



MPLS Point-to-Multipoint Traffic Engineering Support for Static Pseudowires

Table 1: Feature History

Feature Name	Release	Description
Static PW over P2MP	Cisco IOS XE Amsterdam 17.3.1	<p>The Static Pseudowires over Point-to-Multipoint Traffic Engineering (P2MP TE) feature emulates the essential attributes of a unidirectional P2MP service. It can be used to transport layer 2 multicast services from a single source to one or more destinations.</p> <p>This feature is supported on the Cisco RSP2 module.</p> <p>This feature is supported on the Cisco RSP3 module.</p>

The MPLS Point-to-Multipoint Traffic Engineering: Support for Static Pseudowires feature allows you to configure a point-to-multipoint pseudowire (PW) to transport Layer 2 traffic from a single source to one or more destinations. This feature provides traffic segmentation for Multiprotocol Label Switching (MPLS) Point-to-Multipoint Traffic Engineering (P2MP TE) tunnels.

The MPLS Point-to-Multipoint Traffic Engineering: Support for Static Pseudowires feature uses Layer 2 Virtual Private Network (L2VPN) static PWs to provide point-to-multipoint Layer 2 connectivity over an MPLS network to transport Layer 2 traffic. The static PW does not need Label Distribution Protocol (LDP).

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Prerequisites for MPLS Point-to-Multipoint Traffic Engineering Support for Static Pseudowires

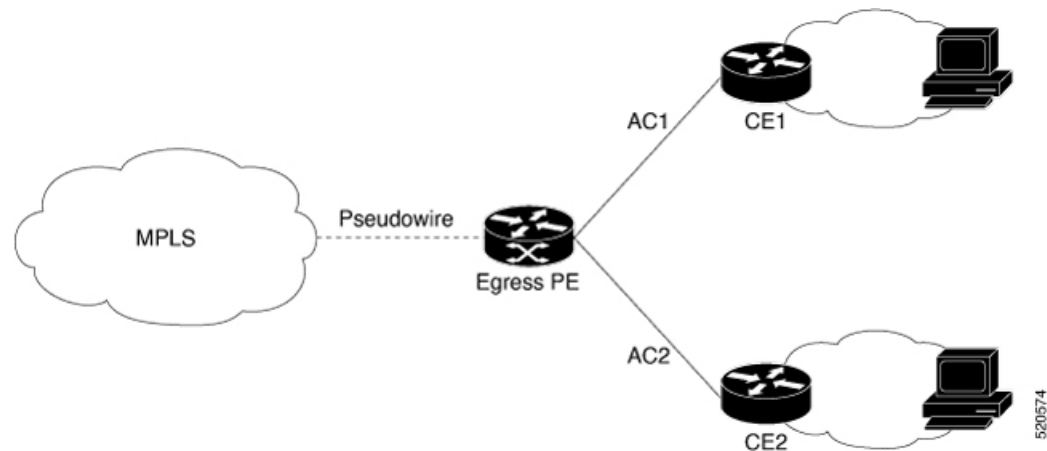
Before configuring the MPLS Point-to-Multipoint Traffic Engineering: Support for Static Pseudowires feature, ensure that the following prerequisite is met:

- If a Cisco RSP3 module acts as a P2MP TE midpoint, it should be running the Cisco IOS XE Release 17.3.1 or later releases.

Restrictions for MPLS Point-to-Multipoint Traffic Engineering Support for Static Pseudowires

- Only EVC-based Ethernet over MPLS is supported. TDM MPLS is **not** supported.
- Multiple Xconnects cannot be configured with same P2MP Tunnel as it leads to traffic drop for one of the Connects.
- If the preferred-paths under pseudowire-class of the Xconnects are swapped, Xconnect interface should be flapped to resume traffic.
- P2MP Tunnel cannot be used to forward Static PW traffic and Global IPv4 multicast traffic (MVPN profile 8) simultaneously.
- Static PW over P2MP is standardized as unidirectional. But the current configuration model does not block packet forwarding from the receiver to the source.
- Local bindings must be unique. Otherwise traffic will accidentally merge.
- Replication of egress is not supported. Only a single CE connects to a PE which is part of the Tunnel destination list of one P2MP Pseudowire.
- Effective Cisco IOS XE 17.3.1, the Static PW over Point-to-Multipoint tunnel can be scaled up to 400 tunnels and 400 Static PWs.

Figure 1: Egress Packet Replication



Note You must use the **no show ip rsvp** command to check tunnel bandwidth. If the total tunnel bandwidth exceeds beyond 750 MB (megabits per second), then the sub-LSPs go down when toggling the **traffic-eng** command with a maximum tunnel bandwidth of 749.9 MB.

For example, there are 82 P2MP tunnels and you configure 9146 kbps for each tunnel. Then the total bandwidth allocated is $(9146 \text{ kbps} * 82 \text{ tunnels}) = 749.9 \text{ MB}$.

Information About MPLS Point-to-Multipoint Traffic Engineering Support for Static Pseudowires

Overview of MPLS Point-to-Multipoint Traffic Engineering Support for Static Pseudowires

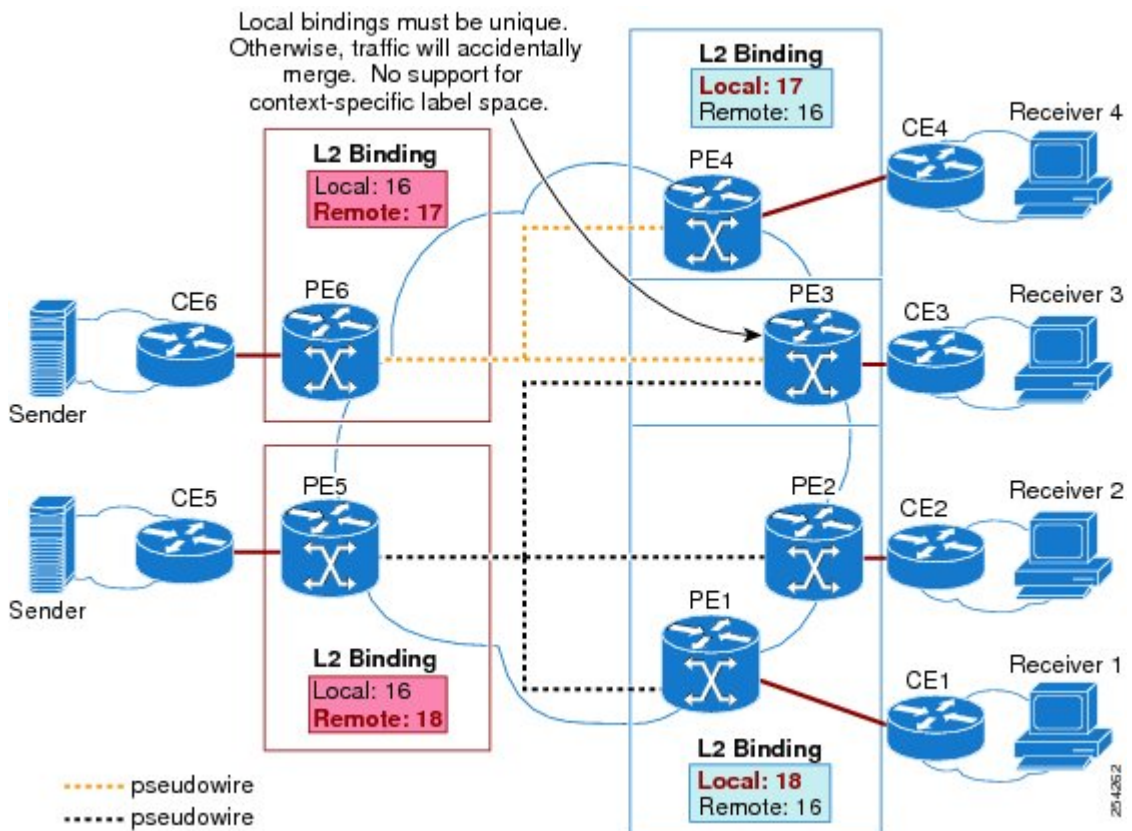
The MPLS Point-to-Multipoint Traffic Engineering: Support for Static Pseudowires feature transports Layer 2 traffic from a single source to one or more destinations. This feature has the following characteristics:

- It uses L2VPN static PWs to provide point-to-multipoint Layer 2 connectivity over an MPLS network to transport Layer 2 traffic.
- The segmentation for MPLS P2MP TE tunnels provided by this feature allows for applications such as video distribution and clock distribution (mobile backhaul).
- This feature is compatible with Cisco nonstop forwarding (NSF), stateful switchover (SSO). See NSF/SSO—MPLS TE and RSVP Graceful Restart and MPLS Point-to-Multipoint Traffic Engineering for information on configuring NSF/SSO with this feature.
- In this implementation, the PW is bidirectional, in accordance with the [Framework and Requirements for Virtual Private Multicast Service](#).

VC Label Collisions

This feature does not support context-specific label spaces. When configuring the MPLS Point-to-Multipoint Traffic Engineering: Support for Static Pseudowires feature, ensure that local bindings are unique. Otherwise, traffic unintentionally merges. In the figure below, both PWs share router PE 3 as an endpoint. The local label on each PW is 16, which causes a collision.

Figure 2: Avoiding VC Label Collisions



Label Spoofing

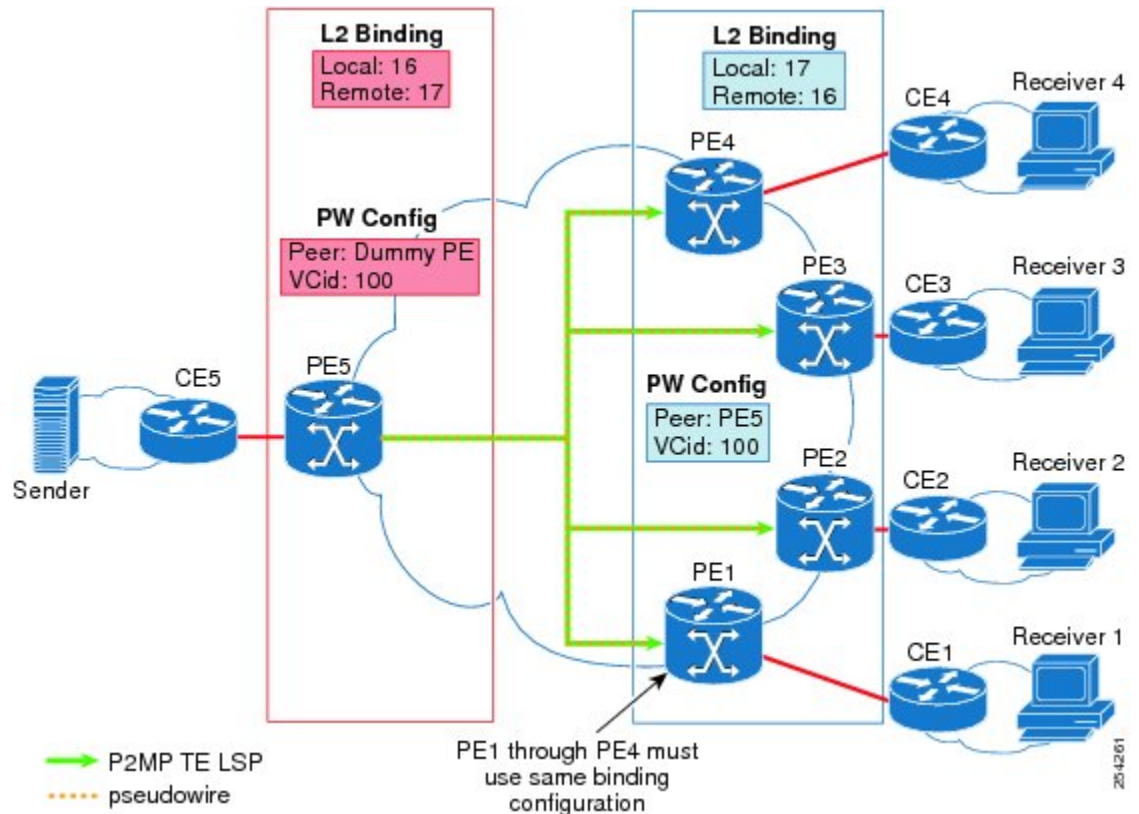
For P2MP static PWs, there is no signaling protocol to verify that the labels are configured correctly on either end. If the labels are not configured correctly, traffic might go to the wrong destinations. Because the traffic going into wrong destinations is a multicast conputation, scalability might be impacted.

The P2MP static PW does not have a context-specific label in the upstream direction and does not use a signaling protocol. Therefore, it is possible to spoof a PW label and route the traffic to the wrong destination. If a PW label is spoofed at the headend, it cannot be validated at the tailend, because the MPLS lookup at the tailend is performed on the global table. So if a spoofed label exists in the global table, traffic is routed to the wrong destination: customer equipment (CE).

The same situation can happen if the user incorrectly configures the static PW label. If the wrong PW label is configured, traffic goes to the wrong destination (CE).

The figure below shows PW label allocation with no context-specific label space.

Figure 3: PW Label Allocation with No Context-Specific Label Space



How to Configure MPLS Point-to-Multipoint Traffic Engineering Support for Static Pseudowires

Configuring the MPLS Label Range

You must specify a static range of MPLS labels using the **mpls label range** command with the **static** keyword.

Procedure

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.

	Command or Action	Purpose
Step 3	<pre>mpls label range <i>minimum-value</i> <i>maximum-value</i> { static <i>minimum-static-value</i> <i>maximum-static-value</i> }</pre> <p>Example:</p> <pre>Router(config)# mpls label range 1001 1003 static 10000 25000</pre>	Specifies a static range of MPLS labels

Configuring the Headend Routers

Perform this task to configure the headend routers:

- MPLS Static Label range must be configured to configure the Static PW Label under Xconnect.
- Under the Pseudowire class, the P2MPTE tunnel interface should be specified as the preferred path.
- 172.10.255.255 is a fake peer IP address. It is very important that this IP address be reserved by the network domain administrator so that it is not used by any other routers in the network.
- Instead of a fake peer IP address, if peer IP address is used that is present in the routing table, then the traffic will flow through the LSP path (formed by the LDP) towards the peer. This happens only if the fallback option under pseudowire class is not disabled (default) and the preferred path is down.

Procedure

	Command or Action	Purpose
Step 1	<pre>enable</pre> <p>Example:</p> <pre>Router> enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	<pre>configure terminal</pre> <p>Example:</p> <pre>Router# configure terminal</pre>	Enters global configuration mode.
Step 3	<pre>pseudowire-class <i>class-name</i></pre> <p>Example:</p> <pre>Router(config)# pseudowire-class static-pw</pre>	Specifies a static AToM PW class and enters PW class configuration mode.
Step 4	<pre>encapsulation mpls</pre> <p>Example:</p> <pre>Router(config-pw)# encapsulation mpls</pre>	Specifies MPLS as the data encapsulation method for tunneling Layer 2 traffic over the PW.
Step 5	<pre>protocol none</pre> <p>Example:</p>	Specifies that no signaling will be used in L2TPv3 sessions created from the static PW.

	Command or Action	Purpose
	<pre>Router(config-pw)# protocol none</pre>	
Step 6	<p>preferred-path [interface tunnel tunnel-number][disable-fallback] Example:</p> <pre>Router(config-pw)# preferred-path interface tunnel 1 disable-fallback</pre>	Specifies the P2MP tunnel as the traffic path and disables the router from using the default path when the preferred path is unreachable.
Step 7	<p>exit Example:</p> <pre>Router(config-pw)# exit</pre>	Exits PW class configuration mode and returns to global configuration mode.
Step 8	<p>interface tunnel number Example:</p> <pre>Router(config)# interface tunnel 1</pre>	Configures a tunnel and enters interface configuration mode.
Step 9	<p>ip unnumbered loopback number Example:</p> <pre>Router(config-if)# ip unnumbered loopback 0</pre>	<p>Enables IP processing on a loopback interface without assigning an explicit IP address to the interface.</p> <ul style="list-style-type: none"> • Specifying loopback 0 gives the tunnel interface an IP address that is the same as that of loopback interface 0. • This command is not effective until loopback interface 0 has been configured with an IP address.
Step 10	<p>tunnel mode mpls traffic-eng point-to-multipoint Example:</p> <pre>Router(config-if)# tunnel mode mpls traffic-eng point-to-multipoint</pre>	Enables MPLS P2MP TE on the tunnel.
Step 11	<p>tunnel destination list mpls traffic-eng {identifier dest-list-id named dest-list-name} Example:</p> <pre>Router(config-if)# tunnel destination list mpls traffic-eng name in-list-01</pre>	Specifies a destination list to specify the IP addresses of point-to-multipoint destinations.
Step 12	<p>exit Example:</p> <pre>Router(config-if)# exit</pre>	Exits interface configuration mode and returns to global configuration mode.

	Command or Action	Purpose
Step 13	interface loopback <i>number</i> Example: Router(config)# interface loopback 0	Configures a loopback interface and enters interface configuration mode.
Step 14	ip address [<i>ip-addressmask</i> [secondary]] Example: Router(config-if)# ip address 172.16.255.5 255.255.255.255	Specifies a primary IP address for the loopback interface.
Step 15	exit Example: Router(config-if)# exit	Exits interface configuration mode and returns to global configuration mode.
Step 16	interface ethernet <i>number</i> Example: Router(config)# interface ethernet 0/0/0	Configures an Ethernet interface and enters interface configuration mode.
Step 17	no ip address [<i>ip-addressmask</i> [secondary]] Example: Router(config-if)# no ip address service instance 100 ethernet	Disables IP processing on the interface.
Step 18	no keepalive [<i>period</i> [<i>retries</i>]] Example: Router(config-if)# no keepalive	Disables the keepalive packets on the interface. <ul style="list-style-type: none"> When the interface goes down, the session continues without shutting down because the keepalive packets are disabled.
Step 19	xconnect <i>peer-ip-address vcid</i> encapsulation mpls manual pw-class <i>class-name</i> Example: Router(config-if)# xconnect 172.16.255.255 100 encapsulation mpls manual pw-class static-pw	Configures a static AToM PW and enters xconnect configuration mode where the static PW labels are set.
Step 20	mpls label <i>local-pseudowire-label</i> <i>remote-pseudowire-label</i> Example:	Configures the AToM static PW connection by defining local and remote circuit labels. <ul style="list-style-type: none"> The label must be an unused static label within the static label range configured using the mplslabrange command.

	Command or Action	Purpose
	<pre>Router(config-if-xconn)# mpls label 16 17</pre>	<ul style="list-style-type: none"> The mplslabel command checks the validity of the label entered and displays an error message if it is not valid. The value supplied for the <i>remote-pseudowire-label</i> argument must be the value of the peer PE's local PW label.
Step 21	<p>mpls control-word</p> <p>Example:</p> <pre>Router(config-if-xconn)# mpls control-word</pre>	<p>Checks whether the MPLS control word is sent.</p> <ul style="list-style-type: none"> This command must be set for Frame Relay data-link connection identifier (DLCI) and ATM adaptation layer 5 (AAL5) attachment circuits. For other attachment circuits, the control word is included by default. If you enable the inclusion of the control word, it must be enabled on both ends of the connection for the circuit to work properly. Inclusion of the control word can be explicitly disabled using the nomplscontrol-word command.
Step 22	<p>end</p> <p>Example:</p> <pre>Router(config-if-xconn)# end</pre>	Exits xconnect configuration mode.

Configuring the MPLS Label Range

You must specify a static range of MPLS labels using the **mpls label range** command with the **static** keyword.

Procedure

	Command or Action	Purpose
Step 1	<p>enable</p> <p>Example:</p> <pre>Router> enable</pre>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> Enter your password if prompted.
Step 2	<p>configure terminal</p> <p>Example:</p> <pre>Router# configure terminal</pre>	Enters global configuration mode.

	Command or Action	Purpose
Step 3	<pre>mpls label range <i>minimum-value</i> <i>maximum-value</i> { static <i>minimum-static-value</i> <i>maximum-static-value</i> }</pre> <p>Example:</p> <pre>Router(config)# mpls label range 1001 1003 static 10000 25000</pre>	Specifies a static range of MPLS labels

Configuring the Tailend Routers

Perform this task to configure the tailend routers:

- MPLS Static Label range should be configured to configure Static PW label under Xconnect.
- The loopback address of the headend router (source of the tree) should be configured under the Xconnect of all tailend routers. The loopback address of the headend router in this example is 10.0.0.1
- All tailend routers should be configured with same remote Virtual Circuit (VC) label of 200, the local VC label of the headend router.

Procedure

Step 1

enable

Example:

```
Router> enable
```

Enables privileged EXEC mode.

- Enter your password if prompted.

Step 2

configure terminal

Example:

```
Router# configure terminal
```

Enters global configuration mode.

Step 3

pseudowire-class *class-name*

Example:

```
Router(config)# pseudowire-class static-pw
```

Specifies a static AToM PW class and enters PW class configuration mode.

Step 4

encapsulation mpls

Example:

```
Router(config-pw)# encapsulation mpls
```

Specifies MPLS as the data encapsulation method for tunneling Layer 2 traffic over the PW.

Step 5 **protocol none**

Example:

```
Router(config-pw) # protocol none
```

Specifies that no signaling will be used in L2TPv3 sessions created from the static PW.

Step 6 **exit**

Example:

```
Router(config-pw) # exit
```

ExitsPW class configuration mode and returns to global configuration mode.

Step 7 **interface loopback *number***

Example:

```
Router(config) # interface loopback 0
```

Configures a loopback interface and enters interface configuration mode.

Step 8 **ip address [*ip-addressmask* [**secondary**]]**

Example:

```
Router(config-if) # ip address 172.16.255.1 255.255.255.255
```

Specifies a primary IP address for the loopback interface.

Step 9 **exit**

Example:

```
Router(config-if) # exit
```

Exits interface configuration mode and returns to global configuration mode.

Step 10 **interface ethernet *number***

Example:

```
Router(config) # interface ethernet 0/0
```

Configures an Ethernet interface and enters interface configuration mode.

Step 11 **no ip address [*ip-addressmask* [**secondary**]]**

Example:

```
Router(config-if) # no ip address
```

Disables IP processing on the interface.

Step 12 **no keepalive [*period* [*retries*]]**

Example:

```
Router(config-if)# no keepalive
```

Disables the keepalive packets on the interface.

- When the interface goes down, the session continues without shutting down because the keepalive packets are disabled.

Step 13 **xconnect** *peer-ip-address vcid encapsulation mpls manual pw-class class-name*

Example:

```
Router(config-if)# xconnect 172.16.255.5 100 encapsulation mpls manual pw-class static-pw
```

Configures a static AToM PW and enters xconnect configuration mode where the static PW labels are set.

Step 14 **mpls label** *local-pseudowire-label remote-pseudowire-label*

Example:

```
Router(config-if-xconn)# mpls label 17 16
```

Configures the AToM static PW connection by defining local and remote circuit labels.

- The label must be an unused static label within the static label range configured using the **mplslabrange** command.
- The **mplslabel** command checks the validity of the label entered and displays an error message if it is not valid. The value supplied for the *remote-pseudowire-label* argument must be the value of the peer PE's local PW label.

Step 15 **mpls control-word**

Example:

```
Router(config-if-xconn)# mpls control-word
```

Checks whether the MPLS control word is sent.

- This command must be set for Frame Relay data-link connection identifier (DLCI) and ATM adaptation layer 5 (AAL5) attachment circuits. For other attachment circuits, the control word is included by default.
- If you enable inclusion of the control word, it must be enabled on both ends of the connection for the circuit to work properly.
- Inclusion of the control word can be explicitly disabled using the **nomplscontrol-word** command.

Step 16 **end**

Example:

```
Router(config-if-xconn)# end
```

Exits xconnect configuration mode.

Verifying the Static PW Configuration

To verify the L2VPN static PW configuration, use the **showrunning-config EXEC** command. To verify that the L2VPN static PW was provisioned correctly, use the **showmplsl2transportvcdetail** and **pingmplspseudowireEXEC** commands as described in the following steps.

Procedure

show mpls l2transport vc detail

For nonstatic PW configurations, this command lists the type of protocol used to send the MPLS labels (such as LDP). For static PW configuration, the value of the signaling protocol field should be Manual.

The following is sample output from the **showmplsl2transportvcdetail** command:

Example:

```
PE21_RSP2#sh mpls l2transport vc 3750 detail
Local interface: Gi0/2/5 up, line protocol up, Eth VLAN 3750 up
  Destination address: 172.10.255.255, VC ID: 3750, VC status: up
  Output interface: Tu3750, imposed label stack {}
  Preferred path: Tunnel3750, active
  Default path: ready
  No adjacency
  Create time: 3d20h, last status change time: 3d20h
  Last label FSM state change time: 3d20h
  Signaling protocol: Manual
  Status TLV support (local/remote)   : disabled/N/A
  LDP route watch                     : enabled
  Label/status state machine          : established, LruRru
  Last local dataplane status rcvd: No fault
  Last BFD dataplane status rcvd: Not sent
  Last BFD peer monitor status rcvd: No fault
  Last local AC circuit status rcvd: No fault
  Last local AC circuit status sent: No fault
  Last local PW i/f circ status rcvd: No fault
  Last local LDP TLV status sent: No status
  Last remote LDP TLV status rcvd: Not sent
  Last remote LDP ADJ status rcvd: No fault
  MPLS VC labels: local 10750, remote 11750
  Group ID: local 21, remote 21
  MTU: local 1500, remote 1500
  Sequencing: receive disabled, send disabled
  Control Word: On (configured: autosense)
  SSO Descriptor: 172.10.255.255/3750, local label: 10750
  Dataplane:
    SSM segment/switch IDs: 1008461/4594 (used), PWID: 112
  VC statistics:
    transit packet totals: receive 0, send 105053403
    transit byte totals:   receive 0, send 53787342336
    transit packet drops: receive 0, seq error 0, send 0
```

Configuration Examples for MPLS Point-to-Multipoint Traffic Engineering Support for Static Pseudowires

Example Configuring the Headend Router (PE5)

In the following sample configuration of the headend router, note the following:

- The **preferred-pathinterface** **tunnel1** command specifies the P2MP tunnel as the preferred path.
- The **tunnelmode** **mplstraffic-engpoint-to-multipoint** command enables the P2MP tunnel.
- The **mplslabel** command defines the static binding.
- The **xconnect** command creates a dummy peer.

```
Router(config)# pseudowire-class STATIC-PW
Router(config-pw-class)# encapsulation mpls
Router(config-pw-class)# protocol none
Router(config-pw-class)# preferred-path interface Tunnel1

!
Router(config)# interface Tunnel1
Router(config-if)# description PE5->PE1,PE2,PE3,PE4-EXCIT
Router(config-if)# ip unnumbered loopback 0
Router(config-if)# tunnel mode mpls traffic-eng point-to-multipoint
Router(config-if)# tunnel destination list mpls traffic-eng name P2MP-EXCIT-DST-LIST
Router(config-if)# tunnel mpls traffic-eng priority 7 7
Router(config-if)# tunnel mpls traffic-eng bandwidth 10000
!
Router(config)# interface loopback 0
Router(config-if)# ip address 172.16.255.5 255.255.255.255
!
Router(config)# interface ethernet 0/0
Router(config-if)# description CONNECTS to CE5
Router(config-if)# no ip address
Router(config-if)# no keepalive
Router(config-if)# xconnect 172.16.255.255 100 encapsulation mpls manual pw-class static-pw
Router(config-if-xconn)# mpls label 16 17
Router(config-if-xconn)# mpls control-word
!
```

Example Configuring the Tailend Router (PE1)

In the following sample configuration of the tailend router, note the following:

- All the tailend routers must use the same binding configuration.
- The **xconnect** command must always be configured on tailend routers.

```
Router(config)# pseudowire-class static-pw
Router(config-pw-class)# encapsulation mpls
Router(config-pw-class)# protocol none
!
Router(config)# interface loopback 0
Router(config-if)# ip address 172.16.255.1 255.255.255.255
!
```

```
Router(config)# interface ethernet 0/0
Router(config-if)# description CONNECTS TO CE1
Router(config-if)# no ip address
Router(config-if)# no keepalive
Router(config-if)# xconnect 172.16.255.5 100 encapsulation mpls manual pw-class static-pw
Router(config-if-xconn)# mpls label 17 16
Router(config-if-xconn)# mpls control-word
!
```

