CE5 {
          site-identifier 5;
          interface ge-2/0/0.0 {
            remote-site-id 3;
          }
        }
        site l2-circuit {
          site-identifier 6;
          interface iw0.1 {
            remote-site-id 3;
          }
        }
      }
    }
  }
```



```
}
```

4. In addition to the **iw0** interface configuration, the Layer 2 interworking **l2iw** protocol must be configured. Without the **l2iw** protocol configuration, the Layer 2 interworking routes are not formed, regardless of whether any **iw** interfaces are present.

   On Router PE5, configure the **l2iw** protocol. To configure the protocol, include the **l2iw** statement at the **[edit protocols]** hierarchy level.

```
[edit]
protocols {
  l2iw;
}
```

Verification

Step-by-Step Procedure

Verifying the Layer 2 Circuit Connection on Router PE1.

1. On Router PE1, use the **show l2circuit connections** command to verify that the Layer 2 Circuit from Router PE1 to Router PE5 is **Up**.

```
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: 5.5.5.5
    Interface                 Type  St     Time last up    # Up trans
    ge-1/0/0.0(vc 100)        rmt   Up     Jan  3 22:00:49 2010    1
      Remote PE: 5.5.5.5, Negotiated control-word: No
      Incoming label: 301328, Outgoing label: 300192
      Local interface: ge-1/0/0.0, Status: Up, Encapsulation: ETHERNET
```

2. On Router PE5, use the **show l2vpn connections** command to verify that the Layer 2 VPN connection is **Up** using the **iw0** peer interface of the Layer 2 circuit.

```
user@PE5> show l2vpn connections
Instance: L2VPN
  Local site: CE5 (5)
    connection-site           Type  St     Time last up     # Up trans
    l2-circuit (6)            loc   OR
    3                         rmt   Up
     Jan  3 22:51:12 2010          1
      Remote PE: 3.3.3.3, Negotiated control-word: Yes (Null)
      Incoming label: 800258, Outgoing label: 800000
      Local interface: ge-2/0/0.0, Status: Up, Encapsulation: ETHERNET
  Local site: l2-circuit (6)
    connection-site           Type  St     Time last up    # Up trans
```

```
CE5 (5)                  loc   OR
3                        rmt   Up     Jan  3 22:56:38 2010    1
  Remote PE: 3.3.3.3, Negotiated control-word: Yes (Null)
  Incoming label: 800262, Outgoing label: 800001
  Local interface: iw0.1, Status: Up, Encapsulation: ETHERNET
```

Step-by-Step Procedure

Verifying that the Layer 2 Circuit is terminating into the Layer 2 VPN connection.

1. On Router PE5, use the **show l2circuit connections** command to verify that the Layer 2 circuit is **Up** using the **iw0** interface. This will be looped through the **iwo.1** interface to the Layer 2 VPN.

   ```
   user@PE5> show l2circuit connections

   Layer-2 Circuit Connections:
   Neighbor: 1.1.1.1
       Interface           Type  St     Time last up  # Up trans
       iw0.0(vc 100)  rmt   Up Jan  3 21:59:07 2010   1
         Remote PE: 1.1.1.1, Negotiated control-word: No
         Incoming label: 300192, Outgoing label: 301328
   ```

2. On Router PE 5, use the **show route table mpls.0** command to verify the Layer 2 circuit and Layer 2 VPN routes. In the example below, the Layer 2 circuit is associated with LDP label **301328** and the Layer 2 VPN is associated with LDP label **800001**. Notice the two **iw0** interfaces that are used for the Layer 2 interworking route.

   ```
   user@PE5>show route table mpls.0

   mpls.0: 18 destinations, 20 routes (18 active, 2 holddown, 0 hidden)
   + = Active Route, - = Last Active, * = Both

   0                  *[MPLS/0] 5d 20:07:31, metric 1
                         Receive
   1                  *[MPLS/0] 5d 20:07:31, metric 1
                         Receive
   2                  *[MPLS/0] 5d 20:07:31, metric 1
                         Receive
   299776             *[LDP/9] 2d 03:00:51, metric 1
   300048             *[LDP/9] 2d 03:00:49, metric 1
                       > to 10.10.6.1 via xe-0/1/0.0, Pop
   300048(S=0)        *[LDP/9] 2d 03:00:49, metric 1
                       > to 10.10.6.1 via xe-0/1/0.0, Pop
   300192             *[L2IW/6] 19:11:05, metric2 1
                       > to 10.10.6.1 via xe-0/1/0.0, Swap 800001
                       [L2CKT/7] 20:08:36
                       > via iw0.0, Pop
   800258             *[L2VPN/7] 19:16:31
                       > via ge-2/0/0.0, Pop      Offset: 4
   800262         *[L2IW/6] 19:11:05, metric2 1
           > to 10.10.3.1 via xe-1/1/0.0, Swap 301328
           [L2VPN/7] 19:11:05
           > via iw0.1, Pop     Offset: 4
   ge-2/0/0.0         *[L2VPN/7] 19:16:31, metric2 1
                       > to 10.10.6.1 via xe-0/1/0.0, Push 800000 Offset: -4
   iw0.0              *[L2CKT/7] 20:08:36, metric2 1
                       > to 10.10.3.1 via xe-1/1/0.0, Push 301328
   iw0.1              *[L2VPN/7] 19:11:05, metric2 1
                       > to 10.10.6.1 via xe-0/1/0.0, Push 800001 Offset: -4
   ```


Related Documentation

- Layer 2 Circuit Overview on page 1
- Layer 2 VPN Overview on page 2
- Layer 2 VPN Applications on page 2
- Using the Layer 2 Interworking Interface to Interconnect a Layer 2 Circuit to a Layer 2 VPN on page 3