OcNOS®

Open Compute
Network Operating System
for Routed Optical Networking
Version 6.4.2

Multi-Protocol Label Switching Guide

May 2024

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Preface

This guide describes how to configure MPLS for OcNOS.

IP Maestro Support

Monitor devices running OcNOS Release 6.3.4-70 and above using IP Maestro software.

Audience

This guide is intended for network administrators and other engineering professionals who configure MPLS for OcNOS.

Conventions

Table 1 shows the conventions used in this guide.

Table 1: Conventions

Convention	Description
Italics	Emphasized terms; titles of books
Note:	Special instructions, suggestions, or warnings
`monospaced type`	Code elements such as commands, parameters, files, and directories

Chapter Organization

The chapters in command references are organized as described in Command Description Format.

The chapters in configuration guides are organized into these major sections:

- An overview that explains a configuration in words
- Topology with a diagram that shows the devices and connections used in the configuration
- Configuration steps in a table for each device where the left-hand side shows the commands you enter and the right-hand side explains the actions that the commands perform
- Validation which shows commands and their output that verify the configuration

Related Documentation

For information about installing OcNOS, see the *Installation Guide* for your platform.

Feature Availability

The features described in this document are available depending upon the OcNOS SKU that you purchased. See the *Feature Matrix* for a description of the OcNOS SKUs.

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Command Line Interface

This chapter introduces the OcNOS Command Line Interface (CLI) and how to use its features.

Overview

You use the CLI to configure, monitor, and maintain OcNOS devices. The CLI is text-based and each command is usually associated with a specific task.

You can give the commands described in this manual locally from the console of a device running OcNOS or remotely from a terminal emulator such as `putty` or `xterm`. You can also use the commands in scripts to automate configuration tasks.

Command Line Interface Help

You access the CLI help by entering a full or partial command string and a question mark “?”. The CLI displays the command keywords or parameters along with a short description. For example, at the CLI command prompt, type:

```
> show ?
```

The CLI displays this keyword list with short descriptions for each keyword:

```
show ?
  application-priority            Application Priority
  arp                             Internet Protocol (IP)
  bfd                             Bidirectional Forwarding Detection (BFD)
  bgp                             Border Gateway Protocol (BGP)
  bi-lsp                          Bi-directional lsp status and configuration
  bridge                          Bridge group commands
  ce-vlan                         COS Preservation for Customer Edge VLAN
  class-map                       Class map entry
  cli                             Show CLI tree of current mode
  clns                            Connectionless-Mode Network Service (CLNS)
  control-adjacency               Control Adjacency status and configuration
  control-channel                 Control Channel status and configuration
  cspf                            CSPF Information
  customer                        Display Customer spanning-tree
  cvlan                           Display CVLAN information
  debugging                       Debugging functions (see also 'undebug')
  etherchannel                    LACP etherchannel
  ethernet                        Layer-2
...
```

If you type the ? in the middle of a keyword, the CLI displays help for that keyword only.

```
> show de?
debugging  Debugging functions (see also 'undebug')
```

If you type the ? in the middle of a keyword, but the incomplete keyword matches several other keywords, OcNOS displays help for all matching keywords.

```
> show i? (CLI does not display the question mark).
interface  Interface status and configuration
ip         IP information
isis       ISIS information
```


Command Completion

The CLI can complete the spelling of a command or a parameter. Begin typing the command or parameter and then press the tab key. For example, at the CLI command prompt type `sh`:

```
> sh
```

Press the tab key. The CLI displays:

```
> show
```

If the spelling of a command or parameter is ambiguous, the CLI displays the choices that match the abbreviation. Type `show i` and press the tab key. The CLI displays:

```
> show i
  interface  ip         ipv6       isis
> show i
```

The CLI displays the `interface` and `ip` keywords. Type `n` to select `interface` and press the tab key. The CLI displays:

```
> show in
> show interface
```

Type ? and the CLI displays the list of parameters for the `show interface` command.

```
> show interface
  IFNAME  Interface name
  |       Output modifiers
  >       Output redirection
  <cr>
```

The CLI displays the only parameter associated with this command, the `IFNAME` parameter.

Command Abbreviations

The CLI accepts abbreviations that uniquely identify a keyword in commands. For example:

```
> sh int xe0
```

is an abbreviation for:

```
> show interface xe0
```

Command Line Errors

Any unknown spelling causes the CLI to display the error `Unrecognized command` in response to the ?. The CLI displays the command again as last entered.

```
> show dd?
% Unrecognized command
> show dd
```

When you press the Enter key after typing an invalid command, the CLI displays:

```
(config)#router ospf here
                         ^
% Invalid input detected at '^' marker.
```

where the ^ points to the first character in error in the command.

If a command is incomplete, the CLI displays the following message:

```
> show
% Incomplete command.
```

Some commands are too long for the display line and can wrap mid-parameter or mid-keyword, as shown below. This does *not* cause an error and the command performs as expected:

```
area 10.10.0.18 virtual-link 10.10.0.19 authent
ication-key 57393
```

Command Negation

Many commands have a `no` form that resets a feature to its default value or disables the feature. For example:

- The `ip address` command assigns an IPv4 address to an interface
- The `no ip address` command removes an IPv4 address from an interface

Syntax Conventions

Table 1 describes the conventions used to represent command syntax in this reference.

Table 1: Syntax conventions

<table>
<tr><th>Convention</th><th>Description</th><th>Example</th></tr>
<tr><td><code>monospaced font</code></td><td>Command strings entered on a command line</td><td><code>show ip ospf</code></td></tr>
<tr><td><code>lowercase</code></td><td>Keywords that you enter exactly as shown in the command syntax.</td><td><code>show ip ospf</code></td></tr>
<tr><td><code>UPPERCASE</code></td><td>See Variable Placeholders</td><td><code>IFNAME</code></td></tr>
<tr><td><code>()</code></td><td>Optional parameters, from which you must select one. Vertical bars delimit the selections. Do not enter the parentheses or vertical bars as part of the command.</td><td><code>(A.B.C.D|<0-4294967295>)</code></td></tr>
<tr><td><code>()</code></td><td>Optional parameters, from which you select one or none. Vertical bars delimit the selections. Do not enter the parentheses or vertical bars as part of the command.</td><td><code>(A.B.C.D|<0-4294967295>|)</code></td></tr>
<tr><td><code>()</code></td><td>Optional parameter which you can specify or omit. Do not enter the parentheses or vertical bar as part of the command.</td><td><code>(IFNAME|)</code></td></tr>
<tr><td><code>{}</code></td><td>Optional parameters, from which you must select one or more. Vertical bars delimit the selections. Do not enter the braces or vertical bars as part of the command.</td><td><code>{intra-area <1-255>|inter-area <1-255>|external <1-255>}</code></td></tr>
</table>

Table 1: Syntax conventions (Continued)

Convention	Description	Example
`[]`	Optional parameters, from which you select zero or more. Vertical bars delimit the selections. Do not enter the brackets or vertical bars as part of the command.	`[<1-65535>|AA:NN|internet|local-AS|no-advertise|no-export]`
`?`	Nonrepeatable parameter. The parameter that follows a question mark can only appear once in a command string. Do not enter the question mark as part of the command.	`?route-map WORD`
`.`	Repeatable parameter. The parameter that follows a period can be repeated more than once. Do not enter the period as part of the command.	`set as-path prepend .<1-65535>`

Variable Placeholders

Table 2 shows the tokens used in command syntax use to represent variables for which you supply a value.

Table 2: Variable placeholders

Token	Description
`WORD`	A contiguous text string (excluding spaces)
`LINE`	A text string, including spaces; no other parameters can follow this parameter
`IFNAME`	Interface name whose format varies depending on the platform; examples are: `eth0`, `Ethernet0`, `ethernet0`, `xe0`
`A.B.C.D`	IPv4 address
`A.B.C.D/M`	IPv4 address and mask/prefix
`X:X::X:X`	IPv6 address
`X:X::X:X/M`	IPv6 address and mask/prefix
`HH:MM:SS`	Time format
`AA:NN`	BGP community value
`XX:XX:XX:XX:XX:XX`	MAC address

`<1-5>`
`<1-65535>`
`<0-2147483647>`
`<0-4294967295>`
	Numeric range

Command Description Format

Table 3 explains the sections used to describe each command in this reference.

Table 3: Command descriptions

Section	Description
Command Name	The name of the command, followed by what the command does and when should it be used
Command Syntax	The syntax of the command
Parameters	Parameters and options for the command
Default	The state before the command is executed
Command Mode	The mode in which the command runs; see Command Modes
Example	An example of the command being executed

Keyboard Operations

Table 4 lists the operations you can perform from the keyboard.

Table 4: Keyboard operations

Key combination	Operation
Left arrow or Ctrl+b	Moves one character to the left. When a command extends beyond a single line, you can press left arrow or Ctrl+b repeatedly to scroll toward the beginning of the line, or you can press Ctrl+a to go directly to the beginning of the line.
Right arrow or Ctrl-f	Moves one character to the right. When a command extends beyond a single line, you can press right arrow or Ctrl+f repeatedly to scroll toward the end of the line, or you can press Ctrl+e to go directly to the end of the line.
Esc, b	Moves back one word
Esc, f	Moves forward one word
Ctrl+e	Moves to end of the line
Ctrl+a	Moves to the beginning of the line
Ctrl+u	Deletes the line
Ctrl+w	Deletes from the cursor to the previous whitespace
Alt+d	Deletes the current word
Ctrl+k	Deletes from the cursor to the end of line
Ctrl+y	Pastes text previously deleted with Ctrl+k, Alt+d, Ctrl+w, or Ctrl+u at the cursor

Table 4: Keyboard operations (Continued)

Key combination	Operation
Ctrl+t	Transposes the current character with the previous character
Ctrl+c	Ignores the current line and redisplays the command prompt
Ctrl+z	Ends configuration mode and returns to exec mode
Ctrl+l	Clears the screen
Up Arrow or Ctrl+p	Scroll backward through command history
Down Arrow or Ctrl+n	Scroll forward through command history

Show Command Modifiers

You can use two tokens to modify the output of a `show` command. Enter a question mark to display these tokens:

```
# show users ?
  | Output modifiers
  > Output redirection
```

You can type the | (vertical bar character) to use output modifiers. For example:

```
> show rsvp | ?
  begin     Begin with the line that matches
  exclude   Exclude lines that match
  include   Include lines that match
  last      Last few lines
  redirect  Redirect output
```

Begin Modifier

The `begin` modifier displays the output beginning with the first line that contains the input string (everything typed after the `begin` keyword). For example:

```
# show running-config | begin xe1
...skipping
interface xe1
 ipv6 address fe80::204:75ff:fee6:5393/64
!
interface xe2
 ipv6 address fe80::20d:56ff:fe96:725a/64
!
line con 0
 login
!
end
```

You can specify a regular expression after the `begin` keyword, This example begins the output at a line with either “xe2” or “xe4”:

```
# show running-config | begin xe[3-4]

...skipping
```



```
interface xe3
 shutdown
!
interface xe4
 shutdown
!
interface svlan0.1
 no shutdown
!
route-map myroute permit 3
!
route-map mymap1 permit 10
!
route-map rmap1 permit 3
!
line con 0
 login
line vty 0 4
 login
!
end
```

Include Modifier

The `include` modifier includes only those lines of output that contain the input string. In the output below, all lines containing the word “input” are included:

```
# show interface xe1 | include input
    input packets 80434552, bytes 2147483647, dropped 0, multicast packets 0
    input errors 0, length 0, overrun 0, CRC 0, frame 0, fifo 1, missed 0
```

You can specify a regular expression after the `include` keyword. This examples includes all lines with “input” or “output”:

```
#show interface xe0 | include (in|out)put
    input packets 597058, bytes 338081476, dropped 0, multicast packets 0
    input errors 0, length 0, overrun 0, CRC 0, frame 0, fifo 0, missed 0
    output packets 613147, bytes 126055987, dropped 0
    output errors 0, aborted 0, carrier 0, fifo 0, heartbeat 0, window 0
```

Exclude Modifier

The `exclude` modifier excludes all lines of output that contain the input string. In the following output example, all lines containing the word “input” are excluded:

```
# show interface xe1 | exclude input
Interface xe1
  Scope: both
  Hardware is Ethernet, address is 0004.75e6.5393
  index 3 metric 1 mtu 1500 <UP,BROADCAST,RUNNING,MULTICAST>
  VRF Binding: Not bound
  Administrative Group(s): None
  DSTE Bandwidth Constraint Mode is MAM
  inet6 fe80::204:75ff:fee6:5393/64
    output packets 4438, bytes 394940, dropped 0
    output errors 0, aborted 0, carrier 0, fifo 0, heartbeat 0, window 0
    collisions 0
```

You can specify a regular expression after the `exclude` keyword. This example excludes lines with “output” or “input”:

```
# show interface xe0 | exclude (in|out)put
Interface xe0
  Scope: both
  Hardware is Ethernet  Current HW addr: 001b.2139.6c4a
  Physical:001b.2139.6c4a  Logical:(not set)
  index 2 metric 1 mtu 1500 duplex-full arp ageing timeout 3000
  <UP,BROADCAST,RUNNING,MULTICAST>
  VRF Binding: Not bound
  Bandwidth 100m
  DHCP client is disabled.
  inet 10.1.2.173/24 broadcast 10.1.2.255
  VRRP Master of :  VRRP is not configured on this interface.
  inet6 fe80::21b:21ff:fe39:6c4a/64
    collisions 0
```

Redirect Modifier

The `redirect` modifier writes the output into a file. The output is not displayed.

```
# show cli history | redirect /var/frame.txt
```

The output redirection token (>) does the same thing:

```
# show cli history >/var/frame.txt
```

Last Modifier

The `last` modifier displays the output of last few number of lines (As per the user input). The last number ranges from 1 to 9999.

For example:

```
#show running-config | last 10
```


String Parameters

The restrictions in Table 5 apply for all string parameters used in OcNOS commands, unless some other restrictions are noted for a particular command.

Table 5: String parameter restrictions

<table>
<tr><th>Restriction</th><th>Description</th></tr>
<tr><td>Input length</td><td>1965 characters or less</td></tr>
<tr><td>Restricted special characters</td><td>“?”, “,”, “>”, “|”, and “=”
The “|” is allowed only for <code>description</code> CLI in interface mode.</td></tr>
</table>

Command Modes

Commands are grouped into modes arranged in a hierarchy. Each mode has its own set of commands. Table 6 lists the command modes common to all protocols.

Table 6: Common command modes

Name	Description
Executive mode	Also called *view* mode, this is the first mode to appear after you start the CLI. It is a base mode from where you can perform basic commands such as `show`, `exit`, `quit`, `help`, and `enable`.
Privileged executive mode	Also called *enable* mode, in this mode you can run additional basic commands such as `debug`, `write`, and `show`.
Configure mode	Also called *configure terminal* mode, in this mode you can run configuration commands and go into other modes such as interface, router, route map, key chain, and address family. Configure mode is single user. Only one user at a time can be in configure mode.
Interface mode	In this mode you can configure protocol-specific settings for a particular interface. Any setting you configure in this mode overrides a setting configured in router mode.
Router mode	This mode is used to configure router-specific settings for a protocol such as BGP or OSPF.

Command Mode Tree

The diagram below shows the common command mode hierarchy.

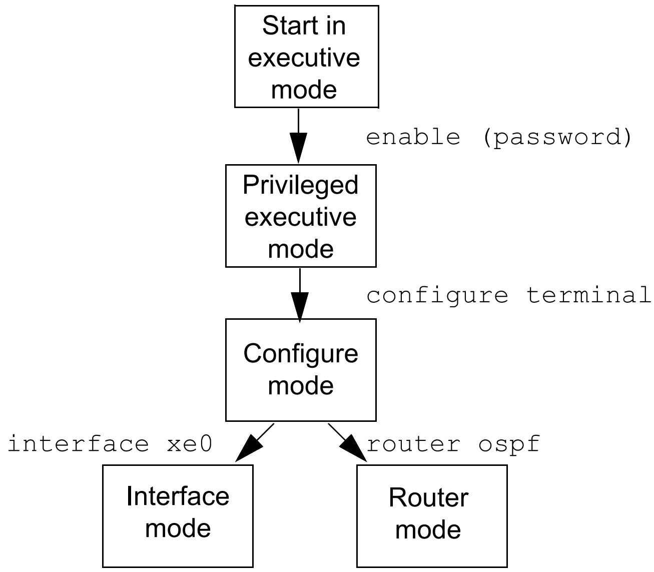


Figure iv-1: Common command modes

To change modes:

1. Enter privileged executive mode by entering `enable` in Executive mode.
2. Enter configure mode by entering `configure terminal` in Privileged Executive mode.

The example below shows moving from executive mode to privileged executive mode to configure mode and finally to router mode:

```
> enable mypassword
# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
(config)# router ospf
(config-router)#
```

Note: Each protocol can have modes in addition to the common command modes. See the command reference for the respective protocol for details.

Transaction-based Command-line Interface

The OcNOS command line interface is transaction based:

- Any changes done in configure mode are stored in a separate *candidate* configuration that you can view with the show transaction current command.
- When a configuration is complete, apply the candidate configuration to the running configuration with the commit command.
- If a commit fails, no configuration is applied as the entire transaction is considered failed. You can continue to change the candidate configuration and then retry the commit.
- Discard the candidate configuration with the abort transaction command.
- Check the last aborted transaction with the show transaction last-aborted command.
- Multiple configurations cannot be removed with a single commit. You must remove each configuration followed by a commit.

Note: All commands MUST be executed only in the default CML shell (`cmlsh`). If you log in as `root` and start `imish`, then the system configurations will go out of sync. The imish shell is not supported and should not be started manually.

Multi-Protocol Label Switching Configuration Guide

CHAPTER 1 Understanding Label Space

This chapter contains configurations for Label Space. It also provides an overview of Label Space concepts.

Overview

The Label space refers to the scope of labels in a given LSR. It determines assignment and distribution of labels to a given peer. During data flow, it decides the key for looking up MPLS table and takes appropriate action based on the entry. Label space is designated either as platform label space or per-interface label space.

Per-platform label space

In this implementation, a label must be unique for the entire platform. A label will be interpreted the same way at all the interfaces. The FIB entry in the router does not contain incoming interface related information. Thus the incoming traffic will be matched only with the label.

Per-interface label space

In this implementation, a label must be unique for a given input interface. A label will be interpreted Uniquely at different interface which allows us to re-use label for different entries. The FIB entry in router must contain incoming interface information along with label. Thus the incoming traffic will be matched with label and incoming interface.

Topology

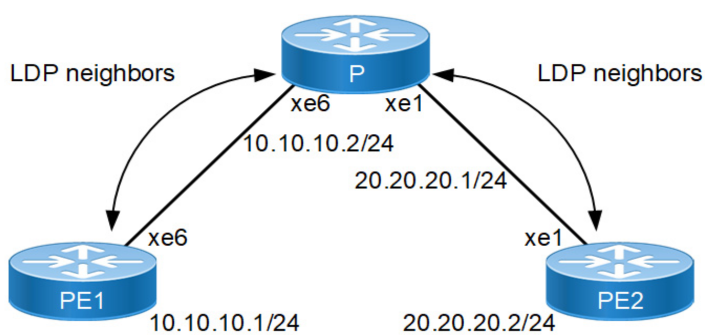


Figure 1-1: LDP Topology

Configuration

Per-Platform Label Space

PE1

`PE1#configure terminal`	Enter configure mode
`PE1(config)#interface lo`	Enter interface mode.
`PE1(config-if)#ip address 1.1.1.1/32`	Configure IP address for the loopback address

`PE1(config-if)#exit`	Exit interface mode
`PE1(config)#interface xe6`	Specify the interface (`xe6`) to be configured
`PE1(config-if)#ip address 10.10.10.1/24`	Configure IP address for the interface
`PE1(config-if)#no shutdown`	Administratively bringing up the interface
`PE1(config-if)#exit`	Exit interface mode
`PE1(config)#router ospf 100`	Configure the routing process and specify the Process ID (100)
`PE1(config-router)#network 10.10.10.0/24 area 0` `PE1(config-router)#network 1.1.1.1/32 area 0`	Define the interface on which OSPF runs and associate the area ID (`0`) with the interface
`PE1(config-router)#exit`	Exit configure mode
`PE1(config)#router ldp`	Enter router mode for LDP
`PE1(config-router)#exit`	Exit router mode for LDP
`PE1(config)#interface xe6`	Specify the interface (xe6)to be configured
`PE1(config-if)#label-switching`	Enabling label switching capability on router
`PE1(config-if)#enable-ldp ipv4`	Enabling ldp on interface
`PE1(config-if)#exit`	Exit interface mode
`PE1(config)#exit`	Exit configure mode

P

`P#configure terminal`	Enter configure mode.
`P(config)#interface lo`	Enter interface mode.
`P(config-if)#ip address 2.2.2.2/32`	Configure IP address for the loopback address
`P(config-if)#exit`	Exit interface mode
`P(config)#interface xe6`	Specify the interface (`xe6`) to be configured
`P(config-if)#ip address 10.10.10.2/24`	Configure IP address for the interface
`P(config-if)#no shutdown`	Administratively bringing up the interface
`P(config)#interface xe1`	Specify the interface (`xe1`) to be configured
`P(config-if)#ip address 20.20.20.1/24`	Configure IP address for the interface
`P(config)#router ospf 100`	Configure the routing process and specify the Process ID (100)

`P(config-router)#network 10.10.10.0/24 area 0`
`P(config-router)#network 20.20.20.0/24 area 0`
`P(config-router)#network 2.2.2.2/32 area 0`
	Define the interface on which OSPF runs and associate the area ID (`0`) with the interface

`P(config-router)#exit`	Exit router mode
`P(config)#router ldp`	Enter router mode for LDP
`P(config-router)#exit`	Exit router mode for LDP
`P(config)#mpls min-label-value 1000 max-label-value 50000 label-space 0`	Configure the minimum label value and maximum label value to be used by Platform label space (Label space 0)
`P(config)#interface xe6`	Specify the interface (xe6)to be configured
`P(config-if)#label-switching`	Enabling label switching capability on router

`P(config-if)#enable-ldp ipv4`	Enabling ldp on interface
`P(config-if)#exit`	Exit interface mode
`P(config)#interface xe1`	Specify the interface (xe1)to be configured
`P(config-if)#label-switching`	Enabling label switching capability on router
`P(config-if)#enable-ldp ipv4`	Enabling ldp on interface
`P(config-if)#exit`	Exit interface mode
`P(config)#exit`	Exit configure mode

PE2

`PE2#configure terminal`	Enter configure mode.
`PE2(config)#interface lo`	Enter interface mode.
`PE2(config-if)#ip address 3.3.3.3/32`	Configure IP address for the loopback address
`PE2(config-if)#exit`	Exit interface mode
`PE2(config)#interface xe1`	Specify the interface `(xe1)` to be configured
`PE2(config-if)#ip address 20.20.20.2/24`	Configure IP address for the interface
`PE2(config-if)#no shutdown`	Administratively bringing up the interface
`PE2(config-if)#exit`	Exit interface mode
`PE2(config)#router ospf 100`	Configure the routing process and specify the Process ID (100)
`PE2(config-router)#network 20.20.20.0/24 area 0` `PE2(config-router)#network 3.3.3.3/32 area 0`	Define the interface on which OSPF runs and associate the area ID `(0)` with the interface
`PE2(config-router)#exit`	Exit router mode
`PE2(config)#router ldp`	Enter router mode for LDP
`PE2(config-router)#exit`	Exit router mode for LDP
`PE2(config)#interface xe1`	Specify the interface (xe1)to be configured
`PE2(config-if)#label-switching`	Enabling label switching capability on router
`PE2(config-if)#enable-ldp ipv4`	Enabling ldp on interface
`PE2(config-if)#exit`	Exit interface mode

Validation

```
P#sh ldp
Router ID                  : 2.2.2.2
LDP Version                : 1
Global Merge Capability    : Merge Capable
Label Advertisement Mode   : Downstream Unsolicited
Label Retention Mode       : Liberal
Label Control Mode         : Independent
Instance Loop Detection    : Off
Request Retry              : Off
Propagate Release          : Disabled
Graceful Restart           : Disabled
```



```
Hello Interval            : 5
Targeted Hello Interval   : 15
Hold time                 : 15
Targeted Hold time        : 45
Keepalive Interval        : 10
Keepalive Timeout         : 30
Request retry Timeout     : 5
Transport Address data    :
  Labelspace 0            : 2.2.2.2 (in use)
Import BGP routes         : No

P#show mpls label-space 0
 Min-label-value : 1000
 Max-label-value : 50000

 module-static   min-label-value  : 1000
                 max-label-value  : 15999
 module-srgb     min-label-value  : 16000
                 max-label-value  : 24319
 module-rsvp     min-label-value  : 0
                 max-label-value  : 0
 module-ldp      min-label-value  : 0
                 max-label-value  : 0
 module-bgp      min-label-value  : 0
                 max-label-value  : 0
 module-ospf     min-label-value  : 0
                 max-label-value  : 0
P#sh mpls ilm-table
Codes: > - selected ILM, p - stale ILM, K - CLI ILM, T - MPLS-TP

Code  FEC               ILM-ID      In-Label    Out-Label   In-Intf   Out-Intf
Nexthop                     LSP-Type
  >   1.1.1.1/32         1            3840         3           N/A      eth1
172.168.25.56                LSP_DEFAULT
  >   3.3.3.3/32         2            3841         3           N/A      eth2
10.10.20.51                  LSP_DEFAULT
```

Per-Interface Label Space

PE1

`PE1#configure terminal`	Enter configure mode
`PE1(config)#interface lo`	Enter interface mode.
`PE1(config-if)#ip address 1.1.1.1/32`	Configure IP address for the loopback address
`PE1(config-if)#exit`	Exit interface mode
`PE1(config)#interface xe6`	Specify the interface `(xe6)` to be configured
`PE1(config-if)#ip address 10.10.10.1/24`	Configure IP address for the interface
`PE1(config-if)#no shutdown`	Administratively bringing up the interface

`PE1(config-if)#exit`	Exit interface mode
`PE1(config)#router ospf 100`	Configure the routing process and specify the Process ID (100)
`PE1(config-router)#network 10.10.10.0/24 area 0` `PE1(config-router)#network 1.1.1.1/32 area 0`	Define the interface on which OSPF runs and associate the area ID `(0)` with the interface
`PE1(config-router)#exit`	Exit configure mode
`PE1(config)#router ldp`	Enter router mode for LDP
`PE1(config-router)#exit`	Exit router mode for LDP
`PE1(config)#mpls min-label-value 60000 max-label-value 80000 label-space 1`	Configure the minimum label value and maximum label value to be used by interface label space (Label space 1 in this case)
`PE1(config)#interface xe6`	Specify the interface (xe6)to be configured
`PE1(config-if)#label-switching`	Enabling label switching capability on router
`PE1(config-if)#enable-ldp ipv4`	Enabling ldp on interface
`PE1(config-if)#exit`	Exit interface mode
`PE1(config)#exit`	Exit configure mode

P

`P#configure terminal`	Enter configure mode.
`P(config)#interface lo`	Enter interface mode.
`P(config-if)#ip address 2.2.2.2/32`	Configure IP address for the loopback address
`P(config-if)#exit`	Exit interface mode
`P(config)#interface xe6`	Specify the interface `(xe6)` to be configured
`P(config-if)#ip address 10.10.10.2/24`	Configure IP address for the interface
`P(config-if)#no shutdown`	Administratively bringing up the interface
`P(config)#interface xe1`	Specify the interface `(xe1)` to be configured
`P(config-if)#ip address 20.20.20.1/24`	Configure IP address for the interface
`P(config)#router ospf 100`	Configure the routing process and specify the Process ID (100)
`P(config-router)#network 10.10.10.0/24 area 0` `P(config-router)#network 20.20.20.0/24 area 0` `P(config-router)#network 2.2.2.2/32 area 0`	Define the interface on which OSPF runs and associate the area ID `(0)` with the interface
`P(config-router)#exit`	Exit router mode
`P(config)#router ldp`	Enter router mode for LDP
`P(config-router)#exit`	Exit router mode for LDP
`P(config)#mpls min-label-value 60000 max-label-value 80000 label-space 1`	Configure the minimum label value and maximum label value to be used by Interface label space (Label space 1)
`P(config)#interface xe6`	Specify the interface (xe6)to be configured
`P(config-if)#label-switching 1`	Enabling label switching capability on router
`P(config-if)#enable-ldp ipv4`	Enabling ldp on interface

`P(config)#interface xe1`	Specify the interface (xe1)to be configured
`P(config-if)#label-switching 1`	Enabling label switching capability on router
`P(config-if)#enable-ldp ipv4`	Enabling ldp on interface
`P(config-if)#exit`	Exit interface mode
`P(config)#exit`	Exit configure mode

PE2

`PE2#configure terminal`	Enter configure mode.
`PE2(config)#interface lo`	Enter interface mode.
`PE2(config-if)#ip address 3.3.3.3/32`	Configure IP address for the loopback address
`PE2(config-if)#exit`	Exit interface mode
`PE2(config)#interface xe1`	Specify the interface `(xe1)` to be configured
`PE2(config-if)#ip address 20.20.20.2/24`	Configure IP address for the interface
`PE2(config-if)#no shutdown`	Administratively bringing up the interface
`PE2(config-if)#exit`	Exit interface mode
`PE2(config)#router ospf 100`	Configure the routing process and specify the Process ID (100)
`PE2(config-router)#network 20.20.20.0/24 area 0` `PE2(config-router)#network 3.3.3.3/32 area 0`	Define the interface on which OSPF runs and associate the area ID `(0)` with the interface
`PE2(config-router)#exit`	Exit router mode
`PE2(config)#router ldp`	Enter router mode for LDP
`PE2(config-router)#exit`	Exit router mode for LDP
`PE2(config)#mpls min-label-value 60000 max-label-value 80000 label-space 1`	Configure the minimum label value and maximum label value to be used by interface label space (Label space 1)
`PE2(config)#interface xe1`	Specify the interface (xe1)to be configured
`PE2(config-if)#label-switching`	Enabling label switching capability on router
`PE2(config-if)#enable-ldp ipv4`	Enabling ldp on interface
`PE2(config-if)#exit`	Exit interface mode

Validation

```
P#show ldp

Router ID                   : 2.2.2.2
LDP Version                 : 1
Global Merge Capability     : Merge Capable
Label Advertisement Mode    : Downstream Unsolicited
Label Retention Mode        : Liberal
Label Control Mode          : Independent
Instance Loop Detection     : Off
Request Retry               : Off
```

```
Propagate Release          : Disabled
Graceful Restart           : Disabled
Hello Interval             : 5
Targeted Hello Interval    : 15
Hold time                  : 15
Targeted Hold time         : 45
Keepalive Interval         : 10
Keepalive Timeout          : 30
Request retry Timeout      : 5
Transport Address data     :
  Labelspace 1             : 2.2.2.2 (in use)
Import BGP routes          : No

P#show mpls label-space 1
 Min-label-value : 60000
 Max-label-value : 80000

 module-static   min-label-value  : 60000
                 max-label-value  : 61000
 module-rsvp     min-label-value  : 0
                 max-label-value  : 0
 module-ldp      min-label-value  : 0
                 max-label-value  : 0
 module-bgp      min-label-value  : 0
                 max-label-value  : 0
 module-ospf     min-label-value  : 0
                 max-label-value  : 0
P#sh mpls ilm
Codes: > - selected ILM, p - stale ILM, K - CLI ILM, T - MPLS-TP

Code  FEC                ILM-ID      In-Label    Out-Label   In-Intf   Out-Intf
Nexthop                      LSP-Type
  >   3.3.3.3/32          3           61441        3          eth1      eth2
10.10.20.51                   LSP_DEFAULT
  >   1.1.1.1/32          4           61440        3          eth2      eth1
172.168.25.56                 LSP_DEFAULT
```

CHAPTER 2 Understanding MPLS TTL Processing

This chapter contains configurations for MPLS-TTL-Processing. It also provides an overview of MPLS-TTL-Processing concepts.

Overview

This feature performs ‘Time To Live’ (TTL) processing for Multi-Protocol Label Switching (MPLS) packets. The TTL processing is decided by the model chosen by you. This feature provides TTL processing of MPLS packets on ingress, egress, and intermediate routers. TTL processing is compliant with RFC 3443.

The details of TTL processing vary with the tunnel model that is configured for TTL processing. The incoming and outgoing TTL of the packet is determined by the configured tunnel model. Two Models are supported, pipe model and uniform model. Pipe model is default model, where MPLS header TTL Value wont get propagated to IP header.

To know more about uniform model and pipe model, refer chapter MPLS DiffServ Configuration.

Topology

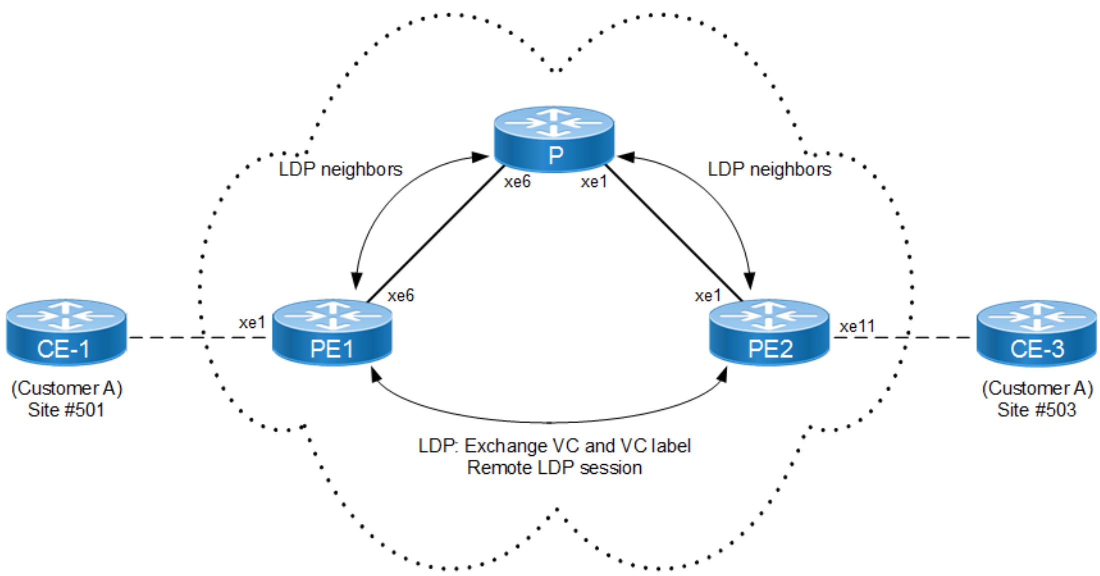


Figure 2-1: TTL Processing Topology

Configuration

PE1

`PE1#configure terminal`	Enter configure mode
`PE1(config)#interface lo`	Enter interface mode.
`PE1(config-if)#ip address 1.1.1.1/32`	Configure IP address for the loopback address
`PE1(config-if)#exit`	Exit interface mode
`PE1(config)#interface xe6`	Specify the interface `(xe6)` to be configured
`PE1(config-if)#ip address 10.10.10.1/24`	Configure IP address for the interface

`PE1(config-if)#no shutdown`	Administratively bringing up the interface
`PE1(config-if)#exit`	Exit interface mode
`PE1(config)#router ospf 100`	Configure the routing process and specify the Process ID (100)
`PE1(config-router)#network 10.10.10.0/24 area 0` `PE1(config-router)#network 1.1.1.1/32 area 0`	Define the interface on which OSPF runs and associate the area ID `(0)` with the interface
`PE1(config-router)#exit`	Exit configure mode
`PE1(config)#router ldp`	Enter router mode for LDP
`PE1(config-router)#exit`	Exit router mode for LDP
`PE1(config)#interface xe6`	Specify the interface (xe6)to be configured
`PE1(config-if)#label-switching`	Enabling label switching capability on router
`PE1(config-if)#enable-ldp ipv4`	Enabling ldp on interface
`PE1(config-if)#exit`	Exit interface mode
`PE1(config)#exit`	Exit configure mode

P

`P#configure terminal`	Enter configure mode.
`P(config)#interface lo`	Enter interface mode.
`P(config-if)#ip address 2.2.2.2/32`	Configure IP address for the loopback address
`P(config-if)#exit`	Exit interface mode
`P(config)#interface xe6`	Specify the interface `(xe6)` to be configured
`P(config-if)#ip address 10.10.10.2/24`	Configure IP address for the interface
`P(config-if)#no shutdown`	Administratively bringing up the interface
`P(config)#interface xe1`	Specify the interface `(xe1)` to be configured
`P(config-if)#ip address 20.20.20.1/24`	Configure IP address for the interface
`P(config)#router ospf 100`	Configure the routing process and specify the Process ID (100)

`P(config-router)#network 10.10.10.0/24 area 0`
`P(config-router)#network 20.20.20.0/24 area 0`
`P(config-router)#network 2.2.2.2/32 area 0`
	Define the interface on which OSPF runs and associate the area ID `(0)` with the interface

`P(config-router)#exit`	Exit router mode
`P(config)#router ldp`	Enter router mode for LDP
`P(config-router)#exit`	Exit router mode for LDP
`P(config)#interface xe6`	Specify the interface (xe6)to be configured
`P(config-if)#label-switching`	Enabling label switching capability on router
`P(config-if)#enable-ldp ipv4`	Enabling ldp on interface
`P(config)#interface xe1`	Specify the interface (xe1)to be configured
`P(config-if)#label-switching`	Enabling label switching capability on router
`P(config-if)#enable-ldp ipv4`	Enabling ldp on interface

`P(config-if)#exit`	Exit interface mode
`P(config)#exit`	Exit configure mode

PE2

`PE2#configure terminal`	Enter configure mode.
`PE2(config)#interface lo`	Enter interface mode.
`PE2(config-if)#ip address 3.3.3.3/32`	Configure IP address for the loopback address
`PE2(config-if)#exit`	Exit interface mode
`PE2(config)#interface xe1`	Specify the interface `(xe1)` to be configured
`PE2(config-if)#ip address 20.20.20.2/24`	Configure IP address for the interface
`PE2(config-if)#no shutdown`	Administratively bringing up the interface
`PE2(config-if)#exit`	Exit interface mode
`PE2(config)#router ospf 100`	Configure the routing process and specify the Process ID (100)
`PE2(config-router)#network 20.20.20.0/24 area 0` `PE2(config-router)#network 3.3.3.3/32 area 0`	Define the interface on which OSPF runs and associate the area ID `(0)` with the interface
`PE2(config)#router ldp`	Enter router mode for LDP
`PE2(config-router)#exit`	Exit router mode for LDP
`PE2(config)#interface xe1`	Specify the interface (xe1)to be configured
`PE2(config-if)#label-switching`	Enabling label switching capability on router
`PE2(config-if)#enable-ldp ipv4`	Enabling ldp on interface
`PE2(config-if)#exit`	Exit interface mode

CHAPTER 3 RSVP-TE Configuration

This chapter contains configurations for Resource Reservation Protocol - Traffic Engineering (RSVP-TE).

RSVP-TE Overview

RSVP-TE is a signaling protocol that supports explicit routing capabilities, To do this, an Explicit Route (ER) object is incorporated into RSVP PATH messages. This object encapsulates a sequence of hops that constitute the explicitly-routed path. Using the ER object, the paths taken by label-switched RSVP-MPLS flows can be pre-determined without conventional IP routing. An ER path can be administratively specified or computed based on CSPF and any policy requirements dictated by the operator through the trunk node, taking the current network state into consideration. A useful application of explicit routing is Traffic Engineering (TE). Using explicitly-routed LSPs, an ingress node can control the path through which traffic flows from itself, through the MPLS network, to the egress node. Explicit routing is therefore useful for the optimization of network resources and an increase in the quality of traffic-oriented performance.

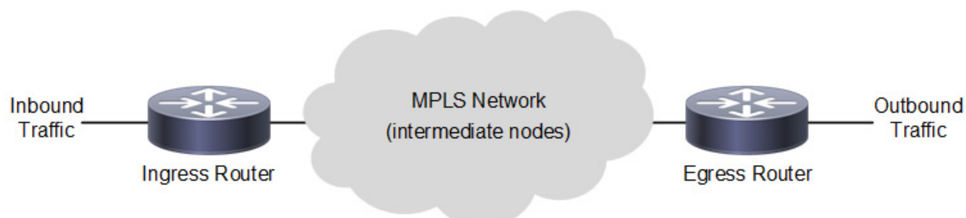


Figure 3-1: Basic RSVP-TE Topology

RSVP-TE Architecture

RSVP-TE is a signaling protocol that supports explicit routing capabilities to establish LSPs in a MPLS network. OcNOS RSVP-TE:

- creates explicitly-routed paths, which might not agree with the route suggested by the IGP (OSPF, RIP) being used. Explicitly-routed LSPs, by definition, do not follow the paths suggested by IGPs.
- queries CSPF for a complete, end-to-end, explicit route based on constraints specified by the operator using RSVP commands.
- performs make-before-break type re-routing of tunnels. (Make-before-break is the creation of a new LSP before the old one is torn down).
- exchanges Hello messages to make node failures easier to detect. This means when there is no hello exchange between routers, then other node is assumed dead or offline (except in the case when the peer is known to not support Hellos).
- provides statistical information of RSVP messages exchanged.

In addition, OcNOS RSVP-TE may be used in unison with BGP to generate MPLS/BGP VPNs, and in unison with LDP to generate Layer-2 Virtual Circuits.

Configure RSVP-TE

Note: The following configuration for establishing a trunk is required on all routers participating in label-switching. Based on the assumption that minimal configurations exist on all participating routers, other examples do not repeat this configuration.

Enable Label Switching - Minimal Configuration

To establish a trunk on a system:

1. Enable label-switching and RSVP-TE on all participating interfaces.
2. Configure a trunk on the ingress router to use the best available IGP path.

   In this example, the Label Switched Path (LSP) is configured using minimal configuration and is setup using the best IP nexthop available. Each router along the path is chosen by the previous router by looking up the best nexthop available in its IP routing table.

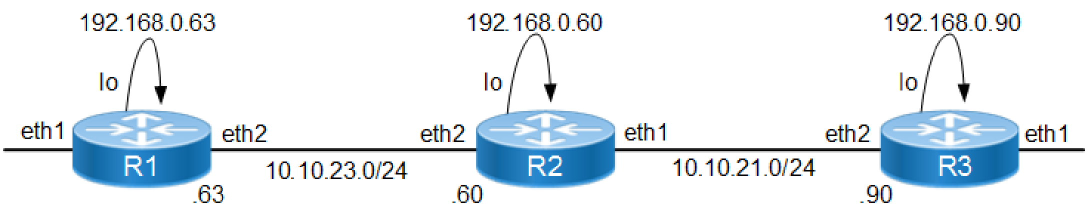


Figure 3-2: Topology for Minimal Configuration

R1

NSM

`#configure terminal`	Enter configure mode.
`(config)#interface lo`	Enter interface mode.
`(config-if)#ip address 192.168.0.63/32 secondary`	Set the IP address for the interface.
`(config-if)#exit`	Exit interface mode.
`(config)#interface eth2`	Enter interface mode.
`(config-if)#ip address 10.10.23.63/24`	Set the IP address for the interface.
`(config-if)#label-switching`	Enable label switching on interface `eth0`.
`(config-if)#exit`	Exit interface mode.

RSVP-TE

`(config)#router rsvp`	Enter `Configure Router` mode.
`(config-router)#exit`	Exit `Router` mode.
`(config)#interface eth2`	Enter interface mode.
`(config-if)#enable-rsvp`	Enable RSVP message exchange on this interface.
`(config-if)#exit`	Exit interface mode.

OSPF

`#configure terminal`	Enter configure mode.
`(config)#router ospf 100`	Configure the Routing process and specify the Process ID `(100)`. The Process ID should be a unique positive integer identifying the routing process.

(config-router)#router-id 192.168.0.63	Configure OSPF router-ID same as loopback interface IP address
(config-router)#network 10.10.23.0/24 area 0	Define the network (10.10.23.0/24) on which OSPF runs and associate the area ID (0).
(config-router)#network 192.168.0.63/32 area 0	Set the IP address of the loopback interface to 192.168.0.63/32.
(config-router)#exit	Exit Router mode.

R2

NSM

#configure terminal	Enter configure mode.
(config)#interface lo	Enter interface mode.
(config-if)#ip address 192.168.0.60/32 secondary	Set the IP address for the interface.
(config-if)#exit	Enable label switching on interface lo.
(config)#interface eth2	Enter interface mode.
(config-if)#ip address 10.10.23.60/24	Set the IP address for the interface.
(config-if)#label-switching	Enable label switching on interface eth2.
(config-if)#exit	Exit interface mode.
(config)#interface eth1	Enter interface mode.
(config-if)#ip address 10.10.21.60/24	Set the IP address for the interface.
(config-if)#label-switching	Enable label switching on interface eth1.
(config-if)#exit	Exit interface mode.

RSVP-TE

(config)#router rsvp	Enter Configure Router mode.
(config-router)#exit	Exit Router mode.
(config)#interface eth2	Enter interface mode.
(config-if)#enable-rsvp	Enable RSVP message exchange on this interface.
(config-if)#exit	Exit interface mode.
(config)#interface eth1	Enter interface mode.
(config-if)#enable-rsvp	Enable RSVP message exchange on this interface.
(config-if)#exit	Exit interface mode.

OSPF

#configure terminal	Enter configure mode.
(config)#router ospf 100	Configure the Routing process and specify the Process ID (100). The Process ID should be a unique positive integer identifying the routing process.
(config-router)#router-id 192.168.0.60	Configure OSPF router-ID same as loopback interface IP address

(config-router)#network 10.10.23.0/24 area 0	Define the first network (10.10.23.0/24) on which OSPF runs and associate the area ID (0).
(config-router)#network 10.10.21.0/24 area 0	Define the second network (10.10.21.0/24) on which OSPF runs and associate the area ID (0).
(config-router)#network 192.168.0.60/32 area 0	Set the IP address of the loopback interface to 192.168.0.63/32.
(config-router)#exit	Exit Router mode.

R3

NSM

#configure terminal	Enter configure mode.
(config)#interface lo	Enter interface mode.
(config-if)#ip address 192.168.0.90/32 secondary	Set the IP address for the interface.
(config-if)#exit	Exit interface mode.
(config)#interface eth1	Enter interface mode.
(config-if)#ip address 10.10.21.90/24	Set the IP address for the interface.
(config-if)#label-switching	Enable label switching on interface eth0.
(config-if)#exit	Exit interface mode.

RSVP-TE

(config)#router rsvp	Enter Configure Router mode.
(config-router)#exit	Exit Router mode.
(config)#interface eth1	Enter interface mode.
(config-if)#enable-rsvp	Enable RSVP message exchange on this interface.
(config-if)#exit	Exit interface mode.

OSPF

#configure terminal	Enter configure mode.
(config)#router ospf 100	Configure the Routing process and specify the Process ID (100). The Process ID should be a unique positive integer identifying the routing process.
(config-router)#router-id 192.168.0.90	Configure OSPF router-ID same as loopback interface IP address
(config-router)#network 10.10.21.0/24 area 0	Define the network (10.10.21.0/24) on which OSPF runs and associate the area ID (0).
(config-router)#network 192.168.0.90/32 area 0	Set the IP address of the loopback interface to 192.168.0.63/32.
(config-router)#exit	Exit Router mode.

Establish a Trunk with CSPF Disabled

OcNOS, Constrained Shortest Path First (CSPF) calculation is enabled by default.Typically, CSPF is disabled when all of the participating nodes do not support the required traffic engineering extensions and LSPs are configured manually to use an explicit path. In this case, an LSP is established only along the path specified by the operator.

Note: This example is based on the assumption that a minimal configuration exists on all participating routers as described in Enable Label Switching - Minimal Configuration.

Topology

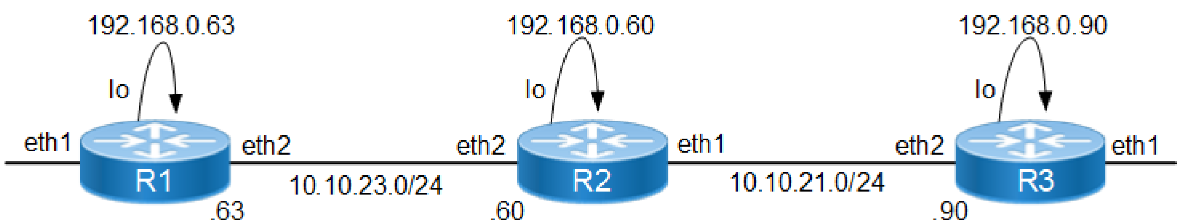


Figure 3-3: Basic Topology

R1 - RSVP-TE

`#configure terminal`	Enter configure mode.
`(config)#rsvp-trunk T1`	Create an RSVP trunk `T1` and enter the Trunk mode.
`(config-trunk)#primary no-cspf`	Specify `no-cspf` since CSPF is enabled by default.
`(config-trunk)#to 192.168.0.90`	Specify the IPv4 egress (destination point) for the LSP.

Establish a Trunk Using CSPF

The RSVP trunk can be configured using CSPF (Constraint-based Shortest Path First). In this case, the RSVP daemon (rsvpd) sends a request to the CSPF server to compute a path through the network to reach the destination. CSPF returns a hop-by-hop path called the Explicit Route to the RSVP daemon to be used in the Explicit Route Object (ERO). Each router along the path sends a `Path` message only to the nexthop specified in the ERO. In the OcNOS implementation, CSPF is enabled by default and if `no-cspf` is not specified, the trunk is CSPF enabled automatically.

Note: This example is based on the assumption that a minimal configuration exists on all participating routers as described in Enable Label Switching - Minimal Configuration.

R1 (RSVP Daemon)

`#configure terminal`	Enter configure mode.
`(config)#rsvp-trunk T1`	Create an RSVP trunk `T1` and enter the Trunk mode.
`(config-trunk)#to 192.168.0.90`	Specify the IPv4 egress (destination point) for the LSP.

Mapping a Route to a Trunk

In the OcNOS implementation, a network can be mapped to a particular trunk using map-route configuration.

Note: This example is based on the assumption that a minimal configuration exists on all participating routers. For configuration details, refer to the “Establishing a Trunk - Minimal Configuration” section.

Topology

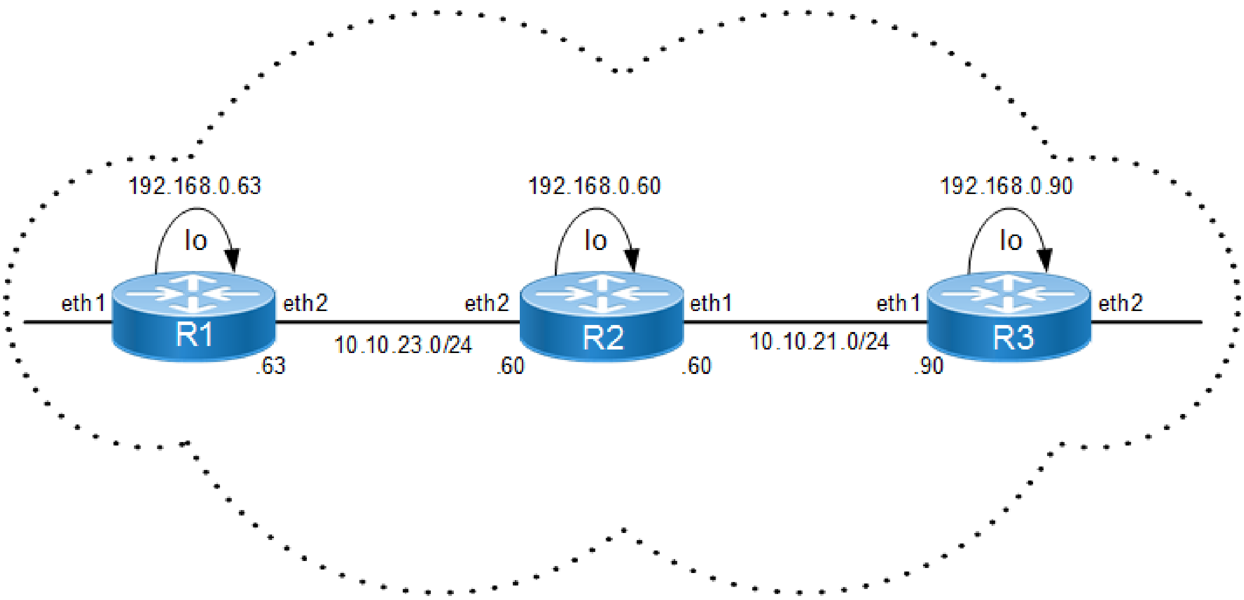


Figure 3-4: Topology for route mapping

R1 - RSVP-TE

`#configure terminal`	Enter configure mode.
`(config)#rsvp-trunk T1`	Create an RSVP trunk T1 and enter the Trunk mode.
`(config-trunk)#map-route 90.90.90.0/24`	Specify the destination prefix that needs to mapped to this trunk.
`(config-trunk)#to 192.168.0.90`	Specify the IPv4 egress (destination point) for the LSP.

Establish a Trunk Using Explicitly-Defined Path

Explicit Route hops can be configured manually in the trunk configuration. In this case, the RSVP daemon uses the configured hops as Explicit Route Objects (ERO). It sets up the LSP using specified hops only.

An ERO is composed of IP addresses called hops. An ERO hop can be defined as loose or strict. A loose hop can be reached by any available route. A strict hop must be reached via a direct link and cannot be routed over any alternate routers in between. In this example, since R3 is defined as loose hop, R2 can use R4 as an intermediate hop to reach R3. However, if it was a strict hop, then R2 would have to use interface `eth1` to reach R3 directly.

Note: This example is based on the assumption that a minimal configuration exists on all participating routers as described in Enable Label Switching - Minimal Configuration.

Topology

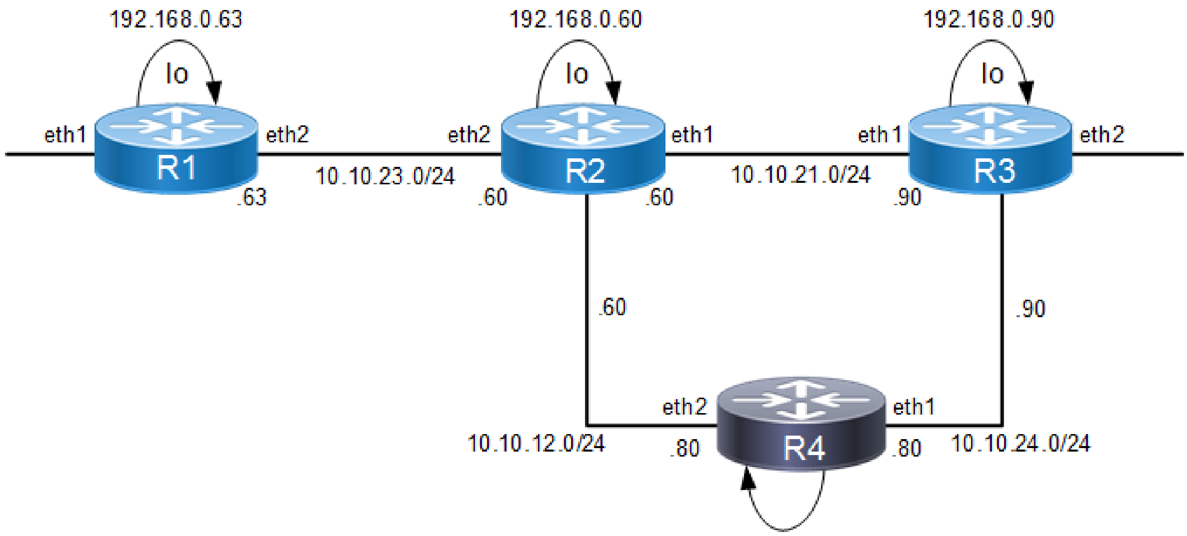


Figure 3-5: Topology for Explicitly Defined Path

R1 - RSVP-Path

`#configure terminal`	Enter configure mode.
`(config)#rsvp-path P1`	Create an RSVP Path `P1` and enter the `Path` mode.
`(config-path)#10.10.23.60 strict`	Configure this explicit route path as a `strict` hop.
`(config-path)#10.10.21.90 loose`	Configure this explicit route path as a `loose` hop.
`(config-path)#exit`	Exit `Path` mode.
`#configure terminal`	Enter configure mode.
`(config)#rsvp-trunk T1`	Create an RSVP trunk `T1` and enter the Trunk mode.
`(config-trunk)#primary no-cspf`	Since CSPF is enabled by default, specify `no-cspf` if CSPF is not required.
`(config-trunk)#primary path P1`	Configure trunk `T1` to use the defined path.
`(config-trunk)#to 192.168.0.90`	Specify the IPv4 egress (destination point) for the LSP.
`(config-trunk)#exit`	Exit `Trunk` mode.

Validation

```
R1#show rsvp session
Ingress RSVP:
To             From              State                    Pri Rt  Style Labelin Labelout
LSPName                            Uptime   Est.time      DSType

192.168.0.90    192.168.0.63     Up                          Yes 1 2 SE     -       24321     T1-
Primary                           00:09:21 0s 3ms   DEFAULT
                       00:09:21 0s 3ms  DEFAULT
```

Add a Secondary LSP to the Trunk

Although the attributes of a Secondary LSP are independent of the Primary LSP, a Secondary LSP cannot be configured without first configuring a Primary LSP. In addition to information on how to configure a secondary LSP, this example illustrates how to define a non-default setup and the hold priority for an LSP. Setup and hold priorities are used to determine which LSP should be given a preference when competing for resources. Specifically, the setup priority of an un-established LSP is compared to the hold priorities of established LSPs, and the numerically lower one is given a preference. However, once the LSP is established, its setup priority is never used until it is pre-empted or reset and is being brought up again.

Note: This example is based on the assumption that a minimal configuration exists on all participating routers as described in Enable Label Switching - Minimal Configuration.

Note: If user provides the RSVP path option for secondary, the primary path exclusion logic gets disabled. User needs to keep primary and secondary path mutually exclusive. Else, RSVP-Primary LSP and RSVP-Secondary LSP may select the same next hop, when RSVP is configured with "loose". Hence RSVP-Path first next-hop should be "strict".

R1 - RSVP-TE

`#configure terminal`	Enter configure mode.
`(config)#rsvp-path myPath`	Specify an RSVP path to be used.
`(config-path)#10.10.23.60 strict`	Configure this explicit route path as a `strict` hop.
`(config-path)#exit`	Exit Path mode.
`(config)#rsvp-path myPath2`	Specify an RSVP path to be used.
`(config-path)#10.10.23.60 loose`	Configure this explicit route path as a `loose` hop.
`(config-path)#exit`	Exit Path mode.
`(config)#rsvp-trunk T1`	Create an RSVP trunk `T1` and enter the Trunk mode.
`(config-trunk)#primary no-cspf`	Since CSPF is enabled by default, specify `no-cspf` if CSPF is not required.
`(config-trunk)#primary path myPath`	Specify an RSVP path to be used.
`(config-trunk)#secondary no-cspf`	Specify the `no-cspf` option for the Secondary LSP.
`(config-trunk)#secondary path myPath2`	Specify an RSVP path to be used.
`(config-trunk)#to 192.168.0.90`	Specify the IPv4 egress (destination point) for the LSP.
`(config-trunk)#exit`	Exit `Trunk` mode.

Validation

This example shows the number of configured RSVP sessions in a router.

R1

```
#show rsvp session count
Total configured: 50000, Up 50000, Down 0

Total ingress sessions: 50000, Up 50000, Down 0
Total transit sessions: 0, Up 0, Down 0
Total egress sessions: 0, Up 0, Down 0
```

Add Multiple Secondary LSP to the trunk

RSVP Multiple Secondary feature tries to provide continuous protection when multiple failures happen. In majority scenarios, feature tries to provide seamless protection. This is a proprietary feature where user can configure multiple secondary sessions in a rsvp-trunk. Each secondary will be associated with a priority. Priority secondary sessions must be programmed with a predefined path. User can configure a maximum of five priority levels. Lowest priority number corresponds to highest priority. Highest priority session will be signaled to be programmed as secondary session. If highest priority session cannot come up, then next available secondary will be selected based on polling. During primary session fail-over, programmed secondary priority session will protect the primary and then goes for an MBB update to act as the primary session until primary comes up. Once the highest priority session comes up as acting primary session, next available secondary priority session will be programmed to signal and come up secondary. Re-optimization timer executed once in every 5 minutes to ensure the best priority session serves as secondary. Configuration updates on secondary priority configurations doesn't trigger MBB and session will be restarted. This example illustrates how to create SVI, enable IGP protocols and RSVP on SVI.

Note: Ensure that the VLAN is configured before creating SVI.

Topology

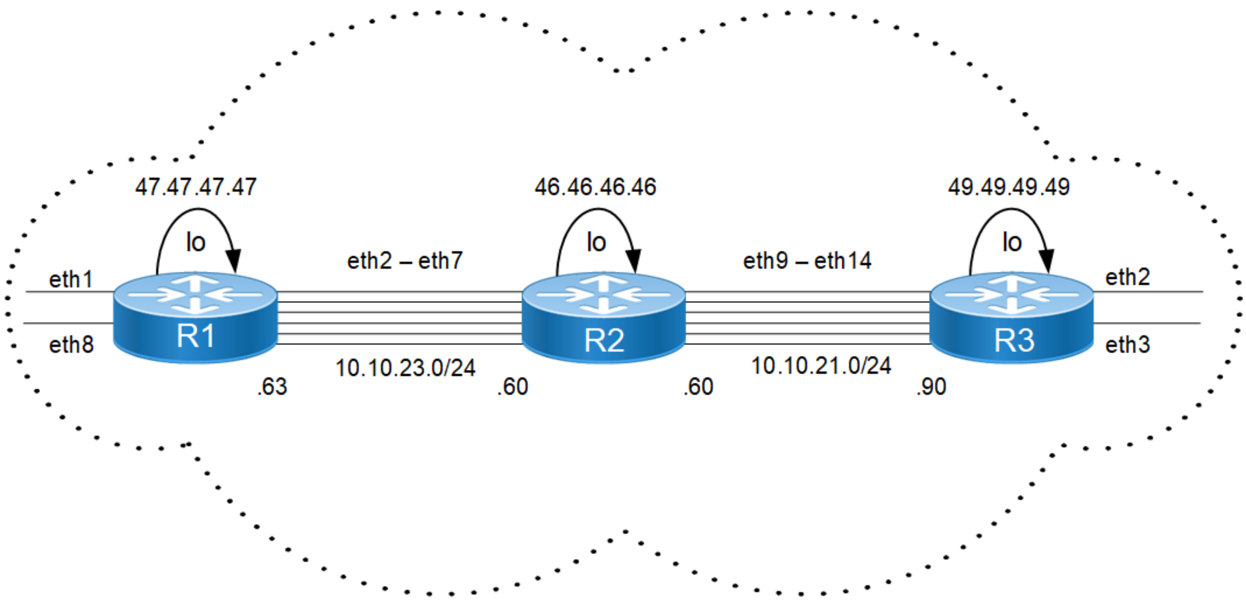


Figure 3-6: Topology for Multiple Secondary Protection

Bridge Configuration

bridge 1 protocol ieee vlan-bridge

no bridge 1 spanning-tree enable bridge-forward

VLAN creation

vlan database

vlan 2-7 bridge 1 state enable

vlan 501-506 bridge 1 state enable

R1

`#configure terminal`	Enter configure mode.
`(config)#router rsvp`	Enable RSVP globally.
`(config-router)#exit`	Exit RSVP mode.
`(config)#interface vlan1.2`	Enter the interface mode.
`(config-if)#ip address 10.10.23.1/24`	Configure the IP Address
`(config-if)#mtu 1600`	Configure MTU size.
`(config-if)#label-switching`	Enable MPLS.
`(config-if)#ip ospf network point-to-point`	Enable OSPF point-to-point network type.
`(config-if)#enable-rsvp`	Enable RSVP at the interface level.
`(config-if)#exit`	Exit the interface mode.
`(config)#interface vlan1.3`	Enter the interface mode.
`(config-if)#ip address 10.10.24.1/24`	Configure the IP Address
`(config-if)#mtu 1600`	Configure MTU size.
`(config-if)#label-switching`	Enable MPLS.
`(config-if)#ip ospf network point-to-point`	Enable OSPF point-to-point network type.
`(config-if)#enable-rsvp`	Enable RSVP at the interface level.
`(config-if)#exit`	Exit the interface mode.
`(config)#interface vlan1.4`	Enter the interface mode.
`(config-if)#ip address 10.10.25.1/24`	Configure the IP Address
`(config-if)#mtu 1600`	Configure MTU size.
`(config-if)#label-switching`	Enable MPLS.
`(config-if)#ip ospf network point-to-point`	Enable OSPF point-to-point network type.
`(config-if)#enable-rsvp`	Enable RSVP at the interface level.
`(config-if)#exit`	Exit the interface mode.
`(config)#interface vlan1.5`	Enter the interface mode.
`(config-if)#ip address 10.10.26.1/24`	Configure the IP Address
`(config-if)#mtu 1600`	Configure MTU size.
`(config-if)#label-switching`	Enable MPLS.
`(config-if)#ip ospf network point-to-point`	Enable OSPF point-to-point network type.
`(config-if)#enable-rsvp`	Enable RSVP at the interface level.
`(config-if)#exit`	Exit the interface mode.
`(config)#interface vlan1.6`	Enter the interface mode.
`(config-if)#ip address 10.10.27.1/24`	Configure the IP Address
`(config-if)#mtu 1600`	Configure MTU size.
`(config-if)#label-switching`	Enable MPLS.
`(config-if)#ip ospf network point-to-point`	Enable OSPF point-to-point network type.
`(config-if)#enable-rsvp`	Enable RSVP at the interface level.
`(config-if)#exit`	Exit the interface mode.
`(config)#interface vlan1.7`	Enter the interface mode.

(config-if)#ip address 10.10.28.1/24	Configure the IP Address
(config-if)#mtu 1600	Configure MTU size.
(config-if)#label-switching	Enable MPLS.
(config-if)#ip ospf network point-to-point	Enable OSPF point-to-point network type.
(config-if)#enable-rsvp	Enable RSVP at the interface level.
(config-if)#exit	Exit the interface mode.
(config)#interface eth2	Enter the interface mode.
(config-if)#switchport	Configure Switchport
(config-if)#bridge-group 1	Assign a Bridge ID to the port channel
(config-if)#switchport mode trunk	Configure trunk
(config-if)#switchport trunk allowed vlan add 2,501	Configure allowed VLANs
(config-if)#switchport trunk native vlan 501	Configure native VLAN.
(config-if)# load-interval 30	Set load interval
(config-if)# mtu 9192	Configure the MTU Size.
(config-if)#exit	Exit the interface mode.
(config)#interface eth3	Enter the interface mode.
(config-if)#switchport	Configure Switchport
(config-if)#bridge-group 1	Assign a Bridge ID to the port channel
(config-if)#switchport mode trunk	Configure trunk
(config-if)#switchport trunk allowed vlan add 3,502	Configure allowed VLANs
(config-if)#switchport trunk native vlan 502	Configure native VLAN.
(config-if)# load-interval 30	Set load interval
(config-if)# mtu 9192	Configure the MTU Size.
(config-if)#exit	Exit the interface mode.
(config)#interface eth4	Enter the interface mode.
(config-if)#switchport	Configure Switchport
(config-if)#bridge-group 1	Assign a Bridge ID to the port channel
(config-if)#switchport mode trunk	Configure trunk
(config-if)#switchport trunk allowed vlan add 4,503	Configure allowed VLANs
(config-if)#switchport trunk native vlan 503	Configure native VLAN.
(config-if)# load-interval 30	Set load interval
(config-if)# mtu 9192	Configure the MTU Size.
(config-if)#exit	Exit the interface mode.
(config)#interface eth5	Enter the interface mode.
(config-if)#switchport	Configure Switchport
(config-if)#bridge-group 1	Assign a Bridge ID to the port channel
(config-if)#switchport mode trunk	Configure trunk
(config-if)#switchport trunk allowed vlan add 5,504	Configure allowed VLANs

`(config-if)#switchport trunk native vlan 504`	Configure native VLAN.
`(config-if)# load-interval 30`	Set load interval
`(config-if)# mtu 9192`	Configure the MTU Size.
`(config-if)#exit`	Exit the interface mode.
`(config)#interface eth6`	Enter the interface mode.
`(config-if)#switchport`	Configure Switchport
`(config-if)#bridge-group 1`	Assign a Bridge ID to the port channel
`(config-if)#switchport mode trunk`	Configure trunk
`(config-if)#switchport trunk allowed vlan add 6,505`	Configure allowed VLANs
`(config-if)#switchport trunk native vlan 505`	Configure native VLAN.
`(config-if)# load-interval 30`	Set load interval
`(config-if)# mtu 9192`	Configure the MTU Size.
`(config-if)#exit`	Exit the interface mode.
`(config)#interface eth7`	Enter the interface mode.
`(config-if)#switchport`	Configure Switchport
`(config-if)#bridge-group 1`	Assign a Bridge ID to the port channel
`(config-if)#switchport mode trunk`	Configure trunk
`(config-if)#switchport trunk allowed vlan add 7,506`	Configure allowed VLANs
`(config-if)#switchport trunk native vlan 506`	Configure native VLAN.
`(config-if)# load-interval 30`	Set load interval
`(config-if)# mtu 9192`	Configure the MTU Size.
`(config-if)#exit`	Exit the interface mode.
`(conf)#rsvp-path p1-r1-r3 mpls`	Create RSVP path
`(conf-path)# 10.10.23.2 strict`	Configure nexthop
`(conf-path)#  10.10.21.2 strict`	Configure nexthop
`(conf)#rsvp-path sp1-r1-r3 mpls`	Create RSVP path
`(conf-path)#10.10.24.2 strict`	Configure nexthop
`(conf-path)#10.10.22.2 strict`	Configure nexthop
`(conf)#rsvp-path sp2-r1-r3 mpls`	Create RSVP path
`(conf-path)#10.10.25.2 strict`	Configure nexthop
`(conf-path)# 10.10.29.2 strict`	Configure nexthop
`(conf)#rsvp-path sp3-r1-r3 mpls`	Create RSVP path
`(conf-path)#10.10.26.2 strict`	Configure nexthop
`(conf-path)# 10.10.30.2 strict`	Configure nexthop
`(conf)#rsvp-path sp4-r1-r3 mpls`	Create RSVP path
`(conf-path)#10.10.27.2 strict`	Configure nexthop
`(conf-path)# 10.10.31.2 strict`	Configure nexthop
`(conf)#rsvp-path sp5-r1-r3 mpls`	Create RSVP path
`(conf-path)# 10.10.28.2 strict`	Configure nexthop

`(conf-path)#10.10.32.2 strict`	Configure nexthop
`(conf)#rsvp-trunk 47-49-test ipv4`	Create a RSVP trunk link
`(conf-trunk)#primary path p1-r1-r3`	Configure primary path for trunk link
`(conf-trunk)# secondary-priority 1 path sp1-r1-r3`	Configure secondary link for trunk link
`(conf-trunk)#secondary-priority 2 path sp2-r1-r3`	Configure secondary link for trunk link
`(conf-trunk)#secondary-priority 3 path sp3-r1-r3`	Configure secondary link for trunk link
`(conf-trunk)#secondary-priority 4 path sp4-r1-r3`	Configure secondary link for trunk link
`(conf-trunk)#secondary-priority 5 path sp5-r1-r3`	Configure secondary link for trunk link
`(conf-trunk)#to 49.49.49.49`	Configure remote node for the LSP

Validation

This example shows the number of configured RSVP sessions in a router.

R1

```
 # show rsvp session
Type  : PRI - Primary, SEC - Secondary, DTR - Detour, BPS - Bypass
State : UP - Up, DN - Down, BU - Backup in Use, SU - Secondary in Use, FS - Forced to
Secondary
* indicates the session is active with local repair at one or more nodes
(P) indicates the secondary-priority session is acting as primary

Ingress RSVP:
To              From            Type    LSPName                        State Uptime    Rt
Style  Labelin  Labelout  DSType
49.49.49.49     47.47.47.47     PRI     47-49-test-Primary                 UP    00:32:35
1 1 SE     -        24961     DEFAULT
49.49.49.49     47.47.47.47     SEC     47-49-test-Secondary-Priority-1 UP    00:32:35
1 1 SE     -        24962     DEFAULT
Total 2 displayed, Up 2, Down 0.

Egress RSVP:
To              From            Type    LSPName                        State Uptime    Rt
Style  Labelin  Labelout  DSType
47.47.47.47     49.49.49.49     PRI     49-47-test-Primary                 UP    00:32:53
1 1 SE     24964    -         ELSP_CON
47.47.47.47     49.49.49.49     PRI     49-47-test-Secondary-Priority-1 UP    00:32:47
1 1 SE     24962    -         ELSP_CON
Total 2 displayed, Up 2, Down 0.

# show rsvp trunk multi-sec-detail
Ingress (Secondary-Priority1)
49.49.49.49
  From: 47.47.47.47, LSPstate: Up, LSPname: 47-49-test-Secondary-Priority-1
  Ingress FSM state: Operational
  Establishment Time: 0s 253ms
```

```
  Setup priority: 7, Hold priority: 0
  CSPF usage: Enabled, CSPF Retry Count: 0, CSPF Retry Interval: 30 seconds
  LSP Re-Optimization: Disabled, Re-Optimization Timer: NA, Cspf Client: OSPF
  IGP-Shortcut: Disabled, LSP metric: 3
  LSP Protection: None
  Label in: -,  Label out:    24962,
  Tspec rate: 0, Fspec rate: 0
  Policer: Not Configured
  Tunnel Id: 5001, LSP Id: 2219, Ext-Tunnel Id: 47.47.47.47
  Downstream: 47.46.3.2, vlan1.1003
  Path refresh: 30 seconds (RR enabled) (due in 27970 seconds)
  Resv lifetime: 157 seconds (due in 138 seconds)
  Retry count: 0, intrvl: 30 seconds
  RRO re-use as ERO: Disabled
  Label Recording: Disabled
  Admin Groups: none
  Configured Path: SP1-47-49 (in use)
  Configured Explicit Route Detail :
   47.46.3.2/32 strict
   46.45.9.2/32 strict
   45.49.24.2/32 strict
  Session Explicit Route Detail :
   47.46.3.2/32 strict
   46.45.9.2/32 strict
   45.49.24.2/32 strict
  Record route:
   -------------------------------------------------------------
   IP Address        Label
   -------------------------------------------------------------
   <self>
   47.46.3.2
   46.45.9.2
   45.49.24.2
  Style: Shared Explicit Filter
  Traffic type: controlled-load
  Minimum Path MTU: 9216
  Last Recorded Error Code: None
  Last Recorded Error Value: None
  Node where Last Recorded Error originated: None
  Trunk Type: mpls
Ingress (Secondary-Priority2)
49.49.49.49
  From: 47.47.47.47, LSPstate: Dn, LSPname: 47-49-test-Secondary-Priority-2
  Ingress FSM state: Idle
  Setup priority: 7, Hold priority: 0
  CSPF usage: Enabled, CSPF Retry Count: 0, CSPF Retry Interval: 30 seconds
  LSP Re-Optimization: Disabled, Re-Optimization Timer: NA, Cspf Client: NA
  IGP-Shortcut: Disabled, LSP metric: 3
  LSP Protection: None
  Label in: -,  Label out: -,
```

```
  Tspec rate: 0, Fspec rate: 0
  Policer: Not Configured
  Tunnel Id: 5001, LSP Id: 2223, Ext-Tunnel Id: 47.47.47.47
  Last Recorded Error Code: None
  Last Recorded Error Value: None
  Node where Last Recorded Error originated: None
  Trunk Type: mpls
Ingress (Secondary-Priority3)
49.49.49.49
  From: 47.47.47.47, LSPstate: Dn, LSPname: 47-49-test-Secondary-Priority-3
  Ingress FSM state: Idle
  Setup priority: 7, Hold priority: 0
  CSPF usage: Enabled, CSPF Retry Count: 0, CSPF Retry Interval: 30 seconds
  LSP Re-Optimization: Disabled, Re-Optimization Timer: NA, Cspf Client: NA
  IGP-Shortcut: Disabled, LSP metric: 65
  LSP Protection: None
  Label in: -,  Label out: -,
  Tspec rate: 0, Fspec rate: 0
  Policer: Not Configured
  Tunnel Id: 5001, LSP Id: 2219, Ext-Tunnel Id: 47.47.47.47
  Last Recorded Error Code: Routing Problem (24)
  Last Recorded Error Value: No route available toward destination (5)
  Node where Last Recorded Error originated: None
  Trunk Type: mpls
Ingress (Secondary-Priority4)
49.49.49.49
  From: 47.47.47.47, LSPstate: Dn, LSPname: 47-49-test-Secondary-Priority-4
  Ingress FSM state: Idle
  Setup priority: 7, Hold priority: 0
  CSPF usage: Enabled, CSPF Retry Count: 0, CSPF Retry Interval: 30 seconds
  LSP Re-Optimization: Disabled, Re-Optimization Timer: NA, Cspf Client: NA
  IGP-Shortcut: Disabled, LSP metric: 65
  LSP Protection: None
  Label in: -,  Label out: -,
  Tspec rate: 0, Fspec rate: 0
  Policer: Not Configured
  Tunnel Id: 5001, LSP Id: 2219, Ext-Tunnel Id: 47.47.47.47
  Last Recorded Error Code: Routing Problem (24)
  Last Recorded Error Value: No route available toward destination (5)
  Node where Last Recorded Error originated: None
  Trunk Type: mpls
Ingress (Secondary-Priority5)
49.49.49.49
  From: 47.47.47.47, LSPstate: Dn, LSPname: 47-49-test-Secondary-Priority-5
  Ingress FSM state: Idle
  Setup priority: 7, Hold priority: 0
  CSPF usage: Enabled, CSPF Retry Count: 0, CSPF Retry Interval: 30 seconds
  LSP Re-Optimization: Disabled, Re-Optimization Timer: NA, Cspf Client: NA
  IGP-Shortcut: Disabled, LSP metric: 65
  LSP Protection: None
```

```
  Label in: -,  Label out: -,
  Tspec rate: 0, Fspec rate: 0
  Policer: Not Configured
  Tunnel Id: 5001, LSP Id: 2219, Ext-Tunnel Id: 47.47.47.47
  Last Recorded Error Code: Routing Problem (24)
  Last Recorded Error Value: No route available toward destination (5)
  Node where Last Recorded Error originated: None
  Trunk Type: mpls
```

R2

Bridge Configuration

bridge 1 protocol ieee vlan-bridge

no bridge 1 spanning-tree enable bridge-forward

VLAN creation (Peer configuration for R1)

vlan database

vlan 2-7 bridge 1 state enable

vlan 507-5012 bridge 1 state enable

VLAN creation (Peer configuration for R3)

vlan database

vlan 9-14 bridge 1 state enable

vlan 513-518 bridge 1 state enable

`#configure terminal`	Enter configure mode.
`(config)#router rsvp`	Enable RSVP globally.
`(config-router)#exit`	Exit RSVP mode.
`(config)#interface vlan1.2`	Enter the interface mode.
`(config-if)#ip address 10.10.23.2/24`	Configure the IP Address
`(config-if)#mtu 1600`	Configure MTU size.
`(config-if)#label-switching`	Enable MPLS.
`(config-if)#ip ospf network point-to-point`	Enable OSPF point-to-point network type.
`(config-if)#enable-rsvp`	Enable RSVP at the interface level.
`(config-if)#exit`	Exit the interface mode.
`(config)#interface vlan1.3`	Enter the interface mode.
`(config-if)#ip address 10.10.24.2/24`	Configure the IP Address
`(config-if)#mtu 1600`	Configure MTU size.
`(config-if)#label-switching`	Enable MPLS.

(config-if)#ip ospf network point-to-point	Enable OSPF point-to-point network type.
(config-if)#enable-rsvp	Enable RSVP at the interface level.
(config-if)#exit	Exit the interface mode.
(config)#interface vlan1.4	Enter the interface mode.
(config-if)#ip address 10.10.25.2/24	Configure the IP Address
(config-if)#mtu 1600	Configure MTU size.
(config-if)#label-switching	Enable MPLS.
(config-if)#ip ospf network point-to-point	Enable OSPF point-to-point network type.
(config-if)#enable-rsvp	Enable RSVP at the interface level.
(config-if)#exit	Exit the interface mode.
(config)#interface vlan1.5	Enter the interface mode.
(config-if)#ip address 10.10.26.2/24	Configure the IP Address
(config-if)#mtu 1600	Configure MTU size.
(config-if)#label-switching	Enable MPLS.
(config-if)#ip ospf network point-to-point	Enable OSPF point-to-point network type.
(config-if)#enable-rsvp	Enable RSVP at the interface level.
(config-if)#exit	Exit the interface mode.
(config)#interface vlan1.6	Enter the interface mode.
(config-if)#ip address 10.10.27.2/24	Configure the IP Address
(config-if)#mtu 1600	Configure MTU size.
(config-if)#label-switching	Enable MPLS.
(config-if)#ip ospf network point-to-point	Enable OSPF point-to-point network type.
(config-if)#enable-rsvp	Enable RSVP at the interface level.
(config-if)#exit	Exit the interface mode.
(config)#interface vlan1.7	Enter the interface mode.
(config-if)#ip address 10.10.28.2/24	Configure the IP Address
(config-if)#mtu 1600	Configure MTU size.
(config-if)#label-switching	Enable MPLS.
(config-if)#ip ospf network point-to-point	Enable OSPF point-to-point network type.
(config-if)#enable-rsvp	Enable RSVP at the interface level.
(config-if)#exit	Exit the interface mode.
(config)#interface vlan1.9	Enter the interface mode.
(config-if)#ip address 10.10.21.1/24	Configure the IP Address
(config-if)#mtu 1600	Configure MTU size.
(config-if)#label-switching	Enable MPLS.
(config-if)#ip ospf network point-to-point	Enable OSPF point-to-point network type.
(config-if)#enable-rsvp	Enable RSVP at the interface level.
(config-if)#exit	Exit the interface mode.
(config)#interface vlan1.10	Enter the interface mode.
(config-if)#ip address 10.10.22.1/24	Configure the IP Address
(config-if)#mtu 1600	Configure MTU size.

(config-if)#label-switching	Enable MPLS.
(config-if)#ip ospf network point-to-point	Enable OSPF point-to-point network type.
(config-if)#enable-rsvp	Enable RSVP at the interface level.
(config-if)#exit	Exit the interface mode.
(config)#interface vlan1.11	Enter the interface mode.
(config-if)#ip address 10.10.29.1/24	Configure the IP Address
(config-if)#mtu 1600	Configure MTU size.
(config-if)#label-switching	Enable MPLS.
(config-if)#ip ospf network point-to-point	Enable OSPF point-to-point network type.
(config-if)#enable-rsvp	Enable RSVP at the interface level.
(config-if)#exit	Exit the interface mode.
(config)#interface vlan1.12	Enter the interface mode.
(config-if)#ip address 10.10.30.1/24	Configure the IP Address
(config-if)#mtu 1600	Configure MTU size.
(config-if)#label-switching	Enable MPLS.
(config-if)#ip ospf network point-to-point	Enable OSPF point-to-point network type.
(config-if)#enable-rsvp	Enable RSVP at the interface level.
(config-if)#exit	Exit the interface mode.
(config)#interface vlan1.13	Enter the interface mode.
(config-if)#ip address 10.10.31.1/24	Configure the IP Address
(config-if)#mtu 1600	Configure MTU size.
(config-if)#label-switching	Enable MPLS.
(config-if)#ip ospf network point-to-point	Enable OSPF point-to-point network type.
(config-if)#enable-rsvp	Enable RSVP at the interface level.
(config-if)#exit	Exit the interface mode.
(config)#interface vlan1.14	Enter the interface mode.
(config-if)#ip address 10.10.32.1/24	Configure the IP Address
(config-if)#mtu 1600	Configure MTU size.
(config-if)#label-switching	Enable MPLS.
(config-if)#ip ospf network point-to-point	Enable OSPF point-to-point network type.
(config-if)#enable-rsvp	Enable RSVP at the interface level.
(config-if)#exit	Exit the interface mode.
(config)#interface eth2	Enter the interface mode.
(config-if)#switchport	Configure Switchport
(config-if)#bridge-group 1	Assign a Bridge ID to the port channel
(config-if)#switchport mode trunk	Configure trunk
(config-if)#switchport trunk allowed vlan add 2,507	Configure allowed VLANs
(config-if)#switchport trunk native vlan 507	Configure native VLAN.
(config-if)# load-interval 30	Set load interval
(config-if)# mtu 9192	Configure the MTU Size.

`(config-if)#exit`	Exit the interface mode.
`(config)#interface eth3`	Enter the interface mode.
`(config-if)#switchport`	Configure Switchport
`(config-if)#bridge-group 1`	Assign a Bridge ID to the port channel
`(config-if)#switchport mode trunk`	Configure trunk
`(config-if)#switchport trunk allowed vlan add 3,508`	Configure allowed VLANs
`(config-if)#switchport trunk native vlan 508`	Configure native VLAN.
`(config-if)# load-interval 30`	Set load interval
`(config-if)# mtu 9192`	Configure the MTU Size.
`(config-if)#exit`	Exit the interface mode.
`(config)#interface eth4`	Enter the interface mode.
`(config-if)#switchport`	Configure Switchport
`(config-if)#bridge-group 1`	Assign a Bridge ID to the port channel
`(config-if)#switchport mode trunk`	Configure trunk
`(config-if)#switchport trunk allowed vlan add 4,509`	Configure allowed VLANs
`(config-if)#switchport trunk native vlan 509`	Configure native VLAN.
`(config-if)# load-interval 30`	Set load interval
`(config-if)# mtu 9192`	Configure the MTU Size.
`(config-if)#exit`	Exit the interface mode.
`(config)#interface eth5`	Enter the interface mode.
`(config-if)#switchport`	Configure Switchport
`(config-if)#bridge-group 1`	Assign a Bridge ID to the port channel
`(config-if)#switchport mode trunk`	Configure trunk
`(config-if)#switchport trunk allowed vlan add 5,510`	Configure allowed VLANs
`(config-if)#switchport trunk native vlan 510`	Configure native VLAN.
`(config-if)# load-interval 30`	Set load interval
`(config-if)# mtu 9192`	Configure the MTU Size.
`(config-if)#exit`	Exit the interface mode.
`(config)#interface eth6`	Enter the interface mode.
`(config-if)#switchport`	Configure Switchport
`(config-if)#bridge-group 1`	Assign a Bridge ID to the port channel
`(config-if)#switchport mode trunk`	Configure trunk
`(config-if)#switchport trunk allowed vlan add 6,511`	Configure allowed VLANs
`(config-if)#switchport trunk native vlan 511`	Configure native VLAN.
`(config-if)# load-interval 30`	Set load interval
`(config-if)# mtu 9192`	Configure the MTU Size.
`(config-if)#exit`	Exit the interface mode.
`(config)#interface eth7`	Enter the interface mode.

(config-if)#switchport	Configure Switchport
(config-if)#bridge-group 1	Assign a Bridge ID to the port channel
(config-if)#switchport mode trunk	Configure trunk
(config-if)#switchport trunk allowed vlan add 7,512	Configure allowed VLANs
(config-if)#switchport trunk native vlan 512	Configure native VLAN.
(config-if)# load-interval 30	Set load interval
(config-if)# mtu 9192	Configure the MTU Size.
(config-if)#exit	Exit the interface mode.
(config)#interface eth9	Enter the interface mode.
(config-if)#switchport	Configure Switchport
(config-if)#bridge-group 1	Assign a Bridge ID to the port channel
(config-if)#switchport mode trunk	Configure trunk
(config-if)#switchport trunk allowed vlan add 9,513	Configure allowed VLANs
(config-if)#switchport trunk native vlan 513	Configure native VLAN.
(config-if)# load-interval 30	Set load interval
(config-if)# mtu 9192	Configure the MTU Size.
(config-if)#exit	Exit the interface mode.
(config)#interface eth10	Enter the interface mode.
(config-if)#switchport	Configure Switchport
(config-if)#bridge-group 1	Assign a Bridge ID to the port channel
(config-if)#switchport mode trunk	Configure trunk
(config-if)#switchport trunk allowed vlan add 10,514	Configure allowed VLANs
(config-if)#switchport trunk native vlan 514	Configure native VLAN.
(config-if)# load-interval 30	Set load interval
(config-if)# mtu 9192	Configure the MTU Size.
(config-if)#exit	Exit the interface mode.
(config)#interface eth11	Enter the interface mode.
(config-if)#switchport	Configure Switchport
(config-if)#bridge-group 1	Assign a Bridge ID to the port channel
(config-if)#switchport mode trunk	Configure trunk
(config-if)#switchport trunk allowed vlan add 11,515	Configure allowed VLANs
(config-if)#switchport trunk native vlan 515	Configure native VLAN.
(config-if)# load-interval 30	Set load interval
(config-if)# mtu 9192	Configure the MTU Size.
(config-if)#exit	Exit the interface mode.
(config)#interface eth12	Enter the interface mode.
(config-if)#switchport	Configure Switchport
(config-if)#bridge-group 1	Assign a Bridge ID to the port channel

`(config-if)#switchport mode trunk`	Configure trunk
`(config-if)#switchport trunk allowed vlan add 12,516`	Configure allowed VLANs
`(config-if)#switchport trunk native vlan 516`	Configure native VLAN.
`(config-if)# load-interval 30`	Set load interval
`(config-if)# mtu 9192`	Configure the MTU Size.
`(config-if)#exit`	Exit the interface mode.
`(config)#interface eth13`	Enter the interface mode.
`(config-if)#switchport`	Configure Switchport
`(config-if)#bridge-group 1`	Assign a Bridge ID to the port channel
`(config-if)#switchport mode trunk`	Configure trunk
`(config-if)#switchport trunk allowed vlan add 13,517`	Configure allowed VLANs
`(config-if)#switchport trunk native vlan 517`	Configure native VLAN.
`(config-if)# load-interval 30`	Set load interval
`(config-if)# mtu 9192`	Configure the MTU Size.
`(config-if)#exit`	Exit the interface mode.
`(config)#interface eth14`	Enter the interface mode.
`(config-if)#switchport`	Configure Switchport
`(config-if)#bridge-group 1`	Assign a Bridge ID to the port channel
`(config-if)#switchport mode trunk`	Configure trunk
`(config-if)#switchport trunk allowed vlan add 14,518`	Configure allowed VLANs
`(config-if)#switchport trunk native vlan 518`	Configure native VLAN.
`(config-if)# load-interval 30`	Set load interval
`(config-if)# mtu 9192`	Configure the MTU Size.
`(config-if)#exit`	Exit the interface mode.

R3

Bridge Configuration

bridge 1 protocol ieee vlan-bridge

no bridge 1 spanning-tree enable bridge-forward

VLAN creation

vlan database

vlan 9-14 bridge 1 state enable

vlan 519-524 bridge 1 state enable

`#configure terminal`	Enter configure mode.
`(config)#router rsvp`	Enable RSVP globally.
`(config-router)#exit`	Exit RSVP mode.

(config)#interface vlan1.9	Enter the interface mode.
(config-if)#ip address 10.10.21.2/24	Configure the IP Address
(config-if)#mtu 1600	Configure MTU size.
(config-if)#label-switching	Enable MPLS.
(config-if)#ip ospf network point-to-point	Enable OSPF point-to-point network type.
(config-if)#enable-rsvp	Enable RSVP at the interface level.
(config-if)#exit	Exit the interface mode.
(config)#interface vlan1.10	Enter the interface mode.
(config-if)#ip address 10.10.22.2/24	Configure the IP Address
(config-if)#mtu 1600	Configure MTU size.
(config-if)#label-switching	Enable MPLS.
(config-if)#ip ospf network point-to-point	Enable OSPF point-to-point network type.
(config-if)#enable-rsvp	Enable RSVP at the interface level.
(config-if)#exit	Exit the interface mode.
(config)#interface vlan1.11	Enter the interface mode.
(config-if)#ip address 10.10.29.2/24	Configure the IP Address
(config-if)#mtu 1600	Configure MTU size.
(config-if)#label-switching	Enable MPLS.
(config-if)#ip ospf network point-to-point	Enable OSPF point-to-point network type.
(config-if)#enable-rsvp	Enable RSVP at the interface level.
(config-if)#exit	Exit the interface mode.
(config)#interface vlan1.12	Enter the interface mode.
(config-if)#ip address 10.10.30.2/24	Configure the IP Address
(config-if)#mtu 1600	Configure MTU size.
(config-if)#label-switching	Enable MPLS.
(config-if)#ip ospf network point-to-point	Enable OSPF point-to-point network type.
(config-if)#enable-rsvp	Enable RSVP at the interface level.
(config-if)#exit	Exit the interface mode.
(config)#interface vlan1.13	Enter the interface mode.
(config-if)#ip address 10.10.31.2/24	Configure the IP Address
(config-if)#mtu 1600	Configure MTU size.
(config-if)#label-switching	Enable MPLS.
(config-if)#ip ospf network point-to-point	Enable OSPF point-to-point network type.
(config-if)#enable-rsvp	Enable RSVP at the interface level.
(config-if)#exit	Exit the interface mode.
(config)#interface vlan1.14	Enter the interface mode.
(config-if)#ip address 10.10.32.2/24	Configure the IP Address
(config-if)#mtu 1600	Configure MTU size.
(config-if)#label-switching	Enable MPLS.
(config-if)#ip ospf network point-to-point	Enable OSPF point-to-point network type.
(config-if)#enable-rsvp	Enable RSVP at the interface level.

(config-if)#exit	Exit the interface mode.
(config)#interface eth9	Enter the interface mode.
(config-if)#switchport	Configure Switchport
(config-if)#bridge-group 1	Assign a Bridge ID to the port channel
(config-if)#switchport mode trunk	Configure trunk
(config-if)#switchport trunk allowed vlan add 9,519	Configure allowed VLANs
(config-if)#switchport trunk native vlan 519	Configure native VLAN.
(config-if)# load-interval 30	Set load interval
(config-if)# mtu 9192	Configure the MTU Size.
(config-if)#exit	Exit the interface mode.
(config)#interface eth10	Enter the interface mode.
(config-if)#switchport	Configure Switchport
(config-if)#bridge-group 1	Assign a Bridge ID to the port channel
(config-if)#switchport mode trunk	Configure trunk
(config-if)#switchport trunk allowed vlan add 10,520	Configure allowed VLANs
(config-if)#switchport trunk native vlan 520	Configure native VLAN.
(config-if)# load-interval 30	Set load interval
(config-if)# mtu 9192	Configure the MTU Size.
(config-if)#exit	Exit the interface mode.
(config)#interface eth11	Enter the interface mode.
(config-if)#switchport	Configure Switchport
(config-if)#bridge-group 1	Assign a Bridge ID to the port channel
(config-if)#switchport mode trunk	Configure trunk
(config-if)#switchport trunk allowed vlan add 11,521	Configure allowed VLANs
(config-if)#switchport trunk native vlan 521	Configure native VLAN.
(config-if)# load-interval 30	Set load interval
(config-if)# mtu 9192	Configure the MTU Size.
(config-if)#exit	Exit the interface mode.
(config)#interface eth12	Enter the interface mode.
(config-if)#switchport	Configure Switchport
(config-if)#bridge-group 1	Assign a Bridge ID to the port channel
(config-if)#switchport mode trunk	Configure trunk
(config-if)#switchport trunk allowed vlan add 12,522	Configure allowed VLANs
(config-if)#switchport trunk native vlan 522	Configure native VLAN.
(config-if)# load-interval 30	Set load interval
(config-if)# mtu 9192	Configure the MTU Size.
(config-if)#exit	Exit the interface mode.
(config)#interface eth13	Enter the interface mode.

(config-if)#switchport	Configure Switchport
(config-if)#bridge-group 1	Assign a Bridge ID to the port channel
(config-if)#switchport mode trunk	Configure trunk
(config-if)#switchport trunk allowed vlan add 13,523	Configure allowed VLANs
(config-if)#switchport trunk native vlan 523	Configure native VLAN.
(config-if)# load-interval 30	Set load interval
(config-if)# mtu 9192	Configure the MTU Size.
(config-if)#exit	Exit the interface mode.
(config)#interface eth14	Enter the interface mode.
(config-if)#switchport	Configure Switchport
(config-if)#bridge-group 1	Assign a Bridge ID to the port channel
(config-if)#switchport mode trunk	Configure trunk
(config-if)#switchport trunk allowed vlan add 14,524	Configure allowed VLANs
(config-if)#switchport trunk native vlan 524	Configure native VLAN.
(config-if)# load-interval 30	Set load interval
(config-if)# mtu 9192	Configure the MTU Size.
(config-if)#exit	Exit the interface mode.
(conf)#rsvp-path sp1-r3-r1 mpls	Create RSVP path
(conf-path)# 10.10.21.1 strict	Configure nexthop
(conf-path)# 10.10.23.1 strict	Configure nexthop
(conf)#rsvp-path sp2-r3-r1 mpls	Create RSVP path
(conf-path)#10.10.22.1 strict	Configure nexthop
(conf-path)#10.10.24.1 strict	Configure nexthop
(conf)#rsvp-path sp2-r3-r1 mpls	Create RSVP path
(conf-path)#10.10.29.2 strict	Configure nexthop
(conf-path)# 10.10.25.1 strict	Configure nexthop
(conf)#rsvp-path sp3-r3-r1 mpls	Create RSVP path
(conf-path)#10.10.30.1 strict	Configure nexthop
(conf-path)# 10.10.26.1 strict	Configure nexthop
(conf)#rsvp-path sp4-r3-r1 mpls	Create RSVP path
(conf-path)#10.10.31.1 strict	Configure nexthop
(conf-path)# 10.10.27.1 strict	Configure nexthop
(conf)#rsvp-path sp5-r3-r1 mpls	Create RSVP path
(conf-path)# 10.10.32.1 strict	Configure nexthop
(conf-path)#10.10.28.1 strict	Configure nexthop
(conf)#rsvp-trunk 49-47-test ipv4	Create a RSVP trunk link
(conf-trunk)#primary path p1-r3-r1	Configure primary path for trunk link
(conf-trunk)# secondary-priority 1 path sp1-r3-r1	Configure secondary link for trunk link

(conf-trunk)#secondary-priority 2 path sp2-r3-r1	Configure secondary link for trunk link
(conf-trunk)#secondary-priority 3 path sp3-r3-r1	Configure secondary link for trunk link
(conf-trunk)#secondary-priority 4 path sp4-r3-r1	Configure secondary link for trunk link
(conf-trunk)#secondary-priority 5 path sp5-r3-r1	Configure secondary link for trunk link
(conf-trunk)#to 47.47.47.47	Configure remote node for the LSP

Validation

This example shows the number of configured RSVP sessions in a router.

R3

```
 # show rsvp session
Type  : PRI - Primary, SEC - Secondary, DTR - Detour, BPS - Bypass
State : UP - Up, DN - Down, BU - Backup in Use, SU - Secondary in Use, FS - Forced to
Secondary
* indicates the session is active with local repair at one or more nodes
(P) indicates the secondary-priority session is acting as primary

Ingress RSVP:
To              From            Type    LSPName                        State Uptime    Rt
Style  Labelin  Labelout  DSType
47.47.47.47      49.49.49.49     PRI     49-47-test-Primary              UP    00:34:57
1 1 SE     -        24970     DEFAULT
47.47.47.47      49.49.49.49     SEC     49-47-test-Secondary-Priority-1 UP    00:34:56
1 1 SE     -        24968     DEFAULT
Total 2 displayed, Up 2, Down 0.

Egress RSVP:
To              From            Type    LSPName                        State Uptime    Rt
Style  Labelin  Labelout  DSType
49.49.49.49      47.47.47.47     PRI     47-49-test-Primary              UP    00:34:45
1 1 SE     31364    -         ELSP_CON
49.49.49.49      47.47.47.47     PRI     47-49-test-Secondary-Priority-1 UP    00:34:44
1 1 SE     31360    -         ELSP_CON
Total 2 displayed, Up 2, Down 0.

# show rsvp trunk multi-sec-detail
Ingress (Secondary-Priority1)
47.47.47.47
  From: 49.49.49.49, LSPstate: Up, LSPname: 49-47-test-Secondary-Priority-1
  Ingress FSM state: Operational
  Establishment Time: 1s 71ms
  Setup priority: 7, Hold priority: 0
  CSPF usage: Enabled, CSPF Retry Count: 0, CSPF Retry Interval: 30 seconds
  LSP Re-Optimization: Disabled, Re-Optimization Timer: NA, Cspf Client: OSPF
  IGP-Shortcut: Disabled, LSP metric: 3
  LSP Protection: None
```

```
  Label in: -,  Label out:    24968,
  Tspec rate: 0, Fspec rate: 0
  Policer: Not Configured
  Tunnel Id: 5001, LSP Id: 2214, Ext-Tunnel Id: 49.49.49.49
  Downstream: 45.49.24.1, vlan1.1024
  Path refresh: 30 seconds (RR enabled) (due in 27829 seconds)
  Resv lifetime: 157 seconds (due in 145 seconds)
  Retry count: 0, intrvl: 30 seconds
  RRO re-use as ERO: Disabled
  Label Recording: Disabled
  Admin Groups: none
  Configured Path: SP1-49-47 (in use)
  Configured Explicit Route Detail :
   45.49.24.1/32 strict
   46.45.9.1/32 strict
   47.46.3.1/32 strict
  Session Explicit Route Detail :
   45.49.24.1/32 strict
   46.45.9.1/32 strict
   47.46.3.1/32 strict
  Record route:
   -------------------------------------------------------------
   IP Address        Label
   -------------------------------------------------------------
   <self>
   45.49.24.1
   46.45.9.1
   47.46.3.1
  Style: Shared Explicit Filter
  Traffic type: controlled-load
  Minimum Path MTU: 9216
  Last Recorded Error Code: None
  Last Recorded Error Value: None
  Node where Last Recorded Error originated: None
  Trunk Type: mpls
Ingress (Secondary-Priority2)
47.47.47.47
  From: 49.49.49.49, LSPstate: Dn, LSPname: 49-47-test-Secondary-Priority-2
  Ingress FSM state: Idle
  Setup priority: 7, Hold priority: 0
  CSPF usage: Enabled, CSPF Retry Count: 0, CSPF Retry Interval: 30 seconds
  LSP Re-Optimization: Disabled, Re-Optimization Timer: NA, Cspf Client: NA
  IGP-Shortcut: Disabled, LSP metric: 3
  LSP Protection: None
  Label in: -,  Label out: -,
  Tspec rate: 0, Fspec rate: 0
  Policer: Not Configured
  Tunnel Id: 5001, LSP Id: 2215, Ext-Tunnel Id: 49.49.49.49
  Last Recorded Error Code: None
  Last Recorded Error Value: None
```



```
  Node where Last Recorded Error originated: None
  Trunk Type: mpls
Ingress (Secondary-Priority3)
47.47.47.47
  From: 49.49.49.49, LSPstate: Dn, LSPname: 49-47-test-Secondary-Priority-3
  Ingress FSM state: Idle
  Setup priority: 7, Hold priority: 0
  CSPF usage: Enabled, CSPF Retry Count: 0, CSPF Retry Interval: 30 seconds
  LSP Re-Optimization: Disabled, Re-Optimization Timer: NA, Cspf Client: NA
  IGP-Shortcut: Disabled, LSP metric: 65
  LSP Protection: None
  Label in: -,  Label out: -,
  Tspec rate: 0, Fspec rate: 0
  Policer: Not Configured
  Tunnel Id: 5001, LSP Id: 2213, Ext-Tunnel Id: 49.49.49.49
  Last Recorded Error Code: Routing Problem (24)
  Last Recorded Error Value: No route available toward destination (5)
  Node where Last Recorded Error originated: None
  Trunk Type: mpls
Ingress (Secondary-Priority4)
47.47.47.47
  From: 49.49.49.49, LSPstate: Dn, LSPname: 49-47-test-Secondary-Priority-4
  Ingress FSM state: Idle
  Setup priority: 7, Hold priority: 0
  CSPF usage: Enabled, CSPF Retry Count: 0, CSPF Retry Interval: 30 seconds
  LSP Re-Optimization: Disabled, Re-Optimization Timer: NA, Cspf Client: NA
  IGP-Shortcut: Disabled, LSP metric: 65
  LSP Protection: None
  Label in: -,  Label out: -,
  Tspec rate: 0, Fspec rate: 0
  Policer: Not Configured
  Tunnel Id: 5001, LSP Id: 2213, Ext-Tunnel Id: 49.49.49.49
  Last Recorded Error Code: Routing Problem (24)
  Last Recorded Error Value: No route available toward destination (5)
  Node where Last Recorded Error originated: None
  Trunk Type: mpls
Ingress (Secondary-Priority5)
47.47.47.47
  From: 49.49.49.49, LSPstate: Dn, LSPname: 49-47-test-Secondary-Priority-5
  Ingress FSM state: Idle
  Setup priority: 7, Hold priority: 0
  CSPF usage: Enabled, CSPF Retry Count: 0, CSPF Retry Interval: 30 seconds
  LSP Re-Optimization: Disabled, Re-Optimization Timer: NA, Cspf Client: NA
  IGP-Shortcut: Disabled, LSP metric: 65
  LSP Protection: None
  Label in: -,  Label out: -,
  Tspec rate: 0, Fspec rate: 0
  Policer: Not Configured
  Tunnel Id: 5001, LSP Id: 2213, Ext-Tunnel Id: 49.49.49.49
  Last Recorded Error Code: Routing Problem (24)
```

```
Last Recorded Error Value: No route available toward destination (5)
Node where Last Recorded Error originated: None
Trunk Type: mpls
```

Add Administrative Group Constraints to an LSP

To add administrative group constraints (also known as color constraints) to an LSP:

- Configure support for required administrative groups in NSM on all participating routers
- Configure required administrative groups on all participating interfaces

The configuration in this example forces the primary LSP to be setup through links that belong either to administrative group A or C. A link that does not belong to either of these administrative groups will not be used for setting up the LSP.

Note: This example is based on the assumption that a minimal configuration exists on all participating routers as described in Enable Label Switching - Minimal Configuration.

R1 - NSM

#configure terminal	Enter configure mode.
(config)#mpls admin-group A 0	Add new administrative groups, specify their names and assign bit values to them.
(config)#mpls admin-group B 1	
(config)#mpls admin-group C 2	
(config)#mpls admin-group D 3	
(config)#mpls admin-group E 4	
(config)#interface eth0	Enter interface mode.
(config-if)#admin-group A	Add administrative groups to the links. When used in the interface mode, this command adds a link between an interface and a group. The name is the name of the group previously configured. You can have multiple groups per interface.
(config-if)#admin-group B	
(config-if)#admin-group C	
(config-if)#exit	Exit interface mode.
(config)#interface eth2	Enter interface mode.
(config-if)#admin-group E	Add administrative groups to the links. When used in the interface mode, this command adds a link between an interface and a group. The name is the name of the group previously configured. You can have multiple groups per interface.
(config-if)#admin-group D	
(config-if)#exit	Exit interface mode.

R2 - NSM

#configure terminal	Enter configure mode.
(config)#mpls admin-group A 0	Add new administrative groups and specify their names and assign bit values to them.
(config)#mpls admin-group C 2	
(config)#interface eth2	Enter interface mode

`(config-if)#admin-group A` `(config-if)#admin-group C`	Add administrative groups to the links. When used in the interface mode, this command adds a link between an interface and a group. The name is the name of the group previously configured. You can have multiple groups per interface.
`(config-if)#exit`	Exit interface mode.

R1 - RSVP-TE

`#configure terminal`	Enter configure mode.
`(config)#rsvp-trunk T1`	Create an RSVP trunk `T1` and enter the Trunk mode.
`(config-trunk)#primary no-cspf`	Since CSPF is enabled by default, specify `no-cspf` if CSPF is not required.
`(config-trunk)#primary path P1`	Specify an RSVP primary path to be used.
`(config-trunk)#primary no-cspf`	Specify the `no-cspf` option for the LSP.
`(config-trunk)#primary include-any A`	Set up the LSP with admin group constraint A.
`(config-trunk)#primary include-any C`	Set up the LSP with admin group constraint C.
`(config-trunk)#to 192.168.0.90`	Specify the IPv4 egress (destination point) for the LSP.

Configure Global Parameters

Some common parameters can be configured in the Router mode on the RSVP-TE daemon. These parameters are global and affect all LSPs. In the following example the interval between two consecutive hello messages is set. The neighbor is defined by the neighbor command. Hello exchanges are enabled only between explicitly configured neighbors (configure this router as a neighbor on R2 (IP address `10.10.23.60`).

Note: This example is based on the assumption that a minimal configuration exists on all participating routers as described in Enable Label Switching - Minimal Configuration.

R1 - RSVP-TE

`#configure terminal`	Enter configure mode.
`(config)#router rsvp`	Enter the router mode for RSVP.
`(config-router)#hello-interval 10`	Set the `hello-interval` (in seconds) between hello packets.
`(config-router)#hello-timeout 35`	Set the `hello-timeout value`. If an LSR has not received a Hello message from a peer within this period, all sessions shared with this peer are reset.
`(config-router)#neighbor 10.10.23.60`	Explicitly specify the neighbor to exchange Hello messages with.

R2 - RSVP-TE

`#configure terminal`	Enter configure mode.
`(config)#router rsvp`	Enter the router mode for RSVP.
`(config-router)#hello-interval 10`	Set the `hello-interval` (in seconds) between hello packets.

(config-router)#hello-timeout 35	Set the `hello-timeout value`. If an LSR has not received a Hello message from a peer within this period, all sessions shared with this peer are reset.
(config-router)#neighbor 10.10.23.63	Explicitly specify the neighbor to exchange Hello messages with.

Fast Reroute Configuration (one-to-one method)

The Fast Reroute (FRR) configuration is a MPLS resiliency technology that provides fast traffic recovery when there is a link or router failure on mission critical services. These mechanisms enable the re-direction of traffic onto backup LSP tunnels in tens of milliseconds, in the event of a failure. The one-to-one backup method creates detour LSPs for each protected LSP at each potential point of local repair. This method is used to protect links and nodes during network failure.

In the below configurations each FRR trunk is mapped to VPWS,VPLS and L3 VPN services.So it includes configurations of VPWS,VPLS and L3 VPN also.

Figure 3-7 is a simple topology example for FRR:

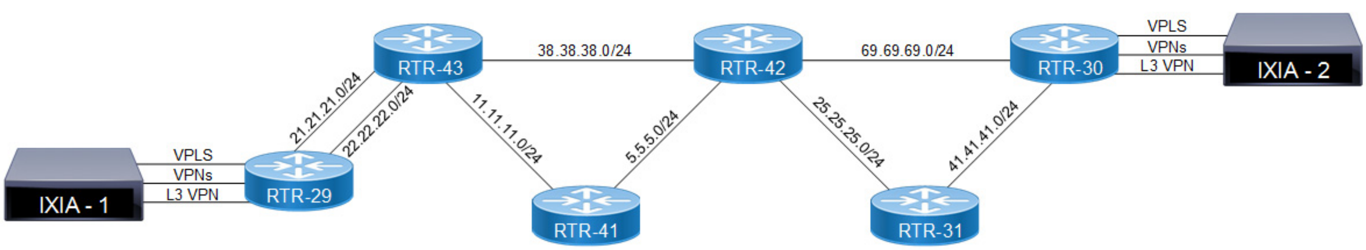


Figure 3-7: Topology Example for Fast Reroute

RTR-29

#configure terminal	Enter configure mode.
(config)#interface lo	Enter interface mode.
(config-if)#ip address 29.29.29.29/32 secondary	Set a secondary IP address of the interface
(config-if)#no shutdown	Administratively bring the interface up.
(config-if)#exit	Exit interface mode.
(config)#router-id 29.29.29.29	Configure the router ID.
(config)#router rsvp	Enter to router rsvp mode.
(config-router)#no-php	Disable PHP
(config-router)#exit	Exit the router mode
(config)#router ldp	Enter to router LDP mode.
(config-router)# targeted-peer ipv4 30.30.30.30	Configure targeted peer.
(config-router-targeted-peer)# exit-targeted-peer-mode	Exit-targeted-peer-mode
(config-router)#exit	Exit router mode

`(config)#interface xe21`	Enter interface mode.
`(config-if)#label-switching`	Enable label switching on interface.
`(config-if)#ip address 21.21.21.29/24`	Set an IP address of the interface.
`(config-if)#no shutdown`	Administratively no shutdown the interface.
`(config-if)#enable-rsvp`	Enable RSVP message exchange on this interface.
`(config-if)#enable-ldp ipv4`	Enable LDP on this interface
`(config-if)#exit`	Exit interface mode.
`(config)#interface xe22`	Enter interface mode.
`(config-if)#label-switching`	Enable label switching on interface
`(config-if)#enable-ldp ipv4`	Enable LDP on this interface
`(config-if)#ip address 22.22.22.29/24`	Set an IP address of the interface.
`(config-if)#no shutdown`	Administratively no shutdown the interface.
`(config-if)#enable-rsvp`	Enable RSVP message exchange on this interface.
`(config-if)#exit`	Exit interface mode.
`(config)#router ospf`	Enter the router configure mode for OSPF.
`(config-router)#router-id 29.29.29.29`	Configure OSPF router-ID same as loopback interface IP address

`(config-router)#network 21.21.21.0/24 area 0`
`(config-router)#network 22.22.22.0/24 area 0`
`(config-router)#network 29.29.29.29/32 area 0`
	Define the network on which OSPF runs and associate the area ID

`(config-router)#exit`	Exit the router configure mode.
`(config)#rsvp-path p21`	Enter the path mode for RSVP pt1.
`(config-path)# 21.21.21.43 strict`	Configure this explicit route path as a strict hop.
`(config-path)# 38.38.38.42 strict`	Configure this explicit route path as a strict hop.
`(config-path)#69.69.69.30 strict`	Configure this explicit route path as a strict hop.
`(config)#exit`	Exit the path mode.
`(config)#rsvp-trunk to_30 ipv4`	Enter the trunk mode for RSVP.
`(config-trunk)#primary fast-reroute protection one-to-one`	Configure primary fast-reroute protection facility for a trunk.
`(config-trunk)# primary fast-reroute node-protection`	Configure primary fast-reroute node protection for the trunk
`(config-trunk)#primary path p21`	Configure trunk to 30 to use the defined path.
`(config-trunk)#to 30.30.30.30`	Specify the IPv4 egress (destination point) for the LSP.
`(config-trunk)#exit`	Exit from trunk mode.
`(config)#ip vrf vrf1`	Configure VRF instance
`(config-vrf)# rd 100:1`	Configure Router Distinguisher value
`(config-vrf)# route-target both 100:1`	Configure route-target as both
`(config-vrf)#exit`	Exit the path mode.
`(config)#interface xe43`	Enter to the interface mode
`(config-if)#ip vrf forwarding vrf1`	Bind the VRF instance to the interface
`(config-if)#ip address 43.43.43.29/24`	Configure IP address
`(config-if)#exit`	Exit interface mode.

`(config)# router bgp 100`	Configure BGP router instance
`(config-router)#neighbor 30.30.30.30 remote-as 100`	Configure neighbor with remote-as
`(config-router)#neighbor 30.30.30.30 update-source 29.29.29.29`	Configure update source as loopback address
`(config-router)#address-family vpnv4 unicast`	Configure VPNv4 address family
`(config-router-af)#neighbor 30.30.30.30 activate`	Activate the VPN neighbor
`(config-router-af)#exit-address-family`	Exit the VPN address family
`(config-router)#address-family ipv4 vrf vrf1`	Configure VRF address family
`(config-router-af)redistribute connected`	Redistribute connected route
`(config-router-af)exit-address-family`	Exit VRF address family
`(config-router)#exit`	Exit router mode
`(config)#mpls l2-circuit vlan10 10 30.30.30.30`	Configure Virtual circuit.
`(config-pseudowire)#exit`	Exit pseudowire config mode.
`(config)#service-template st1`	Template configuration
`(config-svc)#match outer-vlan 10`	Match criteria under template configuration
`(config-svc)#exit`	Exit service template mode
`(config)#service-template st2`	Template configuration
`(config-svc)#match outer-vlan 30`	Match criteria under template configuration
`(config-svc)#exit`	Exit service template mode
`(config)#interface xe44`	Enter interface configuration mode
`(config-if)#switchport`	Configure interface as switch port
`(config-if)#mpls-l2-circuit t1 service-template st1`	Bind the interface to the VC with service template
`(config-if)#exit`	Exit interface configuration mode
`(config)#mpls vpls vpls30 30`	Configure VPLS instance
`(config-vpls)#signaling ldp`	Configure VPLS signaling as LDP
`(config-vpls-sig)#vpls-type vlan`	Configure VPLS type as VLAN encapsulation
`(config-vpls-sig)#vpls-peer 30.30.30.30`	Configure VPLS peer
`(config-vpls-sig)#exit-signaling`	Exit VPLS configuration mode
`(config)#interface xe45`	Enter interface configuration mode
`(config-if)#switchport`	Configure interface as switch port
`(config-if)#mpls-vpls vpls30 service-template st2`	Bind the VPLS instance to the interface
`(config-if-vpls)#exit`	Exit VPLS attachment-circuit mode
`(config-if)#end`	Exit the interface and configure mode

RTR-43

`#configure terminal`	Enter configure mode.
`(config)#interface lo`	Enter interface mode.

(config-if)#ip address 43.43.43.43/32 secondary	Set a secondary IP address of the interface
(config-if)#no shutdown	Administratively shutdown the interface.
(config-if)#exit	Exit interface mode.
(config)#router-id 43.43.43.43	Configure the router ID.
(config)#router rsvp	Enter to router RSVP mode.
(config-router)#no-php	Disable PHP
(config-router)#exit	Exit the router mode
(config)#interface xe5/1	Enter interface mode.
(config-if)#label-switching	Enable label switching on interface.
(config-if)#ip address 11.11.11.43/24	Set an IP address of the interface.
(config-if)#no shutdown	Administratively no shutdown the interface.
(config-if)#enable-rsvp	Enable RSVP message exchange on this interface.
(config-if)#exit	Exit interface mode.
(config)#interface xe9/1	Enter interface mode.
(config-if)#label-switching	Enable label switching on interface
(config-if)#ip address 21.21.21.43/24	Set an IP address of the interface.
(config-if)#no shutdown	Administratively no shutdown the interface.
(config-if)#enable-rsvp	Enable RSVP message exchange on this interface.
(config-if)#exit	Exit interface mode.
(config)#interface xe9/2	Enter interface mode.
(config-if)#label-switching	Enable label switching on interface.
(config-if)#ip address 22.22.22.43/24	Set an IP address of the interface.
(config-if)#no shutdown	Administratively no shutdown the interface.
(config-if)#enable-rsvp	Enable RSVP message exchange on this interface.
(config-if)#exit	Exit interface mode.
(config)#interface xe13/2	Enter interface mode.
(config-if)#label-switching	Enable label switching on interface
(config-if)#ip address 38.38.38.43/24	Set an IP address of the interface.
(config-if)#no shutdown	Administratively no shutdown the interface.
(config-if)#enable-rsvp	Enable RSVP message exchange on this interface.
(config-if)#exit	Exit interface mode.
(config)#router ospf	Enter the router configure mode for OSPF.
(config-router)#router-id 43.43.43.43	Configure OSPF router-ID same as loopback interface IP address
(config-router)#network 11.11.11.0/24 area 0 (config-router)#network 22.22.22.0/24 area 0 (config-router)#network 21.21.21.0/24 area 0 (config-router)#network 38.38.38.0/24 area 0 (config-router)#network 43.43.43.43/32 area 0	Define the network on which OSPF runs and associate the area ID
(config-router)#end	Exit the router and configure mode.

RTR-42

`#configure terminal`	Enter configure mode.
`(config)#interface lo`	Enter interface mode.
`(config-if)#ip address 42.42.42.42/32 secondary`	Set a secondary IP address of the interface
`(config-if)#no shutdown`	Administratively shutdown the interface.
`(config-if)#exit`	Exit interface mode.
`(config)#router-id 42.42.42.42`	Configure the router ID.
`(config)#router rsvp`	Enter to router RSVP mode.
`(config-router)#no-php`	Disable PHP
`(config-router)#exit`	Exit the router mode
`(config)#interface xe2`	Enter interface mode.
`(config-if)#label-switching`	Enable label switching on interface.
`(config-if)#ip address 5.5.5.42/24`	Set an IP address of the interface.
`(config-if)#no shutdown`	Administratively no shutdown the interface.
`(config-if)#enable-rsvp`	Enable RSVP message exchange on this interface.
`(config-if)#exit`	Exit interface mode.
`(config)#interface xe10/1`	Enter interface mode.
`(config-if)#label-switching`	Enable label switching on interface
`(config-if)#ip address 25.25.25.42/24`	Set an IP address of the interface.
`(config-if)#no shutdown`	Administratively no shutdown the interface.
`(config-if)#enable-rsvp`	Enable RSVP message exchange on this interface.
`(config-if)#exit`	Exit interface mode.
`(config)#interface xe3`	Enter interface mode.
`(config-if)#label-switching`	Enable label switching on interface.
`(config-if)#ip address 38.38.38.42/24`	Set an IP address of the interface.
`(config-if)#no shutdown`	Administratively no shutdown the interface.
`(config-if)#enable-rsvp`	Enable RSVP message exchange on this interface.
`(config-if)#exit`	Exit interface mode.
`(config)#interface xe4`	Enter interface mode
`(config-if)#label-switching`	Enable label switching on interface
`(config-if)#ip address 69.69.69.42/24`	Specify an IP address for the interface
`(config-if)#no shutdown`	Administratively no shutdown the interface
`(config-if)#enable-rsvp`	Enable RSVP message exchange on this interface
`(config-if)#exit`	Exit interface mode
`(config)#router ospf`	Enter the router configure mode for OSPF.
`(config-router)#router-id 42.42.42.42`	Configure OSPF router-ID same as loopback interface IP address

(config-router)#network 5.5.5.0/24 area 0 (config-router)#network 25.25.25.0/24 area 0 (config-router)#network 69.69.69.0/24 area 0 (config-router)#network 38.38.38.0/24 area 0 (config-router)#network 42.42.42.42/32 area 0	Define the network on which OSPF runs and associate the area ID
(config-router)#end	Exit the router and configure mode.

RTR-41

#configure terminal	Enter configure mode.
(config)#interface lo	Enter interface mode.
(config-if)#ip address 44.44.44.44/32 secondary	Set a secondary IP address of the interface
(config-if)#no shutdown	Administratively no shutdown the interface.
(config-if)#exit	Exit interface mode.
(config)#router-id 44.44.44.44	Configure the router ID.
(config)#router rsvp	Enter to router RSVP mode.
(config-router)#no-php	Disable PHP
(config-router)#exit	Exit the router mode
(config)#interface xe1/1	Enter interface mode.
(config-if)#label-switching	Enable label switching on interface.
(config-if)#ip address 1.1.1.41/24	Set an IP address of the interface.
(config-if)#no shutdown	Administratively no shutdown the interface.
(config-if)#enable-rsvp	Enable RSVP message exchange on this interface.
(config-if)#exit	Exit interface mode.
(config)#interface xe2	Enter interface mode.
(config-if)#label-switching	Enable label switching on interface
(config-if)#ip address 5.5.5.41/24	Set an IP address of the interface.
(config-if)#no shutdown	Administratively no shutdown the interface.
(config-if)#enable-rsvp	Enable RSVP message exchange on this interface.
(config-if)#exit	Exit interface mode.
(config)#interface xe5/1	Enter interface mode.
(config-if)#label-switching	Enable label switching on interface.
(config-if)#ip address 11.11.11.41/24	Set an IP address of the interface.
(config-if)#no shutdown	Administratively no shutdown the interface.
(config-if)#enable-rsvp	Enable RSVP message exchange on this interface.
(config-if)#exit	Exit interface mode.
(config)#router ospf	Enter the router configure mode for OSPF.
(config-router)#router-id 44.44.44.44	Configure OSPF router-ID same as loopback interface IP address

(config-router)#network 5.5.5.0/24 area 0 (config-router)#network 1.1.1.0/24 area 0 (config-router)#network 11.11.11.0/24 area 0 (config-router)#network 44.44.44.44/32 area 0	Define the network on which OSPF runs and associate the area ID
(config-router)#end	Exit the router and configure mode.

RTR-31

#configure terminal	Enter configure mode.
(config)#interface lo	Enter interface mode.
(config-if)#ip address 31.31.31.31/32 secondary	Set a secondary IP address of the interface
(config-if)#no shutdown	Administratively shutdown the interface.
(config-if)#exit	Exit interface mode.
(config)#router-id 31.31.31.31	Configure the router ID.
(config)#router rsvp	Enter to router RSVP mode.
(config-router)#no-php	Disable PHP
(config-router)#exit	Exit the router mode
(config)#interface xe1	Enter interface mode.
(config-if)#label-switching	Enable label switching on interface.
(config-if)#ip address 1.1.1.31/24	Set an IP address of the interface.
(config-if)#no shutdown	Administratively no shutdown the interface.
(config-if)#enable-rsvp	Enable RSVP message exchange on this interface.
(config-if)#exit	Exit interface mode.
(config)#interface xe25	Enter interface mode.
(config-if)#label-switching	Enable label switching on interface
(config-if)#ip address 25.25.25.31/24	Set an IP address of the interface.
(config-if)#no shutdown	Administratively no shutdown the interface.
(config-if)#enable-rsvp	Enable RSVP message exchange on this interface.
(config-if)#exit	Exit interface mode.
(config)#interface xe41	Enter interface mode.
(config-if)#label-switching	Enable label switching on interface.
(config-if)#ip address 41.41.41.31/24	Set an IP address of the interface.
(config-if)#no shutdown	Administratively no shutdown the interface.
(config-if)#enable-rsvp	Enable RSVP message exchange on this interface.
(config-if)#exit	Exit interface mode.
(config)#router ospf	Enter the router configure mode for OSPF.
(config-router)#router-id 31.31.31.31	Configure OSPF router-ID same as loopback interface IP address

(config-router)#network 1.1.1.0/24 area 0 (config-router)#network 25.25.25.0/24 area 0 (config-router)#network 41.41.41.0/24 area 0 (config-router)#network 31.31.31.31/32 area 0	Define the network on which OSPF runs and associate the area ID
(config-router)#end	Exit the router and configure mode.

RTR-30

#configure terminal	Enter configure mode.
(config)#interface lo	Enter interface mode.
(config-if)#ip address 30.30.30.30/32 secondary	Set a secondary IP address of the interface
(config-if)#no shutdown	Administratively shutdown the interface.
(config-if)#exit	Exit interface mode.
(config)#router-id 30.30.30.30	Configure the router ID.
(config)#router rsvp	Enter to router RSVP mode.
(config-router)#no-php	Disable PHP
(config-router)#exit	Exit the router mode
(config)#router ldp	Enter to router LDP mode.
(config-router)# targeted-peer ipv4 29.29.29.29	Configure targeted peer.
(config-router-targeted-peer)# exit-targeted-peer-mode	Exit-targeted-peer-mode
(config-router)#exit	Exit router mode
(config)#interface xe41	Enter interface mode.
(config-if)#label-switching	Enable label switching on interface.
(config-if)#ip address 41.41.41.30/24	Set an IP address of the interface.
(config-if)#no shutdown	Administratively no shutdown the interface.
(config-if)#enable-rsvp	Enable RSVP message exchange on this interface.
(config-if)#enable-ldp ipv4	Enable LDP on this interface
(config-if)#exit	Exit interface mode.
(config)#interface xe54/1	Enter interface mode.
(config-if)#label-switching	Enable label switching on interface
(config-if)#enable-ldp ipv4	Enable LDP on this interface
(config-if)#ip address 69.69.69.30/24	Set an IP address of the interface.
(config-if)#no shutdown	Administratively no shutdown the interface.
(config-if)#enable-rsvp	Enable RSVP message exchange on this interface.
(config-if)#exit	Exit interface mode.
(config)#router ospf	Enter the router configure mode for OSPF.
(config-router)#router-id 30.30.30.30	Configure OSPF router-ID same as loopback interface IP address

(config-router)#network 41.41.41.0/24 area 0 (config-router)#network 69.69.69.0/24 area 0 (config-router)#network 30.30.30.30/32 area 0	Define the network on which OSPF runs and associate the area ID
(config-router)#exit	Exit the router configure mode.
(config)#rsvp-path p41	Enter the path mode for RSVP pt1.
(config-path)# 41.41.41.31 strict	Configure this explicit route path as a strict hop.
(config-path)# 1.1.1.41 strict	Configure this explicit route path as a strict hop.
(config-path)#11.11.11.43 strict	Configure this explicit route path as a strict hop.
(config)#exit	Exit the path mode.
(config)#rsvp-trunk to_29 ipv4	Enter the trunk mode for rsvp.
(config-trunk)#primary fast-reroute protection one-to-one	Configure primary fast-reroute protection facility for a trunk.
(config-trunk)# primary fast-reroute node-protection	Configure primary fast-reroute node protection for the trunk
(config-trunk)#primary path p41	Configure trunk to_29 to use the defined path.
(config-trunk)#to 29.29.29.29	Specify the IPv4 egress (destination point) for the LSP.
(config-trunk)#exit	Exit from trunk mode.
(config)#ip vrf vrf1	Configure VRF instance
(config-vrf)# rd 100:1	Configure Router Distinguisher value
(config-vrf)# route-target both 100:1	Configure route-target as both
(config-vrf)#exit	Exit the path mode.
(config)#interface xe23	Enter to the interface mode
(config-if)#ip vrf forwarding vrf1	Bind the VRF instance to the interface
(config-if)#ip address 23.23.23.29/24	Configure IP address
(config-if)#exit	Exit interface mode.
(config)# router bgp 100	Configure BGP router instance
(config-router)#neighbor 29.29.29.29 remote-as 100	Configure neighbor with remote-as
(config-router)#neighbor 29.29.29.29 update-source 30.30.30.30	Configure update source as loopback address
(config-router)#address-family vpnv4 unicast	Configure VPNv4 address family
(config-router-af)#neighbor 29.29.29.29 activate	Activate the VPN neighbor
(config-router-af)#exit-address-family	Exit the VPN address family
(config-router)#address-family ipv4 vrf vrf1	Configure VRF address family
(config-router-af)redistribute connected	Redistribute connected route
(config-router-af)exit-address-family	Exit VRF address family
(config-router)#exit	Exit router mode
(config)#mpls l2-circuit vlan10 10 29.29.29.29	Configure Virtual circuit.
(config-pseudowire)#exit	Exit pseudowire config mode.
(config)#service-template st1	Template configuration
(config-svc)#match outer-vlan 10	Match criteria under template configuration

`(config-svc)#exit`	Exit service template mode
`(config)#service-template st2`	Template configuration
`(config-svc)#match outer-vlan 30`	Match criteria under template configuration
`(config-svc)#exit`	Exit service template mode
`(config)#interface xe24`	Enter interface configuration mode
`(config-if)#switchport`	Configure interface as switch port
`(config-if)#mpls-l2-circuit t1 service-template st2`	Bind the interface to the VC with service template
`(config-if)#exit`	Exit interface configuration mode
`(config)#mpls vpls vpls30 30`	Configure VPLS instance
`(config-vpls)#signaling ldp`	Configure VPLS signaling as LDP
`(config-vpls-sig)#vpls-type vlan`	Configure VPLS type as VLAN encapsulation
`(config-vpls-sig)#vpls-peer 29.29.29.29`	Configure VPLS peer
`(config-vpls-sig)#exit-signaling`	Exit VPLS configuration mode
`(config)#interface xe25`	Enter interface configuration mode
`(config-if)#switchport`	Configure interface as switch port
`(config-if)#mpls-vpls vpls30 service-template st2`	Bind the VPLS instance to the interface
`(config-if-vpls)#exit`	Exit VPLS attachment-circuit mode
`(config-if)#end`	Exit the interface and configure mode

Validation

```
RTR-30#show rsvp session
Ingress RSVP:
To                From              State                  Pri Rt  Style Labelin
Labelout LSPName                              Uptime  Est.time   D
SType
29.29.29.29     30.30.30.30     Up                         Yes 1 1 SE    -
24322    to_29-Primary                        00:07:53 0s 118ms  D
EFAULT
29.29.29.29     69.69.69.30     Up                         No  1 1 SE    -
24322    to_29-Detour                         00:07:53 0s 4ms   DEF
AULT
Total 2 displayed, Up 2, Down 0.

Egress RSVP:
To                From              State                  Pri Rt  Style Labelin
Labelout LSPName                              Uptime  Est.time   D
SType
30.30.30.30    29.29.29.29     Up                      Yes 1 1 SE    24960   -
to_30-Primary                     00:07:57 N/A    ELSP
_CON
30.30.30.30    25.25.25.42     Up                      Yes 1 1 SE    24961   -
to_30-Detour                      00:07:57 N/A    ELSP
_CON
Total 2 displayed, Up 2, Down 0.


RTR-30#show mpls forwarding-table
```

```
Codes: > - installed FTN, * - selected FTN, p - stale FTN,
       B - BGP FTN, K - CLI FTN, t - tunnel
       L - LDP FTN, R - RSVP-TE FTN, S - SNMP FTN, I - IGP-Shortcut,
       U - unknown FTN, O - SR-OSPF FTN, i - SR-ISIS FTN, k - SR-CLI FTN

Code    FEC                 FTN-ID    Tunnel-id   Pri   LSP-Type        Out-
Label    Out-Intf       Nexthop
R(t)>   29.29.29.29/32     1       5001       Yes   LSP_DEFAULT    24322
eth2          41.41.41.31
R(t)>   29.29.29.29/32     2       5001       No    LSP_DEFAULT    24322
eth1          69.69.69.42
RTR-30#

RTR-30#show mpls vrf-table
Output for IPv4 VRF table with id: 2
 Primary FTN entry with FEC: 43.43.43.0/24, id: 1, row status: Active
  Owner: BGP, Action-type: Redirect to Tunnel, Exp-bits: 0x0, Incoming DSCP:
none
  Tunnel id: 5001,   Protected LSP id: 0, QoS Resource id: 0, Description: N/A
    Matched bytes:0, pkts:0, TX bytes:0, Pushed pkts:0
     Cross connect ix: 7, in intf: - in label: 0 out-segment ix: 6
      Owner: BGP, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 6, owner: BGP, out intf: eth1, out label: 25602
    Nexthop addr: 29.29.29.29        cross connect ix: 7, op code: Push and
Lookup


Link 41.41.41.0/24 Goes down. Interface xe41 on router 30 is admistratively
disabled with the "shutdown command".

RTR-30#

RTR-30#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
RTR-30(config)#in xe41
RTR-30(config-if)#shutdown
RTR-30(config-if)#


RTR-30#show rsvp session
Ingress RSVP:
To              From            State                Pri Rt  Style Labelin
Labelout LSPName                          Uptime  Est.time   D
SType
29.29.29.29    30.30.30.30    Using Backup       Yes 0 0 SE    -      -
to_29-Primary                 N/A    DEFAULT
29.29.29.29    30.30.30.30     Dn                 Yes 0 0 SE    -      -
to_29-Primary                 N/A    DEFAULT
29.29.29.29     69.69.69.30     Up                  No  1 1 SE    -
24322    to_29-Detour                    00:10:53 0s 4ms  DEF
AULT
Total 3 displayed, Up 1, Down 2.

Egress RSVP:
To              From            State                Pri Rt  Style Labelin
Labelout LSPName                          Uptime  Est.time   D
SType
30.30.30.30    29.29.29.29    Up                 Yes 1 1 SE    24960   -
to_30-Primary                    00:10:57 N/A    ELSP
```

```
_CON
Total 1 displayed, Up 1, Down 0.


RTR-30#show mpls vc-table
VC-ID       Vlan-ID  Inner-Vlan-ID  Access-Intf   Network-Intf  Out Label
Tunnel-Label  Nexthop        Status
10          N/A      N/A            eth4          eth1          24321
24322         29.29.29.29    Active
RTR-30#


RTR-30#show mpls vpls mesh
VPLS-ID    Peer Addr        Tunnel-Label  In-Label   Network-Intf   Out-Label
Lkps/St   PW-INDEX  SIG-Protocol  Status
30         29.29.29.29      24322         24320      xe41           24320
2/Up      2         LDP           Active



Link 41.41.41.0/24 is reestablished. Interfce xe41 is administrativly re-
enabled.


RTR-30#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
RTR-30(config)#in xe41
RTR-30(config-if)#no shutdown
RTR-30(config-if)#
RTR-30#


RTR-30#show rsvp session
Ingress RSVP:
To              From            State                Pri Rt  Style Labelin
Labelout LSPName                         Uptime  Est.time   D
SType
29.29.29.29     30.30.30.30     Up                   Yes 1 1 SE    -
24322    to_29-Primary                   00:00:01 0s 8ms  DEF
AULT
29.29.29.29     69.69.69.30     Up                   No  1 1 SE    -
24322    to_29-Detour                    00:00:01 0s 8ms  DEF
AULT
Total 2 displayed, Up 2, Down 0.

Egress RSVP:
To              From            State                Pri Rt  Style Labelin
Labelout LSPName                         Uptime  Est.time   D
SType
30.30.30.30    29.29.29.29    Up                  Yes 1 1 SE    24960   -
to_30-Primary                   00:13:22 N/A    ELSP
_CON
30.30.30.30    25.25.25.42    Up                  Yes 1 1 SE    24961   -
to_30-Detour                    00:00:08 N/A    ELSP
_CON
Total 2 displayed, Up 2, Down 0.


RTR-30#show mpls forwarding-table
```

```
Codes: > - installed FTN, * - selected FTN, p - stale FTN,
       B - BGP FTN, K - CLI FTN, t - tunnel
       L - LDP FTN, R - RSVP-TE FTN, S - SNMP FTN, I - IGP-Shortcut,
       U - unknown FTN, O - SR-OSPF FTN, i - SR-ISIS FTN, k - SR-CLI FTN

Code    FEC                   FTN-ID    Tunnel-id   Pri   LSP-Type        Out-
Label    Out-Intf        Nexthop
R(t)>   29.29.29.29/32     1       5001       Yes   LSP_DEFAULT    24322
xe41          41.41.41.31
R(t)>   29.29.29.29/32     2       5001       No    LSP_DEFAULT    24322
xe54/1          69.69.69.42
```

Note: The primary LSP, which is in using backup state shall continue to use backup path in case where secondary is provisioned after the LSP state is changed to switch to backup.

MPLS RSVP PING and TRACEROUTE

This example shows MPLS ping and trace route for RSVP

```
#ping mpls rsvp tunnel-name to_30 detail
Sending 5 MPLS Echos to  to_30 , timeout is 5 seconds
Codes:
'!' - Success, 'Q' - request not sent, '.' - timeout,
'x' - Retcode 0, 'M' - Malformed Request, 'm' - Errored TLV,
'N' - LBL Mapping Err, 'D' - DS Mismatch,
'U' - Unknown Interface, 'R' - Transit (LBL Switched),
'B' - IP Forwarded, 'F' No FEC Found, 'f' - FEC Mismatch,
'P' - Protocol Error, 'X' - Unknown code,
'Z' - Reverse FEC Validation Failed
Type 'Ctrl+C' to abort
! seq_num = 1 30.30.30.30 0.28 ms
! seq_num = 2 30.30.30.30 0.24 ms
! seq_num = 3 30.30.30.30 0.22 ms
! seq_num = 4 30.30.30.30 0.22 ms
! seq_num = 5 30.30.30.30 0.22 ms

Success Rate is 100.00 percent (5/5)
round-trip min/avg/max = 0.22/0.25/0.28


RTR-29#trace mpls rsvp tunnel-name to_30 detail
Tracing MPLS Label Switched Path to  to_30 , timeout is 5 seconds

Codes:
'!' - Success, 'Q' - request not sent, '.' - timeout,
'x' - Retcode 0, 'M' - Malformed Request, 'm' - Errored TLV,
'N' - LBL Mapping Err, 'D' - DS Mismatch,
'U' - Unknown Interface, 'R' - Transit (LBL Switched),
'B' - IP Forwarded, 'F' No FEC Found, 'f' - FEC Mismatch,
'P' - Protocol Error, 'X' - Unknown code,
'Z' - Reverse FEC Validation Failed

 Type 'Ctrl+C' to abort

  0 21.21.21.29 [Labels:  24320]
```

```
    R 1 43.43.43.43 [Labels:  24320] 123.22 ms
    R 2 42.42.42.42 [Labels:  24960] 1.60 ms
    ! 3 30.30.30.30 1.62 ms
```

MPLS RSVP Entropy Label Capabilities

To share the load across multiple members of a LAG port in the core of an MPLS network we can use entropy labels

An Entropy Label is always preceded by an Entropy level indicator which is a special Label with value seven, and indicates the next label present is an Entropy label. The trade off is the MPLS stack depth increases by two and it reduces overhead on transit routers.

Note: Load balancing is enabled by default for all the parameters. If you enable load balancing manually, then all the parameters enabled by default are reset and you need to enable the parameters based on which traffic should be load balanced.

Entropy labels will only be added when the remote edge node advertises its capability for Entropy.

The examples below show how entropy can be enabled on a provider edge node as per the setup we need to enable on RTR29 and RTR30 to have entropy enabled in both directions:

```
(config)#router rsvp
(config-router)#entropy-label-capability
```

This enables ELC signaling for RSVP.

For validation, use:

```
#show mpls forwarding-table
Codes: > - installed FTN, * - selected FTN, p - stale FTN, B - BGP FTN, K - CLI FTN, t - 
tunnel
L - LDP FTN, R - RSVP-TE FTN, S - SNMP FTN, I - IGP-Shortcut,
U - unknown FTN, O - SR-OSPF FTN, i - SR-ISIS FTN, k - SR-CLI FTN

Code    FEC         FTN-ID Tunnel-id  Pri  LSP-Type   Out- Label  ELC  Out-Intf  Nexthop
R(t)> 2 9.29.29.29/32  1    5001      Yes LSP_DEFAULT   24322    yes
eth2    1.41.41.31
R(t)>   29.29.29.29/32  2   5001       No  LSP_DEFAULT   4322    yes
eth1    69.69.69.42


#show rsvp session ingress detail
Ingress (Primary)
41.41.41.31
From: 29.29.29.29, LSPstate: Up, LSPname: t1-Primary
Ingress FSM state: Operational
Establishment Time: 0s 3ms
Setup priority: 7, Hold priority: 0
CSPF usage: Enabled, CSPF Retry Count: 0, CSPF Retry Interval: 30 seconds
IGP-Shortcut: Disabled, LSP metric: 1
LSP Protection: None
Label in: -, Label out: 24320, ELC
```

MPLS RSVP LSP Re-optimization

Follow these steps to configure RSVP LSP Re-optimization.

`#configure terminal`	Enter configure mode.
`(config)#rsvp-trunk T1`	Create an RSVP trunk T1 and enter the Trunk mode.
`(config-trunk)#reoptimize`	Enable re-optimization of the session.

`#configure terminal`	Enter configure mode.
`(config)#router rsvp`	Enter RSVP mode
`(config-router)#lsp-reoptimization-timer 5`	Sets the re-optimization timer for the session.

Follow these steps to force the LSP to be re-optimized.

`(config)#rsvp-trunk t1 force-reoptimize`	Re-optimize the LSP forcefully

CHAPTER 4 RSVP-TE Facility Backup (Facility Bypass)

RSVP supports multiple path protection mechanisms and facility backup is one of them. With facility backup protection, N number of LSPs sharing the common path can be protected using one bypass tunnel which leads to resource utilization.

Note: Do not configure a facility backup trunk with the same transit node as that of the primary trunk.

Topology

As shown in Figure 4-1, we have four routers R1, R2, R3, and R4.

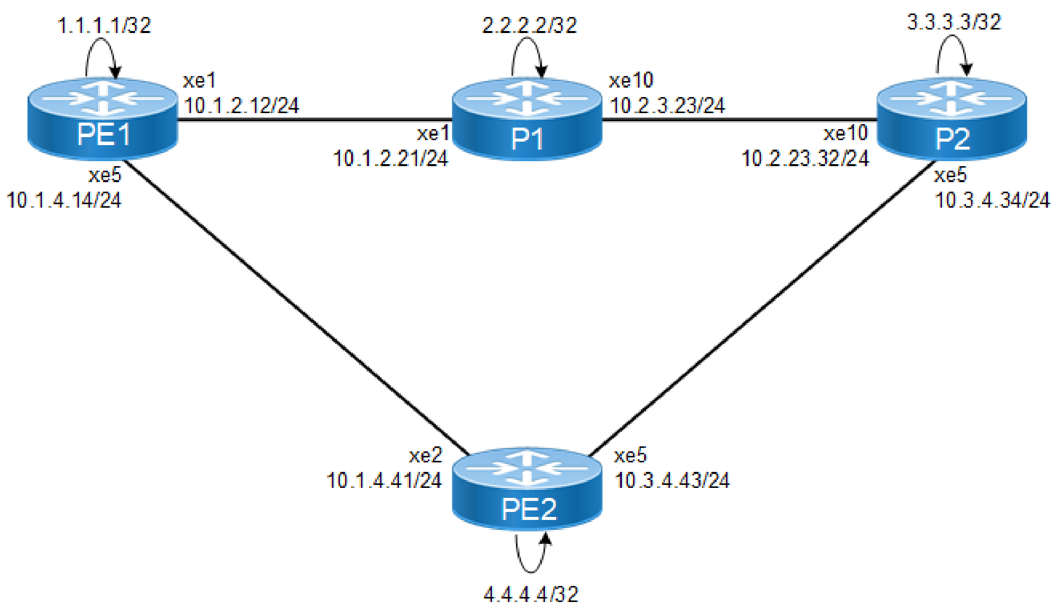


Figure 4-1: RSVP facility backup

Configuration

PE1

`#configure terminal`	Enter configuration mode
`(config)#interface lo`	Specify interface loopback for configuration
`(config-if)#ip address 1.1.1.1/32 secondary`	Configure ip address of loopback
`(config-if)#exit`	Exit interface configuration mode
`(config)#interface xe1`	Specify interface xe1 for configuration
`(config-if)#ip address 10.1.2.12/24`	Configure ip address of interface
`(config)#exit`	Exit interface configuration mode

(config-if)#int xe5	Specify interface xe1 for configuration
(config-if)#ip address 10.1.4.14/24	Configure ip address of loopback
(config-if)#exit	Exit configuration mode
(config)#router ospf 1	Configure the router OSPF with process id
(config-router)#router-id 1.1.1.1	Configure OSPF router-id
(config-router)#network 1.1.1.1/32 area 1	Define the network of the interface with area 0
(config-router)#network 10.1.2.0/24 area 1	Define the network of the interface with area 0
(config-router)#network 10.1.4.0/24 area 1	Define the network of the interface with area 0
(config-router)#exit	Exit the configure mode
(config)#bfd interval 3 minrx 3 multiplier 3	Configure BFD interval
(config)#exit	Exit the configure mode
(config)#router ospf 1	Enter router OSPF mode with process id
(config-router)#bfd all-interfaces	Enable the OSPF enabled interfaces with bfd
(config-router)#exit	Exit the router mode
(config)#router rsvp	Enter router RSVP
(config-router)#exit	Exit the router configuration mode
(config)#interface xe1	Enter the interface mode
(config-if)#enable-rsvp	Enable RSVP
(config-if)#label-switching	Enable label-switching
(config-if)#exit	Exit the interface configuration mode
(config)#interface xe5	Enter the interface mode
(config-if)#enable-rsvp	Enable RSVP
(config-if)#label-switching	Enable label-switching
(config-if)#commit	Commit the transaction.

P1

(config)#interface lo	Specify the interface (lo)
(config-if)#ip address 2.2.2.2/32 secondary	Enter the loopback ip address as secondary
(config-if)#exit	Exit the interface configure mode
(config-if)#int xe1	Specify the interface(xe1)
(config-if)#ip address 10.1.2.21/24	Configure the IP address for the interface
(config-if)#exit	Exit the interface mode
(config-if)#int xe10	Specify the interface(xe1)
(config-if)#ip address 10.2.3.23/24	Configure the IP address for the interface
(config-if)#exit	Exit the configuration mode
(config)#router ospf 1	Configure OSPF router-id
(config-router)#router-id 2.2.2.2	Configure the router id
(config-router)#network 2.2.2.2/32 area 1	Define the network of the interface with area 0
(config-router)#network 10.1.2.0/24 area 1	Define the network of the interface with area 0
(config-router)#network 10.2.3.0/24 area 1	Define the network of the interface with area 0

`(config-router)#exit`	Exit the configure mode
`(config)#bfd interval 3 minrx 3 multiplier 3`	Configure BFD interval
`(config)#exit`	Exit the configure mode
`(config)#router ospf 1`	Enter router OSPF mode with process id
`(config-router)#bfd all-interfaces`	Enable the OSPF enabled interfaces with bfd
`(config-router)#exit`	Exit the router mode
`(config)#router rsvp`	Enter router RSVP
`(config-router)#exit`	Exit the router configuration mode
`(config)#interface xe1`	Enter the interface mode
`(config-if)#enable-rsvp`	Enable RSVP
`(config-if)#label-switching`	Enable label-switching
`(config-if)#exit`	Exit the interface configuration mode
`(config)#interface xe10`	Enter the interface mode
`(config-if)#enable-rsvp`	Enable RSVP
`(config-if)#label-switching`	Enable label-switching
`(config-if)#commit`	Commit the transaction.

P2

`(config)#interface lo`	Specify the interface (lo)
`(config-if)#ip address 3.3.3.3/32 secondary`	Enter the loopback ip address as secondary
`(config-if)#exit`	Exit the interface configuration mode
`(config-if)#int xe10`	Specify the interface(xe1)
`(config-if)#ip address 10.2.3.32/24`	Configure the IP address for the interface
`(config-if)#exit`	Exit the interface mode
`(config-if)#interface xe5`	Specify the interface(xe1)
`(config-if)#ip address 10.3.4.34/24`	Configure the IP address for the interface
`(config-if)#exit`	Exit the configuration mode
`(config)#router ospf 1`	Configure OSPF router-id
`(config-router)#router-id 3.3.3.3`	Configure the router id
`(config-router)#network 3.3.3.3/32 area 1`	Define the network of the interface with area 0
`(config-router)#network 10.3.4.0/24 area 1`	Define the network of the interface with area 0
`(config-router)#network 10.2.3.0/24 area 1`	Define the network of the interface with area 0
`(config-router)#exit`	Exit the configure mode
`(config)#bfd interval 3 minrx 3 multiplier 3`	Configure BFD interval
`(config)#exit`	Exit the configure mode
`(config)#router ospf 1`	Enter router OSPF mode with process id
`(config-router)#bfd all-interfaces`	Enable the OSPF enabled interfaces with bfd
`(config-router)#exit`	Exit the router mode
`(config)#router rsvp`	Enter router RSVP
`(config-router)#exit`	Exit the router configuration mode

(config)#interface xe10	Enter the interface mode
(config-if)#enable-rsvp	Enable RSVP
(config-if)#label-switching	Enable label-switching
(config-if)#exit	Exit the interface configuration mode
(config)#interface xe5	Enter the interface mode
(config-if)#enable-rsvp	Enable RSVP
(config-if)#label-switching	Enable label-switching
(config-if)#commit	Commit the transaction.

PE2

(config)#interface lo	Specify the interface (lo)
(config-if)#ip address 4.4.4.4/32 secondary	Enter the loopback IP address as secondary
(config-if)#exit	Exit the interface configuration mode
(config-if)#interface xe2	Specify the interface(xe1)
(config-if)#ip address 10.1.4.41/24	Configure the ip address for the interface
(config-if)#exit	Exit the interface mode
(config-if)#int xe5	Specify the interface(xe1)
(config-if)#ip address 10.3.4.43/24	Configure the ip address for the interface
(config-if)#exit	Exit the configuration mode
(config)#router ospf 1	Configure ospf router-id
(config-router)#router-id 4.4.4.4	Configure the router id
(config-router)#network 4.4.4.4/32 area 1	Define the network of the interface with area 0
(config-router)#network 10.1.4.0/24 area 1	Define the network of the interface with area 0
(config-router)#network 10.3.4.0/24 area 1	Define the network of the interface with area 0
(config-router)#exit	Exit the configure mode
(config)#bfd interval 3 minrx 3 multiplier 3	Configure BFD interval
(config)#exit	Exit the configuration mode
(config)#router ospf 1	Exit the router OSPF mode with process id
(config-router)#bfd all-interfaces	Enable the OSPF enabled interfaces with bfd
(config-router)#exit	Exit the router mode
(config)#router rsvp	Enter router RSVP
(config-router)#exit	Exit the router configuration mode
(config)#interface xe1	Enter the interface mode
(config-if)#enable-rsvp	Enable RSVP
(config-if)#label-switching	Enable label-switching
(config-if)#exit	Exit the interface configuration mode
(config)#interface xe5	Enter the interface mode
(config-if)#enable-rsvp	Enable RSVP
(config-if)#label-switching	Enable label-switching
(config-if)#commit	Commit the transaction.

RSVP Path on PE1

(config)#rsvp-path primary_1	Enter the rsvp-path configuration mode with name
(config-path)#10.1.2.21 strict	Specify the first next-hop ip address
(config-path)#10.2.3.32 strict	Specify the second next-hop ip address
(config-path)#exit	Exit the rsvp-path configuration mode
#configure terminal	Enter the configuration mode
(config)#rsvp-path bypass_1	Enter the rsvp-path configuration mode with name
(config-path)#10.1.4.41 strict	Specify the first next-hop ip address
(config-path)#10.3.4.34 strict	Specify the second next-hop ip address
(config-path)#exit	Exit the rsvp-path configuration mode
#configure terminal	Enter the configuration mode
(config)#rsvp-trunk R1-R3	Enter the rsvp trunk to be created with name
(config-trunk)#primary path primary_1	Configure primary path for the trunk
(config-trunk)#to 3.3.3.3	Enter the destination ip
(config-trunk)# primary fast-reroute protection facility	Configure facility backup protection for the trunk
(config-trunk)#exit	Exit the configuration mode
(config)#rsvp-bypass B1-B8	Enter the rsvp bypass to be created with name
(config-trunk)#path bypass_1	Configure primary path for the trunk
(config-trunk)#to 3.3.3.3	Enter the destination IP
(config-if)#commit	Commit the transaction.

Validation

OSPF Neighborship

PE1

```
#show ip ospf neighbor

Total number of full neighbors: 2
OSPF process 1 VRF(default):
Neighbor ID     Pri   State            Dead Time   Address         Interface
Instance ID
2.2.2.2         1   Full/Backup     00:00:38   10.1.2.21            xe1
0
4.4.4.4         1   Full/DR          00:00:33   10.1.4.41            xe5
0
```

P1

```
#show ip ospf neighbor

Total number of full neighbors: 2
OSPF process 1 VRF(default):
Neighbor ID     Pri   State           Dead Time   Address     Interface    Instance ID
```

```
1.1.1.1          1    Full/DR        00:00:35    10.1.2.12       xe1           0
3.3.3.3          1    Full/Backup    00:00:34    10.2.3.32       xe10          0
```

P2

```
#show ip ospf neighbor

Total number of full neighbors: 2
OSPF process 1 VRF(default):
Neighbor ID     Pri   State     Dead Time   Address     Interface         Instance ID
2.2.2.2          1   Full/DR     00:00:37     10.2.3.23     xe10              0
4.4.4.4          1   Full/Backup 00:00:39     10.3.4.43     xe5               0
```

PE2

```
#show ip ospf neighbor

Total number of full neighbors: 2
OSPF process 1 VRF(default):
Neighbor ID    Pri   State          Dead Time   Address         Interface     Instance ID
1.1.1.1        1   Full/Backup      00:00:38      10.1.4.14      xe2           0
3.3.3.3        1    Full/DR         00:00:36      10.3.4.34      xe5           0
```

RSVP Session

PE1

```
#show rsvp session
Type  : PRI - Primary, SEC - Secondary, DTR - Detour, BPS - Bypass
State : UP - Up, DN - Down, BU - Backup in Use, SU - Secondary in Use, FS - Forced to
Secondary
* indicates the session is active with local repair at one or more nodes

Ingress RSVP:
To              From           Type  LSPName                        State Uptime    Rt
Style  Labelin  Labelout  DSType
3.3.3.3        1.1.1.1         PRI   R1-R3-Primary                    UP    00:54:48  1
1 SE     -        24321     DEFAULT
3.3.3.3        1.1.1.1         BPS   B1-B4-Bypass                     UP    01:08:32  1
1 SE     -        24321     DEFAULT
Total 2 displayed, Up 2, Down 0.
#show rsvp bypass
Ingress RSVP:
To              From           LSPName                        State Uptime    Rt  Style
Labelin  Labelout  DSType
3.3.3.3        1.1.1.1        B1-B4-Bypass                    UP    01:09:17  1 1 SE
-        24321     DEFAULT


#show rsvp bypass protected-lsp-list
Bypass trunk: B1-B4
Bypass trunk bandwidth type: best-effort
List of LSP's Protected:
Tunnel-id     Lsp Id     Lsp Name                  Role     Ext_tnl_id     Ingress
Egress
```

```
5001        2202      R1-R3-Primary            Ingress   1.1.1.1       1.1.1.1
3.3.3.3
Total LSP protected : 1
 Bandwidth in use : 0


#show rsvp bypass B1-B4 protected-lsp-list
Bypass trunk: B1-B4
Bypass trunk bandwidth type: best-effort
List of LSP's Protected:
Tunnel-id     Lsp Id     Lsp Name                  Role     Ext_tnl_id     Ingress
Egress
5001        2202      R1-R3-Primary            Ingress   1.1.1.1       1.1.1.1
3.3.3.3
Total LSP protected : 1
 Bandwidth in use : 0


#show rsvp session detail
Ingress (Primary)
3.3.3.3
  From: 1.1.1.1, LSPstate: Up, LSPname: R1-R3-Primary
  Ingress FSM state: Operational
  Establishment Time: 0s 8ms
  Setup priority: 7, Hold priority: 0
  CSPF usage: Enabled, CSPF Retry Count: 0, CSPF Retry Interval: 30 seconds
  IGP-Shortcut: Disabled, LSP metric: 2
  LSP Protection: facility
  Fast-Reroute bandwidth : 0
  Protection type desired: Link
  Fast-Reroute Setup priority: 7, Hold priority: 0
  Bypass trunk: B1-B4,  Merge Point: 10.2.3.32,  MP Label: 3
    Bypass OutLabel: 24321,  OutIntf: xe5
    Protection provided -> Type: Link, BW: Best-effort
  Label in: -,  Label out:    24321
  Tspec rate: 0, Fspec rate: 0
  Policer: Not Configured
  Tunnel Id: 5001, LSP Id: 2202, Ext-Tunnel Id: 1.1.1.1
  Downstream: 10.1.2.21, xe1
  Path refresh: 30 seconds (RR enabled) (due in 26564 seconds)
  Resv refresh: 0 seconds (due in 0 seconds)
  Resv lifetime: 157 seconds (due in 150 seconds)
  Retry count: 0, intrvl: 30 seconds
  RRO re-use as ERO: Disabled
  Label Recording: Enabled
  Admin Groups: none
  Configured Path: primary_1 (in use)
  Configured Explicit Route Detail :
   10.1.2.21/32 strict
   10.2.3.32/32 strict
  Session Explicit Route Detail :
```

```
   10.1.2.21/32 strict
   10.2.3.32/32 strict
  Record route:
   LP = 1 -> PLR's Downstream link is protected      PU = 1 -> Protection is in use on 
PLR
   NP = 1 -> PLR's Downstream neighbor is protected  BP = 1 -> BW protection available 
at PLR
   -------------------------------------------------------------
   IP Address        Label     (LP, PU, NP, BP)
   -------------------------------------------------------------
   <self>
   10.1.2.21         24321     ( 0,  0,  0,  0)
   10.2.3.32         3         ( 0,  0,  0,  0)
  Style: Shared Explicit Filter
  Traffic type: controlled-load
  Minimum Path MTU: 1500
  Last Recorded Error Code: None
  Last Recorded Error Value: None
  Node where Last Recorded Error originated: None
  Trunk Type: mpls
Ingress (Bypass)
3.3.3.3
  From: 1.1.1.1, LSPstate: Up, LSPname: B1-B4-Bypass
  Ingress FSM state: Operational
  Establishment Time: 0s 14ms
  Setup priority: 7, Hold priority: 0
  CSPF usage: Enabled, CSPF Retry Count: 0, CSPF Retry Interval: 30 seconds
  IGP-Shortcut: Disabled, LSP metric: 2
  LSP Protection: None
  Bypass trunk bandwidth type: Best-effort
   Label in: -,  Label out:    24321
  Tspec rate: 0, Fspec rate: 0
  Policer: Not Configured
  Tunnel Id: 5002, LSP Id: 2203, Ext-Tunnel Id: 1.1.1.1
  Downstream: 10.1.4.41, xe5
  Path refresh: 30 seconds (RR enabled) (due in 25747 seconds)
  Resv lifetime: 157 seconds (due in 139 seconds)
  Retry count: 0, intrvl: 30 seconds
  RRO re-use as ERO: Disabled
  Label Recording: Disabled
  Admin Groups: none
  Configured Path: bypass_1 (in use)
  Configured Explicit Route Detail :
   10.1.4.41/32 strict
   10.3.4.34/32 strict
  Session Explicit Route Detail :
   10.1.4.41/32 strict
   10.3.4.34/32 strict
  Record route:
   -------------------------------------------------------------
   IP Address        Label
```



```
   -------------------------------------------------------------
   <self>
   10.1.4.41
   10.3.4.34
  Style: Shared Explicit Filter
  Traffic type: controlled-load
  Minimum Path MTU: 1500
  Last Recorded Error Code: None
  Last Recorded Error Value: None
  Node where Last Recorded Error originated: None
  Trunk Type: mpls
  Total LSP protected : 1, Bandwidth in use : 0
```

P1

```
#show rsvp session
Type  : PRI - Primary, SEC - Secondary, DTR - Detour, BPS - Bypass
State : UP - Up, DN - Down, BU - Backup in Use, SU - Secondary in Use, FS - Forced to
Secondary
* indicates the session is active with local repair at one or more nodes

Transit RSVP:
To             From            Type  LSPName                        State Uptime    Rt
Style  Labelin  Labelout  DSType
3.3.3.3        1.1.1.1         PRI   R1-R3-Primary                   UP    00:57:44  1
1 SE     24321    3         ELSP_CON
Total 1 displayed, Up 1, Down 0.

#show rsvp session de
Transit
3.3.3.3
  From: 1.1.1.1, LSPstate: Up, LSPname: R1-R3-Primary
  Transit upstream state: Operational, downstream state: Operational
  Setup priority: 7, Hold priority: 0
  IGP-Shortcut: Disabled, LSP metric: 65
  LSP Protection: facility
  Fast-Reroute bandwidth : 0
  Protection type desired: Link
  Fast-Reroute Setup priority: 7, Hold priority: 0
  Label in:    24321,  Label out:        3
  Tspec rate: 0, Fspec rate: 0
  Tunnel Id: 5001, LSP Id: 2202, Ext-Tunnel Id: 1.1.1.1
  Downstream: 10.2.3.32, xe10   Upstream: 10.1.2.12, xe1
  Path refresh: 30 seconds (RR enabled) (due in 26500 seconds)
  Path lifetime: 157 seconds (due in 126 seconds)
  Resv refresh: 30 seconds (RR enabled) (due in 20926 seconds)
  Resv lifetime: 157 seconds (due in 151 seconds)
  RRO re-use as ERO: Disabled
  Label Recording: Enabled
  Admin Groups:   Received Explicit Route Detail :
   10.1.2.21/32 strict
   10.2.3.32/32 strict
```

```
  Session Explicit Route Detail :
   10.2.3.32/32 strict
  Record route:
   -------------------------------------------------------------
   IP Address        Label
   -------------------------------------------------------------
   10.1.2.12         24321
   <self>
   10.2.3.32         3
  Style: Shared Explicit Filter
  Traffic type: controlled-load
  Minimum Path MTU: 1500
  LSP Type:  ELSP_CONFIG
  CLASS    DSCP_value     EXP_value
  Last Recorded Error Code: None
  Last Recorded Error Value: None
  Node where Last Recorded Error originated: None
  Trunk Type: mpls
```

P2

```
#show rsvp session
Type  : PRI - Primary, SEC - Secondary, DTR - Detour, BPS - Bypass
State : UP - Up, DN - Down, BU - Backup in Use, SU - Secondary in Use, FS - Forced to
Secondary
* indicates the session is active with local repair at one or more nodes

Egress RSVP:
To              From            Type  LSPName                        State Uptime    Rt
Style  Labelin  Labelout  DSType
3.3.3.3         1.1.1.1         PRI   R1-R3-Primary                   UP    00:58:47  1
1 SE     3        -         ELSP_CON
3.3.3.3         1.1.1.1         PRI   B1-B4-Bypass                    UP    01:12:30  1
1 SE     3        -         ELSP_CON
Total 2 displayed, Up 2, Down 0

#show rsvp session detail
Egress
3.3.3.3
  From: 1.1.1.1, LSPstate: Up, LSPname: R1-R3-Primary
  Egress FSM state: Operational
  Setup priority: 7, Hold priority: 0
  IGP-Shortcut: Disabled, LSP metric: 65
  LSP Protection: facility
  Fast-Reroute bandwidth : 0
  Protection type desired: Link
  Fast-Reroute Setup priority: 7, Hold priority: 0
  Label in:        3,  Label out: -
  Tspec rate: 0, Fspec rate: 0
  Tunnel Id: 5001, LSP Id: 2202, Ext-Tunnel Id: 1.1.1.1
  Upstream: 10.2.3.23, xe10
  Path lifetime: 157 seconds (due in 140 seconds)
```

```
  Resv refresh: 30 seconds (RR enabled) (due in 37780 seconds)
  RRO re-use as ERO: Disabled
  Label Recording: Enabled
  Admin Groups:   Received Explicit Route Detail :
   10.2.3.32/32 strict
  Record route:
   -------------------------------------------------------------
   IP Address        Label
   -------------------------------------------------------------
   10.1.2.12         24321
   10.2.3.23         3
   <self>
  Style: Shared Explicit Filter
  Traffic type: controlled-load
  Minimum Path MTU: 1500
  LSP Type:  ELSP_CONFIG
  CLASS    DSCP_value     EXP_value
  Last Recorded Error Code: None
  Last Recorded Error Value: None
  Node where Last Recorded Error originated: None
  Trunk Type: mpls
Egress
3.3.3.3
  From: 1.1.1.1, LSPstate: Up, LSPname: B1-B4-Bypass
  Egress FSM state: Operational
  Setup priority: 7, Hold priority: 0
  IGP-Shortcut: Disabled, LSP metric: 65
  LSP Protection: None
  Label in:        3,  Label out: -
  Tspec rate: 0, Fspec rate: 0
  Tunnel Id: 5002, LSP Id: 2203, Ext-Tunnel Id: 1.1.1.1
  Upstream: 10.3.4.43, xe5
  Path lifetime: 157 seconds (due in 134 seconds)
  Resv refresh: 30 seconds (RR enabled) (due in 29222 seconds)
  RRO re-use as ERO: Disabled
  Label Recording: Disabled
  Admin Groups:   Received Explicit Route Detail :
   10.3.4.34/32 strict
  Record route:
   -------------------------------------------------------------
   IP Address        Label
   -------------------------------------------------------------
   10.1.4.14
   10.3.4.43
   <self>
  Style: Shared Explicit Filter
  Traffic type: controlled-load
  Minimum Path MTU: 1500
  LSP Type:  ELSP_CONFIG
  CLASS    DSCP_value     EXP_value
```

```
  Last Recorded Error Code: None
  Last Recorded Error Value: None
  Node where Last Recorded Error originated: None
  Trunk Type: mpls.
```

PE2

```
#show rsvp session
Type  : PRI - Primary, SEC - Secondary, DTR - Detour, BPS - Bypass
State : UP - Up, DN - Down, BU - Backup in Use, SU - Secondary in Use, FS - Forced to
Secondary
* indicates the session is active with local repair at one or more nodes

Transit RSVP:
To               From            Type  LSPName                        State Uptime    Rt
Style  Labelin  Labelout  DSType
3.3.3.3         1.1.1.1         PRI   B1-B4-Bypass                     UP    01:14:12  1
1 SE     24321    3         ELSP_CON
Total 1 displayed, Up 1, Down 0.


#show rsvp session de
Transit
3.3.3.3
  From: 1.1.1.1, LSPstate: Up, LSPname: B1-B4-Bypass
  Transit upstream state: Operational, downstream state: Operational
  Setup priority: 7, Hold priority: 0
  IGP-Shortcut: Disabled, LSP metric: 65
  LSP Protection: None
  Label in:    24321,  Label out:        3
  Tspec rate: 0, Fspec rate: 0
  Tunnel Id: 5002, LSP Id: 2203, Ext-Tunnel Id: 1.1.1.1
  Downstream: 10.3.4.34, xe5   Upstream: 10.1.4.14, xe2
  Path refresh: 30 seconds (RR enabled) (due in 25543 seconds)
  Path lifetime: 157 seconds (due in 146 seconds)
  Resv refresh: 30 seconds (RR enabled) (due in 17729 seconds)
  Resv lifetime: 157 seconds (due in 135 seconds)
  RRO re-use as ERO: Disabled
  Label Recording: Disabled
  Admin Groups:   Received Explicit Route Detail :
   10.1.4.41/32 strict
   10.3.4.34/32 strict
  Session Explicit Route Detail :
   10.3.4.34/32 strict
  Record route:
   --------------------------------------------------------------
   IP Address        Label
   --------------------------------------------------------------
   10.1.4.14
   <self>
   10.3.4.34
  Style: Shared Explicit Filter
```



```
Traffic type: controlled-load
Minimum Path MTU: 1500
LSP Type:  ELSP_CONFIG
CLASS    DSCP_value     EXP_value
Last Recorded Error Code: None
Last Recorded Error Value: None
Node where Last Recorded Error originated: None
Trunk Type: mpls
```

Limitations

Dedicated Bypass Bandwidth

Refer the topology defined above.

Suppose we have two primary tunnels P1 (100mbps) and P2(20mbps) ingressing from R1 and egressing at R3 (path R1->R2>R3) and asking for BW protection and we have two Bypass tunnels bp1 (120mbps) and bp2(80mbps) type dedicated with same ingress and egress router taking Path R1->R4->R3. Below are the two cases defined in which we can observe different kinds of behavior.

1. Let the primary P1 and P2 come up.

CASE 1:

i) If the bypass bp1 (120mbps) comes up first it will give protection to both the primaries P1 and P2. bp2 should remain idle and will not give protection if there are no other primary tunnels asking for it.

CASE 2:

i) If the bypass bp2 (80mbps) comes up first it will give protection to only the primary P2 (20mbps) that will have satisfied protection which will not be changed until the bypass will go down.

ii) After that if bp1 (120mbps) comes it will provide protection to primary P1 (100mbps).

So in the CASE 1 after the protection has been provided to both the primary tunnels P1 and P2 by bypass bp1 if new primary tunnel P3 comes up with BW protection of 80mbps it would be given by bp2 (80mbps).

But in the CASE 2 as bp2 has only 60mbps left (20mbps is being used by P2) and it would not give protection to P3 tunnel and it will remain unprotected. To get the protection new tunnel has to have setup and hold priorities higher than other tunnels which are already been served with the bypass protection.

Secondary Tunnel

Suppose we have primary tunnel P1 (100mbps) ingressing from R1 and egressing at R3 (path R1->R2>R3) and asking for BW protection and we have Bypass tunnel bp1 (120mbps) type dedicated with same ingress and egress router taking Path R1->R4->R3. Then Bypass will start providing protection to primary P1.

If the primary went down it will start using the local protection.

After that if the secondary tunnel is provisioned, primary LSP, which is in using backup state shall continue to use backup path and will not shift over to secondary path.

Facility Bypass with Ring Topology Configuration

This section contains a complete Facility Bypass with Ring Topology configuration.

During facility bypass integration to OcNOS SP, few issues were reported when upstream and downstream interfaces of a session happens to be same (i.e. protection path is same as upstream path) and also CSPF most likely had some issues where LSP path used to formed by crossing the head node of the path.

Considering the information available in RSVP to impose restriction, bypass tunnel path crossing primary LSP node anywhere in between merge point were not considered for mapping.

Below assumption point was added in ERD and documents were updated on the line.

If protection is requested by primary session, then initial bypass matching criteria will be to ensure egress (merge point) node of bypass will be one of the nodes of primary LSP and bypass never intersect any node of primary LSP until the merge point.

The facility bypass method takes advantage of the MPLS label stack. Instead of creating a separate LSP for every backed-up LSP, a single LSP is created that serves to back up a set of LSPs. We call such an LSP tunnel a bypass tunnel. The bypass tunnel must intersect the path of the original LSP(s) somewhere downstream of the PLR. Naturally, this constrains the set of LSPs being backed up via that bypass tunnel to those that pass through some common downstream node. All LSPs that pass through the point of local repair and through this common node that do not also use the facilities involved in the bypass tunnel are candidates for this set of LSPs.

By multiple facility bypass tunnels, we mean that multiple facility bypass tunnels can be created to the same egress/ MP. For a protected LSP there could be multiple candidates available. The mapping of the LSP to one of the backup tunnels has to be efficiently done so that we can extract the maximum benefit out of those backup tunnels available

Topology

Figure 4-2 displays a sample Facility Bypass with Ring topology.

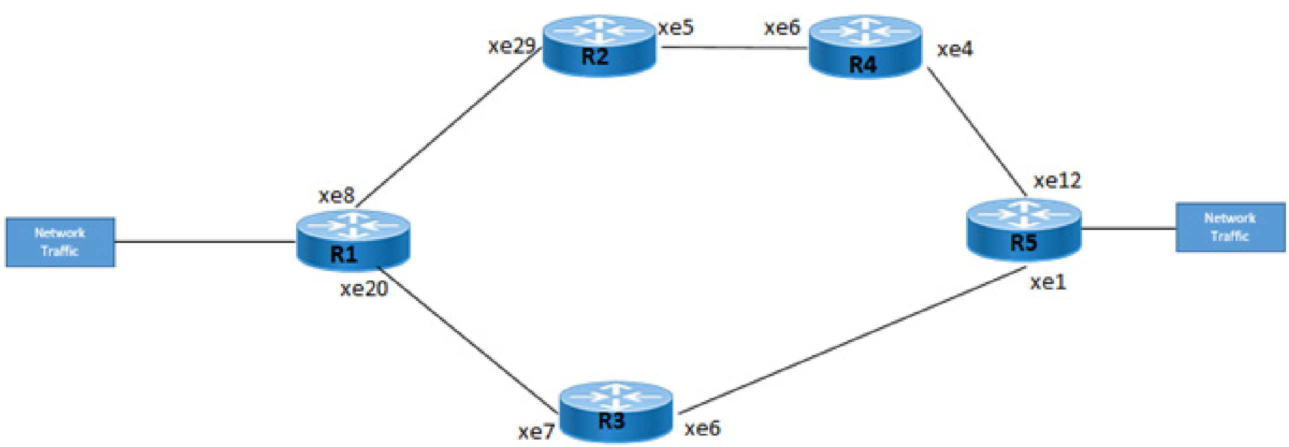


Figure 4-2: Facility Bypass with Ring Topology

Configurations

All configuration commands in the table below should be followed for each router.

R1

`#configure terminal`	Enter configure mode.
`(config)#interface lo`	Enter interface mode.
`(config-if)#ip address 1.1.1.1/32 secondary`	Configure IP address for the loopback interface.

(config-if)# ip router isis ISIS-IGP	Enable IS-IS routing on an interface
(config-if)#exit	Exit interface mode.
(config)#bfd interval 3 minrx 3 multiplier	Configure BFD interval
(config)# router-id 1.1.1.1	Assigning router-id
(config)#router rsvp	Enter router mode for RSVP.
(config-router)#exit	Exit router configuration mode.
(config)#interface xe8	Specify the Interface to be configured.
(config-if)#ip address 10.1.1.1/24	Configure IP address for the interface.
(config-if)#no shutdown	Administratively bringing up the interface.
(config-if)# label-switching	Enable label switching on the interface
(config-if)# isis network point-to-point	Configure the ISIS interface network type as point to point
(config-if)# ip router isis ISIS-IGP	Enable IS-IS routing on an interface
(config-if)# enable-rsvp	Enable rsvp configuration on interface
(config-if)#exit	Exit interface mode.
(config)#interface xe20	Specify the Interface to be configured
(config-if)#ip address 12.1.1.1/24	Configure IP address for the interface.
(config-if)#no shutdown	Administratively bringing up the interface.
(config-if)# label-switching	Enable label switching on the interface
(config-if)# isis network point-to-point	Configure the ISIS interface network type as point to point
(config-if)# ip router isis ISIS-IGP	Enable IS-IS routing on an interface
(config-if)# enable-rsvp	Enable rsvp configuration on interface
(config-if)#exit	Exit interface mode.
(config)# router isis ISIS-IGP	Create an IS-IS routing instance
(config-router)# is-type level-1	Configure instance as level-1only routing.
(config-router)# metric-style wide	Configure the new style of metric type as wide.
(config-router)# mpls traffic-eng router-id 1.1.1.1	Configure MPLS-TE unique router-id TLV.
(config-router)# mpls traffic-eng level-1	Enable MPLS-TE in is-type Level-1
(config-router)# capability cspf	Enable CSPF feature for ISIS instance.
(config-router)# dynamic-hostname	Configure the hostname to be advertised for an ISIS instance
(config-router)# bfd all-interfaces	Enable BFD for all neighbors.
(config-router)# net 49.0000.0000.0001.00	Set a Network Entity Title for this instance, specifying the area address and the system ID.
(config-router)#exit	Exit router mode.
(config)# rsvp-path R1-R5-PRI-001	Create a rsvp path
(config-path)# 10.1.1.2 strict	Configure this explicit router path as a strict hop
(config-path)# 14.1.1.3 strict	Configure this explicit router path as a strict hop
(config-path)# 17.1.1.3 strict	Configure this explicit router path as a strict hop
(config-path)# exit	Exit the rsvp-path mode
(config)# rsvp-path R1-R5-BPS-001	Create a rsvp path
(config-path)# 12.1.1.2 strict	Configure this explicit router path as a strict hop

`(config-path)# 15.1.1.3 strict`	Configure this explicit router path as a strict hop
`(config-path)# exit`	Exit the rsvp-path mode
`(config)#rsvp-trunk R1-R5-PRI-001`	Enter the trunk mode for RSVP
`(config-trunk)#primary fast-reroute protection facility`	Configure primary fast-reroute protection facility for a trunk.
`(config-trunk)#primary fast-reroute node-protection`	Configure primary fast-reroute node protection for a trunk.
`(config-trunk)#primary path R1-R5-PRI-001`	Configure trunk to use the defined path.
`(config-trunk)#to 5.5.5.5`	Specify the IPv4 egress (destination point) for the LSP
`(config-path)# exit`	Exit the rsvp-trunk mode
`(config)#rsvp-bypass R1-R5-BPS-001`	Enter the bypass mode for RSVP
`(config-trunk)#path R1-R5-BPS-001`	Configure path for bypass tunnel
`(config-trunk)#to 5.5.5.5`	Specify the IPv4 egress (destination point) for the LSP
`(config-path)# exit`	Exit the rsvp-bypass mode
`(config)#commit`	Commit the transaction.

R2

`#configure terminal`	Enter configure mode.
`(config)#interface lo`	Enter interface mode.
`(config-if)#ip address 2.2.2.2/32 secondary`	Configure IP address for the loopback interface.
`(config-if)# ip router isis ISIS-IGP`	Enable IS-IS routing on an interface
`(config-if)#exit`	Exit interface mode.
`(config)# router-id 2.2.2.2`	Assigning router-id
`(config)#bfd interval 3 minrx 3 multiplier`	Configure BFD interval
`(config)#router rsvp`	Enter router mode for RSVP.
`(config-router)#exit`	Exit router configuration mode.
`(config)#interface xe29`	Specify the Interface to be configured.
`(config-if)#ip address 10.1.1.2/24`	Configure IP address for the interface.
`(config-if)#no shutdown`	Administratively bringing up the interface.
`(config-if)# label-switching`	Enable label switching on the interface
`(config-if)# isis network point-to-point`	Configure the ISIS interface network type as point to point
`(config-if)# ip router isis ISIS-IGP`	Enable IS-IS routing on an interface
`(config-if)# enable-rsvp`	Enable rsvp configuration on interface
`(config-if)#exit`	Exit interface mode.
`(config)#interface xe5`	Specify the Interface to be configured
`(config-if)#ip address 14.1.1.2/24`	Configure IP address for the interface.
`(config-if)#no shutdown`	Administratively bringing up the interface.
`(config-if)# label-switching`	Enable label switching on the interface
`(config-if)# isis network point-to-point`	Configure the ISIS interface network type as point to point
`(config-if)# ip router isis ISIS-IGP`	Enable IS-IS routing on an interface
`(config-if)# enable-rsvp`	Enable rsvp configuration on interface

(config-if)#exit	Exit interface mode.
(config)# router isis ISIS-IGP	Create an IS-IS routing instance
(config-router)# is-type level-1	Configure instance as level-1only routing.
(config-router)# metric-style wide	Configure the new style of metric type as wide.
(config-router)# mpls traffic-eng router-id 2.2.2.2	Configure MPLS-TE unique router-id TLV.
(config-router)# mpls traffic-eng level-1	Enable MPLS-TE in is-type Level-1
(config-router)# capability cspf	Enable CSPF feature for ISIS instance.
(config-router)# dynamic-hostname	Configure the hostname to be advertised for an ISIS instance
(config-router)# bfd all-interfaces	Enable BFD for all neighbors.
(config-router)# net 49.0000.0000.0002.00	Set a Network Entity Title for this instance, specifying the area address and the system ID.
(config-router)#exit	Exit router mode.
(config)#commit	Commit the transaction.

R3

#configure terminal	Enter configure mode.
(config)#interface lo	Enter interface mode.
(config-if)#ip address 3.3.3.3/32 secondary	Configure IP address for the loopback interface.
(config-if)# ip router isis ISIS-IGP	Enable IS-IS routing on an interface
(config-if)#exit	Exit interface mode.
(config)# router-id 3.3.3.3	Assigning router-id
(config)#bfd interval 3 minrx 3 multiplier	Configure BFD interval
(config)#router rsvp	Enter router mode for RSVP.
(config-router)#exit	Exit router configuration mode.
(config)#interface xe7	Specify the Interface to be configured.
(config-if)#ip address 12.1.1.2/24	Configure IP address for the interface.
(config-if)#no shutdown	Administratively bringing up the interface.
(config-if)# label-switching	Enable label switching on the interface
(config-if)# isis network point-to-point	Configure the ISIS interface network type as point to point
(config-if)# ip router isis ISIS-IGP	Enable IS-IS routing on an interface
(config-if)# enable-rsvp	Enable rsvp configuration on interface
(config-if)#exit	Exit interface mode.
(config)#interface xe6	Specify the Interface to be configured
(config-if)#ip address 15.1.1.2/24	Configure IP address for the interface.
(config-if)#no shutdown	Administratively bringing up the interface.
(config-if)# label-switching	Enable label switching on the interface
(config-if)# isis network point-to-point	Configure the ISIS interface network type as point to point
(config-if)# ip router isis ISIS-IGP	Enable IS-IS routing on an interface
(config-if)# enable-rsvp	Enable rsvp configuration on interface
(config-if)#exit	Exit interface mode.

(config)# router isis ISIS-IGP	Create an IS-IS routing instance
(config-router)# is-type level-1	Configure instance as level-1only routing.
(config-router)# metric-style wide	Configure the new style of metric type as wide.
(config-router)# mpls traffic-eng router-id 3.3.3.3	Configure MPLS-TE unique router-id TLV.
(config-router)# mpls traffic-eng level-1	Enable MPLS-TE in is-type Level-1
(config-router)# capability cspf	Enable CSPF feature for ISIS instance.
(config-router)# dynamic-hostname	Configure the hostname to be advertised for an ISIS instance
(config-router)# bfd all-interfaces	Enable BFD for all neighbors.
(config-router)# net 49.0000.0000.0003.00	Set a Network Entity Title for this instance, specifying the area address and the system ID.
(config-router)#exit	Exit router mode.
(config)#commit	Commit the transaction.

R4

#configure terminal	Enter configure mode.
(config)#interface lo	Enter interface mode.
(config-if)#ip address 4.4.4.4/32 secondary	Configure IP address for the loopback interface.
(config-if)# ip router isis ISIS-IGP	Enable IS-IS routing on an interface
(config-if)#exit	Exit interface mode.
(config)# router-id 4.4.4.4	Assigning router-id
(config)#bfd interval 3 minrx 3 multiplier	Configure BFD interval
(config)#router rsvp	Enter router mode for RSVP.
(config-router)#exit	Exit router configuration mode.
(config)#interface xe4	Specify the Interface to be configured.
(config-if)#ip address 17.1.1.2/24	Configure IP address for the interface.
(config-if)#no shutdown	Administratively bringing up the interface.
(config-if)# label-switching	Enable label switching on the interface
(config-if)# isis network point-to-point	Configure the ISIS interface network type as point to point
(config-if)# ip router isis ISIS-IGP	Enable IS-IS routing on an interface
(config-if)# enable-rsvp	Enable rsvp configuration on interface
(config-if)#exit	Exit interface mode.
(config)#interface xe6	Specify the Interface to be configured
(config-if)#ip address 14.1.1.3/24	Configure IP address for the interface.
(config-if)#no shutdown	Administratively bringing up the interface.
(config-if)# label-switching	Enable label switching on the interface
(config-if)# isis network point-to-point	Configure the ISIS interface network type as point to point
(config-if)# ip router isis ISIS-IGP	Enable IS-IS routing on an interface
(config-if)# enable-rsvp	Enable rsvp configuration on interface
(config-if)#exit	Exit interface mode.
(config)# router isis ISIS-IGP	Create an IS-IS routing instance

`(config-router)# is-type level-1`	Configure instance as level-1only routing.
`(config-router)# metric-style wide`	Configure the new style of metric type as wide.
`(config-router)# mpls traffic-eng router-id 4.4.4.4`	Configure MPLS-TE unique router-id TLV.
`(config-router)# mpls traffic-eng level-1`	Enable MPLS-TE in is-type Level-1
`(config-router)# capability cspf`	Enable CSPF feature for ISIS instance.
`(config-router)# dynamic-hostname`	Configure the hostname to be advertised for an ISIS instance
`(config-router)# bfd all-interfaces`	Enable BFD for all neighbors.
`(config-router)# net 49.0000.0000.0004.00`	Set a Network Entity Title for this instance, specifying the area address and the system ID.
`(config-router)#exit`	Exit router mode.
`(config)#commit`	Commit the transaction.

R5

`#configure terminal`	Enter configure mode.
`(config)#interface lo`	Enter interface mode.
`(config-if)#ip address 5.5.5.5/32 secondary`	Configure IP address for the loopback interface.
`(config-if)# ip router isis ISIS-IGP`	Enable IS-IS routing on an interface
`(config-if)#exit`	Exit interface mode.
`(config)# router-id 5.5.5.5`	Assigning router-id
`(config)#bfd interval 3 minrx 3 multiplier`	Configure BFD interval
`(config)#router rsvp`	Enter router mode for RSVP.
`(config-router)#exit`	Exit router configuration mode.
`(config)#interface xe12`	Specify the Interface to be configured.
`(config-if)#ip address 17.1.1.3/24`	Configure IP address for the interface.
`(config-if)#no shutdown`	Administratively bringing up the interface.
`(config-if)# label-switching`	Enable label switching on the interface
`(config-if)# isis network point-to-point`	Configure the ISIS interface network type as point to point
`(config-if)# ip router isis ISIS-IGP`	Enable IS-IS routing on an interface
`(config-if)# enable-rsvp`	Enable rsvp configuration on interface
`(config-if)#exit`	Exit interface mode.
`(config)#interface xe1`	Specify the Interface to be configured
`(config-if)#ip address 15.1.1.3/24`	Configure IP address for the interface.
`(config-if)#no shutdown`	Administratively bringing up the interface.
`(config-if)# label-switching`	Enable label switching on the interface
`(config-if)# isis network point-to-point`	Configure the ISIS interface network type as point to point
`(config-if)# ip router isis ISIS-IGP`	Enable IS-IS routing on an interface
`(config-if)# enable-rsvp`	Enable rsvp configuration on interface
`(config-if)#exit`	Exit interface mode.
`(config)# router isis ISIS-IGP`	Create an IS-IS routing instance
`(config-router)# is-type level-1`	Configure instance as level-1only routing.

`(config-router)# metric-style wide`	Configure the new style of metric type as wide.
`(config-router)# mpls traffic-eng router-id 5.5.5.5`	Configure MPLS-TE unique router-id TLV.
`(config-router)# mpls traffic-eng level-1`	Enable MPLS-TE in is-type Level-1
`(config-router)# capability cspf`	Enable CSPF feature for ISIS instance.
`(config-router)# dynamic-hostname`	Configure the hostname to be advertised for an ISIS instance
`(config-router)# bfd all-interfaces`	Enable BFD for all neighbors.
`(config-router)# net 49.0000.0000.0005.00`	Set a Network Entity Title for this instance, specifying the area address and the system ID.
`(config-router)#exit`	Exit router mode.
`(config)#commit`	Commit the transaction.

Validation

RSVP Session

Validate that the RSVP Session is up.

R1:

```
R1#show rsvp session
Type  : PRI - Primary, SEC - Secondary, DTR - Detour, BPS - Bypass
State : UP - Up, DN - Down, BU - Backup in Use, SU - Secondary in Use, FS - Forced to
Secondary
* indicates the session is active with local repair at one or more nodes
(P) indicates the secondary-priority session is acting as primary

Ingress RSVP:
To              From            Type    LSPName                        State Uptime    Rt
Style  Labelin  Labelout  DSType
5.5.5.5          1.1.1.1         PRI     R1-R5-PRI-001-Primary           UP    00:49:18
1 1 SE     -        52480     DEFAULT
5.5.5.5          1.1.1.1         BPS     R1-R5-BPS-001-Bypass            UP    05:24:23
1 1 SE     -        25600     DEFAULT
Total 2 displayed, Up 2, Down 0.

R1#show rsvp session detail
Ingress (Primary)
5.5.5.5
  From: 1.1.1.1, LSPstate: Up, LSPname: R1-R5-PRI-001-Primary
  Ingress FSM state: Operational
  Establishment Time: 322s 925ms
  Setup priority: 7, Hold priority: 0
  CSPF usage: Enabled, CSPF Retry Count: 0, CSPF Retry Interval: 30 seconds
  LSP Re-Optimization: Disabled, Re-Optimization Timer: NA, Cspf Client: ISIS
  IGP-Shortcut: Disabled, LSP metric: 30
  LSP Protection: facility
  Fast-Reroute bandwidth : 0
  Protection type desired: Node
  Fast-Reroute Hop limit: 255
```

```
  Fast-Reroute Setup priority: 7, Hold priority: 0
  Bypass trunk: R1-R5-BPS-001,  Merge Point: 17.1.1.3,  MP Label: 25600
    Bypass OutLabel: 25600,  OutIntf: xe20
    Protection provided -> Type: Node, BW: Best-effort
  Label in: -,  Label out:    52480,
  Tspec rate: 0, Fspec rate: 0
  Policer: Not Configured
  Tunnel Id: 5001, LSP Id: 2201, Ext-Tunnel Id: 1.1.1.1
  Bind value: 0, Oper state: NA, Alloc mode: NA
  Downstream: 10.1.1.2, xe8
  Path refresh: 30 seconds (RR enabled) (due in 27023 seconds)
  Resv refresh: 0 seconds (due in 0 seconds)
  Resv lifetime: 157 seconds (due in 128 seconds)
  Retry count: 0, intrvl: 30 seconds
  RRO re-use as ERO: Disabled
  Label Recording: Enabled
  Admin Groups: none
  Configured Path: R1-R5-PRI-001 (in use)
  Configured Explicit Route Detail :
   10.1.1.2/32 strict
   14.1.1.3/32 strict
   17.1.1.3/32 strict
  Session Explicit Route Detail :
   10.1.1.2/32 strict
   14.1.1.3/32 strict
   17.1.1.3/32 strict
  Record route:
   LP = 1 -> PLR's Downstream link is protected      PU = 1 -> Protection is in use on
PLR
   NP = 1 -> PLR's Downstream neighbor is protected  BP = 1 -> BW protection available
at PLR
   -------------------------------------------------------------
   IP Address         Label     (LP, PU, NP, BP)
   -------------------------------------------------------------
   <self>
   10.1.1.2           52480     ( 0,  0,  0,  0)
   14.1.1.3           52480     ( 0,  0,  0,  0)
   17.1.1.3           25600     ( 0,  0,  0,  0)
  Style: Shared Explicit Filter
  Traffic type: controlled-load
  Minimum Path MTU: 9216
Recorded Time : N/A
  Current Error:
    Code : None, Value : None
    Originated Node : None, Recorded Time : N/A
  Last Signaled Error:
    Code : None, Value : None
    Originated Node : None, Recorded Time : N/A
  Trunk Type: mpls
Ingress (Bypass)
5.5.5.5
```

```
  From: 1.1.1.1, LSPstate: Up, LSPname: R1-R5-BPS-001-Bypass
  Ingress FSM state: Operational
  Establishment Time: 0s 4ms
  Setup priority: 7, Hold priority: 0
  CSPF usage: Enabled, CSPF Retry Count: 0, CSPF Retry Interval: 30 seconds
  LSP Re-Optimization: Disabled, Re-Optimization Timer: NA, Cspf Client: ISIS
  IGP-Shortcut: Disabled, LSP metric: 20
  LSP Protection: None
  Bypass trunk bandwidth type: Best-effort
   Label in: -,  Label out:    25600,
  Tspec rate: 0, Fspec rate: 0
  Policer: Not Configured
  Tunnel Id: 5002, LSP Id: 2205, Ext-Tunnel Id: 1.1.1.1
  Bind value: 0, Oper state: NA, Alloc mode: NA
  Downstream: 12.1.1.2, xe20
  Path refresh: 30 seconds (RR enabled) (due in 10514 seconds)
  Resv lifetime: 157 seconds (due in 141 seconds)
  Retry count: 0, intrvl: 30 seconds
  RRO re-use as ERO: Disabled
  Label Recording: Disabled
  Admin Groups: none
  Configured Path: R1-R5-BPS-001 (in use)
  Configured Explicit Route Detail :
   12.1.1.2/32 strict
   15.1.1.3/32 strict
  Session Explicit Route Detail :
   12.1.1.2/32 strict
   15.1.1.3/32 strict
  Record route:
   -------------------------------------------------------------
   IP Address        Label
   -------------------------------------------------------------
   <self>
   12.1.1.2
   15.1.1.3
  Style: Shared Explicit Filter
  Traffic type: controlled-load
  Minimum Path MTU: 9216
Recorded Time : N/A
  Current Error:
    Code : None, Value : None
    Originated Node : None, Recorded Time : N/A
  Last Signaled Error:
    Code : RSVP System error (23), Value : N/A (0)
    Originated Node : 15.1.1.3, Recorded Time : 2023 May 16 08:52:51
  Trunk Type: mpls
  Total LSP protected : 1, Bandwidth in use : 0
```

R2:

```
R2#show rsvp session
```



```
Type  : PRI - Primary, SEC - Secondary, DTR - Detour, BPS - Bypass
State : UP - Up, DN - Down, BU - Backup in Use, SU - Secondary in Use, FS - Forced to
Secondary
* indicates the session is active with local repair at one or more nodes
(P) indicates the secondary-priority session is acting as primary

Transit RSVP:
To             From           Type    LSPName                        State Uptime    Rt
Style  Labelin  Labelout  DSType
5.5.5.5         1.1.1.1         PRI     R1-R5-PRI-001-Primary           UP    00:49:59
1 1 SE     52480    52480     ELSP_CON
Total 1 displayed, Up 1, Down 0.

R2#
R2#
R2#show rsvp session detail
Transit
5.5.5.5
  From: 1.1.1.1, LSPstate: Up, LSPname: R1-R5-PRI-001-Primary
  Transit upstream state: Operational, downstream state: Operational
  Setup priority: 7, Hold priority: 0
  IGP-Shortcut: Disabled, LSP metric: 65
  LSP Protection: facility
  Fast-Reroute bandwidth : 0
  Protection type desired: Node
  Fast-Reroute Hop limit: 255
  Fast-Reroute Setup priority: 7, Hold priority: 0
  Label in:    52480,  Label out:    52480,
  Tspec rate: 0, Fspec rate: 0
  Tunnel Id: 5001, LSP Id: 2201, Ext-Tunnel Id: 1.1.1.1
  Bind value: 0, Oper state: NA, Alloc mode: NA
  Downstream: 14.1.1.3, xe5   Upstream: 10.1.1.1, xe29
  Path refresh: 30 seconds (RR enabled) (due in 27004 seconds)
  Path lifetime: 157 seconds (due in 130 seconds)
  Resv refresh: 30 seconds (RR enabled) (due in 19943 seconds)
  Resv lifetime: 157 seconds (due in 141 seconds)
  RRO re-use as ERO: Disabled
  Label Recording: Enabled
  Admin Groups:   Received Explicit Route Detail :
   10.1.1.2/32 strict
   14.1.1.3/32 strict
   17.1.1.3/32 strict
  Session Explicit Route Detail :
   14.1.1.3/32 strict
   17.1.1.3/32 strict
  Record route:
   --------------------------------------------------------------
   IP Address        Label
   --------------------------------------------------------------
   10.1.1.1          52480
   <self>
```

```
   14.1.1.3          52480
   17.1.1.3          25600
  Style: Shared Explicit Filter
  Traffic type: controlled-load
  Minimum Path MTU: 9216
  LSP Type:  ELSP_CONFIG
  CLASS    DSCP_value     EXP_value
  Current Error:
    Code : None, Value : None
    Originated Node : None, Recorded Time : N/A
  Trunk Type: mpls
```

R3:

```
R3#show rsvp session
Type  : PRI - Primary, SEC - Secondary, DTR - Detour, BPS - Bypass
State : UP - Up, DN - Down, BU - Backup in Use, SU - Secondary in Use, FS - Forced to
Secondary
* indicates the session is active with local repair at one or more nodes
(P) indicates the secondary-priority session is acting as primary

Transit RSVP:
To             From           Type    LSPName                       State Uptime    Rt
Style  Labelin  Labelout  DSType
5.5.5.5         1.1.1.1         PRI     R1-R5-BPS-001-Bypass            UP    05:25:48
1 1 SE     25600    3         ELSP_CON
Total 1 displayed, Up 1, Down 0.

R3#show rsvp session detail
Transit
5.5.5.5
  From: 1.1.1.1, LSPstate: Up, LSPname: R1-R5-BPS-001-Bypass
  Transit upstream state: Operational, downstream state: Operational
  Setup priority: 7, Hold priority: 0
  IGP-Shortcut: Disabled, LSP metric: 65
  LSP Protection: None
  Label in:    25600,  Label out:        3,
  Tspec rate: 0, Fspec rate: 0
  Tunnel Id: 5002, LSP Id: 2205, Ext-Tunnel Id: 1.1.1.1
  Bind value: 0, Oper state: NA, Alloc mode: NA
  Downstream: 15.1.1.3, xe6   Upstream: 12.1.1.1, xe7
  Path refresh: 30 seconds (RR enabled) (due in 10445 seconds)
  Path lifetime: 157 seconds (due in 155 seconds)
  Resv refresh: 30 seconds (RR enabled) (due in 24008 seconds)
  Resv lifetime: 157 seconds (due in 140 seconds)
  RRO re-use as ERO: Disabled
  Label Recording: Disabled
  Admin Groups:   Received Explicit Route Detail :
   12.1.1.2/32 strict
   15.1.1.3/32 strict
  Session Explicit Route Detail :
   15.1.1.3/32 strict
```

```
  Record route:
   -------------------------------------------------------------
   IP Address        Label
   -------------------------------------------------------------
   12.1.1.1
   <self>
   15.1.1.3
  Style: Shared Explicit Filter
  Traffic type: controlled-load
  Minimum Path MTU: 9216
  LSP Type:  ELSP_CONFIG
  CLASS    DSCP_value     EXP_value
Recorded Time : N/A
  Current Error:
    Code : None, Value : None
    Originated Node : None, Recorded Time : N/A
  Trunk Type: mpls
R3#
```

R4:

```
R4#show rsvp session
Type  : PRI - Primary, SEC - Secondary, DTR - Detour, BPS - Bypass
State : UP - Up, DN - Down, BU - Backup in Use, SU - Secondary in Use, FS - Forced to
Secondary
* indicates the session is active with local repair at one or more nodes
(P) indicates the secondary-priority session is acting as primary

Transit RSVP:
To             From           Type    LSPName                       State Uptime    Rt
Style  Labelin  Labelout  DSType
5.5.5.5         1.1.1.1         PRI     R1-R5-PRI-001-Primary           UP    00:51:13
1 1 SE     52480    25600     ELSP_CON
Total 1 displayed, Up 1, Down 0.

R4#
R4#
R4#show rsvp session detail
Transit
5.5.5.5
  From: 1.1.1.1, LSPstate: Up, LSPname: R1-R5-PRI-001-Primary
  Transit upstream state: Operational, downstream state: Operational
  Setup priority: 7, Hold priority: 0
  IGP-Shortcut: Disabled, LSP metric: 65
  LSP Protection: facility
  Fast-Reroute bandwidth : 0
  Protection type desired: Node
  Fast-Reroute Hop limit: 255
  Fast-Reroute Setup priority: 7, Hold priority: 0
  Label in:    52480,  Label out:    25600,
  Tspec rate: 0, Fspec rate: 0
  Tunnel Id: 5001, LSP Id: 2201, Ext-Tunnel Id: 1.1.1.1
```

```
  Bind value: 0, Oper state: NA, Alloc mode: NA
  Downstream: 17.1.1.3, xe4   Upstream: 14.1.1.2, xe6
  Path refresh: 30 seconds (RR enabled) (due in 26908 seconds)
  Path lifetime: 157 seconds (due in 148 seconds)
  Resv refresh: 30 seconds (RR enabled) (due in 37164 seconds)
  Resv lifetime: 157 seconds (due in 144 seconds)
  RRO re-use as ERO: Disabled
  Label Recording: Enabled
  Admin Groups:   Received Explicit Route Detail :
   14.1.1.3/32 strict
   17.1.1.3/32 strict
  Session Explicit Route Detail :
   17.1.1.3/32 strict
  Record route:
   -------------------------------------------------------------
   IP Address        Label
   -------------------------------------------------------------
   10.1.1.1          52480
   14.1.1.2          52480
   <self>
   17.1.1.3          25600
  Style: Shared Explicit Filter
  Traffic type: controlled-load
  Minimum Path MTU: 9216
  LSP Type:  ELSP_CONFIG
  CLASS    DSCP_value     EXP_value
  Current Error:
    Code : None, Value : None
    Originated Node : None, Recorded Time : N/A
  Trunk Type: mpls
```

R5:

```
R5#show rsvp session
Type  : PRI - Primary, SEC - Secondary, DTR - Detour, BPS - Bypass
State : UP - Up, DN - Down, BU - Backup in Use, SU - Secondary in Use, FS - Forced to 
Secondary
* indicates the session is active with local repair at one or more nodes
(P) indicates the secondary-priority session is acting as primary

Egress RSVP:
To              From            Type    LSPName                       State Uptime    Rt 
Style  Labelin  Labelout  DSType
5.5.5.5         1.1.1.1         PRI     R1-R5-PRI-001-Primary           UP    00:51:45
1 1 SE     25600    -         ELSP_CON
5.5.5.5         1.1.1.1         PRI     R1-R5-BPS-001-Bypass            UP    05:26:50
1 1 SE     3        -         ELSP_CON
Total 2 displayed, Up 2, Down 0.

R5#show rsvp session detail
Egress
5.5.5.5
```

```
  From: 1.1.1.1, LSPstate: Up, LSPname: R1-R5-PRI-001-Primary
  Egress FSM state: Operational
  Setup priority: 7, Hold priority: 0
  IGP-Shortcut: Disabled, LSP metric: 65
  LSP Protection: facility
  Fast-Reroute bandwidth : 0
  Protection type desired: Node
  Fast-Reroute Hop limit: 255
  Fast-Reroute Setup priority: 7, Hold priority: 0
  Label in:    25600,  Label out: -,
  Tspec rate: 0, Fspec rate: 0
  Tunnel Id: 5001, LSP Id: 2201, Ext-Tunnel Id: 1.1.1.1
  Bind value: 0, Oper state: NA, Alloc mode: NA
  Upstream: 17.1.1.2, xe12
  Path lifetime: 157 seconds (due in 126 seconds)
  Resv refresh: 30 seconds (RR enabled) (due in 28434 seconds)
  RRO re-use as ERO: Disabled
  Label Recording: Enabled
  Admin Groups:   Received Explicit Route Detail :
   17.1.1.3/32 strict
  Record route:
   -------------------------------------------------------------
   IP Address        Label
   -------------------------------------------------------------
   10.1.1.1          52480
   14.1.1.2          52480
   17.1.1.2          25600
   <self>
  Style: Shared Explicit Filter
  Traffic type: controlled-load
  Minimum Path MTU: 9216
  LSP Type:  ELSP_CONFIG
  CLASS    DSCP_value     EXP_value
Recorded Time : N/A
  Current Error:
    Code : None, Value : None
    Originated Node : None, Recorded Time : N/A
  Trunk Type: mpls
Egress
5.5.5.5
  From: 1.1.1.1, LSPstate: Up, LSPname: R1-R5-BPS-001-Bypass
  Egress FSM state: Operational
  Setup priority: 7, Hold priority: 0
  IGP-Shortcut: Disabled, LSP metric: 65
  LSP Protection: None
  Label in:        3,  Label out: -,
  Tspec rate: 0, Fspec rate: 0
  Tunnel Id: 5002, LSP Id: 2205, Ext-Tunnel Id: 1.1.1.1
  Bind value: 0, Oper state: NA, Alloc mode: NA
  Upstream: 15.1.1.2, xe1
```

```
  Path lifetime: 157 seconds (due in 141 seconds)
  Resv refresh: 30 seconds (RR enabled) (due in 927 seconds)
  RRO re-use as ERO: Disabled
  Label Recording: Disabled
  Admin Groups:   Received Explicit Route Detail :
   15.1.1.3/32 strict
  Record route:
   -------------------------------------------------------------
   IP Address        Label
   -------------------------------------------------------------
   12.1.1.1
   15.1.1.2
   <self>
  Style: Shared Explicit Filter
  Traffic type: controlled-load
  Minimum Path MTU: 9216
  LSP Type:  ELSP_CONFIG
  CLASS    DSCP_value     EXP_value
Recorded Time : N/A
  Current Error:
    Code : None, Value : None
    Originated Node : None, Recorded Time : N/A
  Trunk Type: mpls
```

RSVP Bypass

Validate that the RSVP bypass session is up.

R1:

```
R1#   show rsvp bypass
Ingress RSVP:
To              From            LSPName                         State Uptime    Rt  Style
Labelin  Labelout  DSType
5.5.5.5         1.1.1.1         R1-R5-BPS-001-Bypass            UP    05:27:41  1 1 SE
-        25600     DEFAULT
To validate RSVP bypass session details
R1#   show rsvp bypass detail
Ingress (Bypass)
5.5.5.5
  From: 1.1.1.1, LSPstate: Up, LSPname: R1-R5-BPS-001-Bypass
  Ingress FSM state: Operational
  Establishment Time: 0s 4ms
  Setup priority: 7, Hold priority: 0
  CSPF usage: Enabled, CSPF Retry Count: 0, CSPF Retry Interval: 30 seconds
  LSP Re-Optimization: Disabled, Re-Optimization Timer: NA, Cspf Client: ISIS
  IGP-Shortcut: Disabled, LSP metric: 20
  LSP Protection: None
  Bypass trunk bandwidth type: Best-effort
   Label in: -,  Label out:    25600,
  Tspec rate: 0, Fspec rate: 0
  Policer: Not Configured
  Tunnel Id: 5002, LSP Id: 2205, Ext-Tunnel Id: 1.1.1.1
```

```
  Bind value: 0, Oper state: NA, Alloc mode: NA
  Downstream: 12.1.1.2, xe20
  Path refresh: 30 seconds (RR enabled) (due in 10319 seconds)
  Resv lifetime: 157 seconds (due in 126 seconds)
  Retry count: 0, intrvl: 30 seconds
  RRO re-use as ERO: Disabled
  Label Recording: Disabled
  Admin Groups: none
  Configured Path: R1-R5-BPS-001 (in use)
  Configured Explicit Route Detail :
   12.1.1.2/32 strict
   15.1.1.3/32 strict
  Session Explicit Route Detail :
   12.1.1.2/32 strict
   15.1.1.3/32 strict
  Record route:
   --------------------------------------------------------------
   IP Address        Label
   --------------------------------------------------------------
   <self>
   12.1.1.2
   15.1.1.3
  Style: Shared Explicit Filter
  Traffic type: controlled-load
  Minimum Path MTU: 9216
Recorded Time : N/A
  Current Error:
    Code : None, Value : None
    Originated Node : None, Recorded Time : N/A
  Last Signaled Error:
    Code : RSVP System error (23), Value : N/A (0)
    Originated Node : 15.1.1.3, Recorded Time : 2023 May 16 08:52:51
  Trunk Type: mpls
  Total LSP protected : 1, Bandwidth in use : 0
To validate RSVP bypass Protected-lsp-list
R1#   show rsvp bypass protected-lsp-list
Bypass trunk: R1-R5-BPS-001
Bypass trunk bandwidth type: best-effort
List of LSP's Protected:
Tunnel-id     Lsp Id     Lsp Name                 Role     Ext_tnl_id     Ingress
Egress
5001        2201      R1-R5-PRI-001-Primary       Ingress  1.1.1.1       1.1.1.1
5.5.5.5
Total LSP protected : 1
 Bandwidth in use : 0
```

CHAPTER 5 Virtual Private Wire Service Configuration

This chapter shows configurations for Virtual Private Wire Service (VPWS), where a point-to-point Layer 2 VPN service interconnects multiple Ethernet LANs across an MPLS backbone.

Overview

An MPLS Layer 2 Virtual Circuit (VC) is a point-to-point Layer 2 connection transported via MPLS on the service provider's network. The Layer 2 circuit is transported over a single Label Switched Path (LSP) tunnel between two Provider Edge (PE) routers.

The following diagram illustrates the configuration steps in this section. In this sample, the VC host devices, Host1 and Host2, are connected to the Provider Edge (PE) router PE-1; and Host3 and Host4 are connected to PE-2. The VC is established between PE-1 and PE-2. Interface eth2, on PE-1 and PE-2, is connected to the customer network; eth1, on PE-1 and PE-2, is connected to the MPLS cloud.

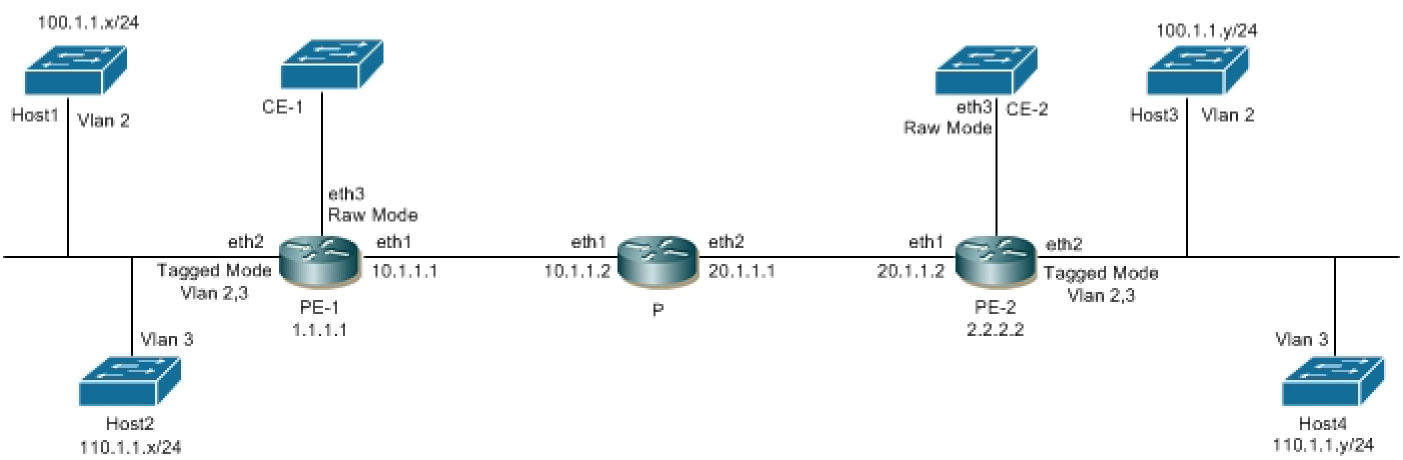


Figure 5-1: MPLS Layer 2 Virtual Circuit

The VC configuration process can be divided into the following steps:

Note: Loopback addresses being used should be advertised through OSPF, or should be statically routed.

1. Configure the IP address and OSPF for the PE-1, P (Provider), and PE-2 routers.
2. Configure MPLS and LDP on PE-1, P, and PE-2, and LDP targeted peer for the PE-1 and PE-2 routers. (If RSVP is used for configuring trunks, LDP must be configured on PE-1 and PE-2, and RSVP must be configured on PE-1, P, and PE-2.)
3. Configure the VC.
4. Bind the customer interface to the VC.

Configure IP Address and OSPF on Routers

Configure the IP addresses and OSPF on the PE-1, P, and PE-2 routers.

PE-1

`#configure terminal`	Enter configure mode.
`(config)#interface lo`	Specify the loopback interface `(lo0)` to be configured.
`(config-if)#ip address 1.1.1.1/32 secondary`	Set the IP address of the loopback interface to `1.1.1.1/32`.
`(config-if)#exit`	Exit interface mode.
`(config)#interface eth1`	Specify the interface `(eth1)` to be configured.
`(config-if)#ip address 10.1.1.1/24`	Set the IP address of the interface to `10.1.1.1/24`.
`(config-if)#exit`	Exit interface mode.
`(config)#router ospf 100`	Configure the routing process and specify the Process ID (100). The Process ID should be a unique positive integer identifying the routing process.
`(config-router)#network 10.1.1.0/24 area 0` `(config-router)#network 1.1.1.1/32 area 0`	Define the interface on which OSPF runs and associate the area ID `(0)` with the interface.

P

`#configure terminal`	Enter configure mode.
`(config)#interface lo`	Specify the loopback interface `(lo0)` to be configured.
`(config-if)#ip address 9.9.9.9/32 secondary`	Set the IP address of the loopback interface to `9.9.9.9/32`.
`(config-if)#exit`	Exit interface mode.
`(config)#interface eth1`	Specify the interface `(eth1)` to be configured.
`(config-if)#ip address 10.1.1.2/24`	Set the IP address of the interface to `10.1.1.2/24`.
`(config-if)#exit`	Exit interface mode.
`(config)#interface eth2`	Specify the interface `(eth2)` to be configured.
`(config-if)#ip address 20.1.1.1/24`	Set the IP address of the interface to `20.1.1.1/24`.
`(config-if)#exit`	Exit interface mode.
`(config)#router ospf 100`	Configure the routing process and specify the Process ID (100). The Process ID should be a unique positive integer identifying the routing process.

`(config-router)#network 10.1.1.0/24 area 0`
`(config-router)#network 20.1.1.0/24 area 0`
`(config-router)#network 9.9.9.9/32 area 0`
	Define the interface on which OSPF runs and associate the area ID `(0)` with the interface.

PE-2

`#configure terminal`	Enter configure mode.
`(config)#interface lo`	Specify the loopback interface `(lo0)` to be configured.
`(config-if)#ip address 2.2.2.2/32 secondary`	Set the IP address of the loopback interface to `2.2.2.2/32`.
`(config-if)#exit`	Exit interface mode.
`(config)#interface eth1`	Specify the interface `(eth1)` to be configured.
`(config-if)#ip address 20.1.1.2/24`	Set the IP address of the interface to `20.1.1.2/24`.

(config-if)#exit	Exit interface mode.
(config)#router ospf 100	Configure the routing process and specify the Process ID (100). The Process ID should be a unique positive integer identifying the routing process.
(config-router)#network 20.1.1.0/24 area 0 (config-router)#network 2.2.2.2/32 area 0	Define the interface on which OSPF runs, and associate the area ID (0) with the interface.

Configure MPLS, LDP, and LDP Targeted Peer on Routers

Configure MPLS and LDP on PE-1, P, and PE-2, and LDP targeted peers on PE-1 and PE-2.

Note: If RSVP is used for configuring trunks, LDP must be configured on PE-1 and PE-2, and RSVP must be configured on PE-1, P, and PE-2,

PE-1

#configure terminal	Enter configure mode.
(config)#router ldp	Enter the Router mode.
(config-router)#transport-address ipv4 1.1.1.1	Configure the transport address to be used for a TCP session over which LDP will run on an IPv4 interface.
(config-router)#targeted-peer ipv4 2.2.2.2	Specify the targeted LDP peer on PE-1.
(config-router-targeted-peer)# exit	Exit the Router targeted peer mode.
(config-router)#exit	Exit the Router mode.
(config)#interface eth1	Specify the interface (eth1) to be configured.
(config-if)#label-switching	Enable label switching on interface eth1.
(config-if)#enable-ldp ipv4	Enable LDP on interface eth1.

P

#configure terminal	Enter configure mode.
(config)#router ldp	Enter the Router mode.
(config-router)#transport-address ipv4 9.9.9.9	Configure the transport address to be used for a TCP session over which LDP will run on an IPv4 interface.
(config-router)#exit	Exit the Router mode.
(config)#interface eth1	Specify the interface (eth1) to be configured.
(config-if)#label-switching	Enable label switching on interface eth2.
(config-if)#enable-ldp ipv4	Enable LDP on interface eth2.
(config-if)#exit	Exit interface mode.
(config)#interface eth2	Specify the interface (eth2) to be configured.
(config-if)#label-switching	Enable label switching on interface eth2.
(config-if)#enable-ldp ipv4	Enable LDP on interface eth2.

PE-2

`#configure terminal`	Enter configure mode.
`(config)#router ldp`	Enter the Router mode.
`(config-router)#transport-address ipv4 2.2.2.2`	Configure the transport address to be used for a TCP session over which LDP will run on an IPv4 interface.
`(config-router)#targeted-peer ipv4 1.1.1.1`	Specify the targeted LDP peer on PE-2.
`(config-router-targeted-peer)# exit`	Exit the Router targeted peer mode.
`(config-router)#exit`	Exit the Router mode.
`(config)#interface eth1`	Specify the interface(eth1) to be configured.
`(config-if)#label-switching`	Enable label switching on interface eth1.
`(config-if)#enable-ldp ipv4`	Enable LDP on interface eth1.

Configure VC

Configure the VC. Each VC ID uniquely identifies the Layer-2 circuit among all the Layer-2 circuits.

Note: Both PE routers (endpoints) must be configured with the same VC-ID (`100` in this example).

PE-1

`#configure terminal`	Enter configure mode.
`(config)#mpls l2-circuit t1 100 2.2.2.2`	Configure the VC for PE-2. In this example, `t1` is the VC name, `100` is the VC ID, and `2.2.2.2` is the VC endpoint IP address.

PE-2

`#configure terminal`	Enter configure mode.
`(config)#mpls l2-circuit t1 100 1.1.1.1`	Configure the VC for PE-1. In this example, `t1` is the VC name, `100` is the VC ID, and `1.1.1.1` is the VC endpoint IP address.

Bind Customer Interface to VC

Bind the customer interface to the VC using one of the two procedures described below: Layer-2 untagged traffic or Layer-2 tagged traffic.

Note: Layer 2 VCs can only be bound to Layer 2 interfaces. The VC encapsulation method should be Ethernet (default), VLAN.

Layer 2 Untagged Traffic

Use Access mode for Layer 2 untagged traffic.

PE-1

`#configure terminal`	Enter configure mode.
`(config)#service-template SUT1`	Create a service template SUT1
`(config-svc)#match untagged`	Allow untagged traffic.
`(config-svc)#exit`	Exit the service template mode
`(config)#interface eth3`	Specify the interface (eth3) to be configured.
`(config-if)#switchport`	Switch to Layer-2 mode.
`(config-if)#mpls-l2-circuit t1 service-template SUT1`	Bind the interface to the VC with service template.

PE-2

`#configure terminal`	Enter configure mode.
`(config)#service-template SUT1`	Create a service template SUT1
`(config-svc)#match untagged`	Allow untagged traffic.
`(config-svc)#exit`	Exit the service template mode
`(config)#interface eth3`	Specify the interface (eth3) to be configured.
`(config-if)#switchport`	Switch to Layer-2 mode.
`(config-if)#mpls-l2-circuit t1 service-template SUT1`	Bind the interface to the VC with service template.

Layer 2 Tagged Traffic

Use Trunk mode for Layer-2 tagged traffic. The following configuration allows only VLAN 2 and 3 traffic.

PE-1

`#configure terminal`	Enter configure mode.
`(config)#mpls l2-circuit t2 200 2.2.2.2`	Configure the VC for PE-2. In this example, t2 is the VC name, 200 is the VC ID, and 2.2.2.2 is the VC endpoint IP address.
`(config-pseudowire)#exit`	Exit pseudowire config mode.
`(config)#service-template ST1`	Create a service template ST1
`(config-svc)#match outer-vlan 2`	Allow VLAN 2 traffic on this VC.
`(config-svc)#match outer-vlan 3`	Allow VLAN 3 traffic on this VC.
`(config-svc)#exit`	Exit the service template mode
`(config)#interface eth2`	Specify the interface (eth2) to be configured.
`(config-if)#switchport`	Switch to Layer-2 mode.
`(config-if)#mpls-l2-circuit t2 service-template ST1`	Bind the interface to the VC with service template.

PE-2

`#configure terminal`	Enter configure mode.
`(config)#mpls l2-circuit t2 200 1.1.1.1`	Configure the VC for PE-2. In this example, t2 is the VC name, 200 is the VC ID, and 1.1.1.1 is the VC endpoint IP address.
`(config-pseudowire)#exit`	Exit pseudowire config mode.
`(config)#service-template ST1`	Create a service template ST1
`(config-svc)#match outer-vlan 2`	Allow VLAN 2 traffic on this VC.
`(config-svc)#match outer-vlan 3`	Allow VLAN 3 traffic on this VC.
`(config-svc)#exit`	Exit the service template mode
`(config)#interface eth2`	Specify the interface (eth2) to be configured.
`(config-if)#switchport`	Switch to Layer-2 mode.
`(config-if)#mpls-l2-circuit t2 service-template ST1`	Bind the interface to the VC with service template.

Validation

Use the show ldp mpls-l2-circuit (Control Plane) command, and the show mpls vc-table (Forwarding Plane) command, to display complete information about the Layer 2 VC.

If the VC State is UP in the output from the show ldp mpls-l2 circuit command, and the Status is Active in the output of the show mpls vc-table command, a ping from CE1 to CE2 should be successful.

```
#show ldp mpls-l2-circuit
Transport    Client      VC       Trans    Local       Remote       Destination
VC ID        Binding     State    Type     VC Label    VC Label     Address
100          eth3        UP   Ethernet VLAN 24320       24321        2.2.2.2
200          eth2        UP   Ethernet VLAN 24321       24322        2.2.2.2


#show mpls vc-table
VC-ID      Vlan-ID  Inner-Vlan-ID  Access-Intf   Network-Intf  Out Label  Tunnel-Label
Nexthop          Status
100         N/A      N/A           eth3           eth6          24321      24320
2.2.2.2          Active
200         N/A      N/A           eth2           eth6          24322      24320
2.2.2.2          Active
#
```

These additional commands can also be used to display information about the Layer 2 virtual circuits.

```
show ldp mpls-l2-circuit detail
show ldp mpls-l2-circuit VC-ID
show ldp mpls-l2-circuit VC-ID detail
show mpls l2-circuit
```

Configure a Static Layer-2 VC

For a static MPLS Layer 2 VC configuration:

1. Configure the VC with the manual option
2. Configure the VC FIB entry
3. Bind the VC; all steps are in the configurations that follow.

PE-1

`#configure terminal`	Enter configure mode.
`PE1(config)#mpls l2-circuit t3 300 2.2.2.2 manual`	Configure the VC ID with the manual option (no signaling used).
`PE1(config-pseudowire)#exit`	Exit pseudowire config mode.
`PE1(config)#service-template ST3`	Create a service template ST3
`PE1(config-svc)#exit`	Exit the service template mode
`PE1(config)#interface eth2`	Add an FTN entry; where 1000 is the incoming label, 2000 is the outgoing label, 2.2.2.2 is the endpoint, eth1 is the incoming interface name, and eth2 is outgoing interface name.
`PE1(config-if)#mpls-l2-circuit t2 service-template ST3`	Bind the interface to the VC with service template.
`PE1(config-if)#exit`	Exit interface mode
`PE1(config)#mpls l2-circuit-fib-entry 300 1000 2000 2.2.2.2 eth1 eth2`	Configure the VC ID with the manual option (no signaling used).

PE-2

`#configure terminal`	Enter configure mode.
`PE2(config)#mpls l2-circuit t3 300 1.1.1.1 manual`	Configure the VC ID with the manual option (no signaling used).
`PE1(config-pseudowire)#exit`	Exit pseudowire config mode.
`PE1(config)#service-template ST3`	Create a service template ST3
`(config-svc)#exit`	Exit the service template mode
`PE2(config)#interface eth2`	Add an FTN entry; where 2000 is the incoming label, 1000 is the outgoing label, 1.1.1.1 is the endpoint, eth1 is the incoming interface name, and eth 2 is outgoing interface name.
`PE2(config-if)#mpls-l2-circuit t2 service-template ST3`	Bind the interface to the VC with service template.
`PE2(config-if)#exit`	Exit interface mode.
`PE2(config)#mpls l2-circuit-fib-entry 300 2000 1000 1.1.1.1 eth1 eth2`	Configure the VC ID with the manual option (no signaling used).
`PE2(config)#end`	Exit configure mode

Validation

This example shows number of configured VCs and its status.

```
#show mpls vc-table count
 -------------------------------
```

```
  Num PWs       : 3
  Active PWs    : 3
  OAM-only PWs : 0
  Inactive PWs : 0
 -------------------------------

 #show ldp mpls-l2-circuit count
 ----------------------------------------------
 Num Signaled PWs: 3        [UP: 3]
 ----------------------------------------------
```

Service template Configuration

PE-1

`#configure terminal`	Enter configure mode.
`(config)#mpls l2-circuit vc1 10 2.2.2.2`	Configure the VC
`(config-pseudowire)#service-tpid dot1.ad`	Configure Service-TPID as dot1.ad (0x88a8)
`(config-pseudowire)#exit`	Exit pseudowire config mode.
`(config)# service-template template1`	Configure the service template.
`(config-svc)# match double-tag outer-vlan 204 inner-vlan 203`	Matching criteria for service template.
`(config-svc)#rewrite ingress pop outgoing-tpid dot1.ad`	Action performed for service template.
`(config-svc)#exit`	Exit configure SVC mode
`(config)#interface eth2`	Specify the interface `(eth2)` to be configured.
`(config-if)#switchport`	Switch to Layer-2 mode.
`(config-if)# switchport dot1q ethertype 0x88a8`	Configure interface ethertype as dot1.ad (0x88a8)
`(config-if)#mpls-l2-circuit vc1 service-template template1`	Bind the interface to the VC with service template.
`(config-if)#exit`	End of Interface and configurations mode.

PE-2

`(config)#mpls l2-circuit vc1 10 1.1.1.1`	Configure the VC.
`(config-pseudowire)#service-tpid dot1.ad`	Configure Service-TPID as dot1.ad (0x88a8)
`(config-pseudowire)#exit`	Exit pseudowire config mode.
`(config)# service-template template1`	Configure the service template.
`(config-svc)# match double-tag outer-vlan 204 inner-vlan 203`	Matching criteria for service template.
`(config-svc)# rewrite ingress pop outgoing-tpid dot1.ad`	Action performed for service template.
`(config-svc)#exit`	Exit configure SVC mode
`(config)#interface eth2`	Specify the interface `(eth2)` to be configured.

(config-if)#switchport	Switch to Layer-2 mode.
(config-if)#switchport dot1q ethertype 0x88a8	Configure interface ethertype as dot1.ad (0x88a8)
(config-if)#mpls-l2-circuit vc1 service-template template1	Bind the interface to the VC with service template.
(config-if)#exit	End of interface and configurations mode.

Validation

PE1

```
PE1#sh ldp mpls-l2-circuit detail
PW ID: 10, VC state is up
Access IF: eth2,up,AC state is up
Session IF: eth1, state is up
Destination: 2.2.2.2, Peer LDP Ident: 2.2.2.2
Local vctype: vlan, remote vctype :vlan
Local groupid: 0, remote groupid: 0
Local label: 24322, remote label: 52482
Local MTU: 1500, Remote MTU: 1500
Local Control Word: disabled  Remote Control Word: Not-Applicable  Current
use: disabled
Local PW Status Capability : disabled
Remote PW Status Capability : disabled
Current PW Status TLV : disabled


PE1#sh mpls l2-circuit detail
MPLS Layer-2 Virtual Circuit: vc1, id: 10  PW-INDEX: 1 service-tpid: dot1.ad
 Endpoint: 2.2.2.2
 Control Word: 0
 MPLS Layer-2 Virtual Circuit Group: none
 Bound to interface: eth2
 Virtual Circuit Type: Ethernet VLAN
 Virtual Circuit is configured as Primary
 Virtual Circuit is configured as Active
 Virtual Circuit is active
 Service-template : template1
  Match criteria : 204/203
  Action type : Pop
  Outgoing tpid : dot1.ad


PE1#sh mpls vc-table
VC-ID       Vlan-ID  Inner-Vlan-ID  Access-Intf   Network-Intf  Out Label
Tunnel-Label  Nexthop         Status
10          N/A      N/A            eth2          eth1           52482
52480         2.2.2.2         Active
```

Service-template with multiple match support

This is to validate the multiple match criteria support in a service template. When multiple match statements are configured only rewrite push is supported, rewrite translate and pop are not supported.

PE-1

`#configure terminal`	Enter configure mode.
`(config)#mpls l2-circuit t4 400 2.2.2.2`	Configure the VC for PE-1. In this example, t4 is the VC name, 400 is the VC ID, and 2.2.2.2 is the VC endpoint IP address.
`(config-pseudowire)#exit`	Exit pseudowire config mode.
`(config)#service-template template4`	Template configuration
`(config-svc)# match outer-vlan 700`	Allow VLAN 700 traffic on this VC
`(config-svc)# match double-tag outer-vlan 1200 inner-vlan 3200`	Allow double tag match with s+c tags
`(config-svc)# match untagged`	Allow untagged traffic
`(config-svc)# rewrite ingress push 300`	Push Action performed for service template
`(config)#interface eth2`	Specify the interface (eth2) to be configured.
`(config-if)#switchport`	Switch to Layer-2 mode.
`(config-if)#mpls-l2-circuit t4 service-template template4`	Bind the interface to the VC with service template.

PE-2

`#configure terminal`	Enter configure mode.
`(config)#mpls l2-circuit t4 400 1.1.1.1`	Configure the VC for PE-2. In this example, t4 is the VC name, 400 is the VC ID, and 1.1.1.1 is the VC endpoint IP address.
`(config-pseudowire)#exit`	Exit pseudowire config mode.
`(config)#service-template template4`	Template configuration
`(config-svc)# match outer-vlan 700`	Allow VLAN 700 traffic on this VC
`(config-svc)# match double-tag outer-vlan 1200 inner-vlan 3200`	Allow double tag match with s+c tags
`(config-svc)# match untagged`	Allow untagged traffic
`(config-svc)# rewrite ingress push 300`	Push Action performed for service template
`(config)#interface eth2`	Specify the interface (eth2) to be configured.
`(config-if)#switchport`	Switch to Layer-2 mode.
`(config-if)#mpls-l2-circuit t4 service-template template4`	Bind the interface to the VC with service template.

Validation

```
PE1#sh ldp mpls-l2-circuit detail
PW ID: 400, VC state is up
Access IF: eth2,up,AC state is up
Session IF: eth1, state is up
Destination: 2.2.2.2, Peer LDP Ident: 2.2.2.2
Local vctype: vlan, remote vctype :vlan
Local groupid: 0, remote groupid: 0
Local label: 24324, remote label: 52485
Local MTU: 1500, Remote MTU: 1500
Local Control Word: disabled  Remote Control Word: Not-Applicable  Current use: disabled
Local PW Status Capability : disabled
Remote PW Status Capability : disabled
```



```
Current PW Status TLV : disabled


PE1#sh mpls l2-circuit detail
MPLS Layer-2 Virtual Circuit: t4, id: 400  PW-INDEX: 4 service-tpid: dot1.q

 Endpoint: 2.2.2.2
 Control Word: 0
 MPLS Layer-2 Virtual Circuit Group: none
 Bound to interface: eth2
 Virtual Circuit Type: Ethernet VLAN
 Virtual Circuit is configured as Primary
 Virtual Circuit is configured as Active
 Virtual Circuit is active
 Service-template : template4
  Match criteria : 700
 1200/3200
  untagged
  Action type : Push
  Action value : 300

PE1#show mpls vc-table
VC-ID      Vlan-ID  Inner-Vlan-ID  Access-Intf   Network-Intf  Out Label  Tunnel-Label  Nexthop         Status     Ecmp-Group
400         N/A      N/A            eth2           eth1          24322      24320         2.2.2.2         Active     N/A


PE2#show mpls vc-table
VC-ID      Vlan-ID  Inner-Vlan-ID  Access-Intf   Network-Intf  Out Label  Tunnel-Label  Nexthop         Status     Ecmp-Group
400         N/A      N/A            eth2           eth1          24321      24325         1.1.1.1         Active     N/A
```

CHAPTER 6 LDP Configuration

This chapter contains LDP (Label Distribution Protocol) configuration examples.

Label Distribution Protocol Overview

The Label Distribution Protocol (LDP) is a routing protocol used in MPLS technology. The LDP daemon (`ldpd`) uses NSM services to obtain routing information. Routers send Hello packets to establish Hello Adjacencies with other nearby routers. This opens the way for sessions between routers to be established during which routers exchange labels in preparation for forwarding packets.

LDP generates labels for and exchanges labels between peer routers. It works in with other routing protocols (RIP, OSPF and BGP) to create label-switched paths (LSP) used when forwarding packets. A label-switched path is the path taken by all packets that belong to the Forwarding Equivalence Class (FEC) corresponding to that LSP. This is analogous to establishing a virtual circuit in ATM (Asynchronous Transfer Mechanism). In this way, OcNOS LDP assigns labels to every destination address and destination prefix provided by OcNOS. The LDP interface to the MPLS forwarder adds labels to, and deletes labels from, the forwarding tables.

LDP Adjacencies

LDP defines a mechanism for discovering adjacent, LDP capable Label Switching Routers (LSR) that participate in label switching (adjacencies). Whenever a new router comes up it sends out a hello packet to a specified, multicast address announcing itself to the network. Every router directly connected to the network receives the packet. Receipt of a hello packet from another LSR creates a *Hello Adjacency* with that LSR. To create a Hello Adjacency with an LSR that cannot send/receive multicast packets, LDP allows a router to be manually configured to send unicast Hello packets to non-multicast LSRs . This non-multicast LSR is a *targeted peer*. Adjacencies are maintained by sending out periodic Hello packets to the multicast group and to all targeted peers. Hello packets are sent using UDP.

LDP Session

LDP capable LSRs establish a session before exchanging label information. All the session messages are sent using TCP to ensure reliable delivery. After the LSRs establish a session and negotiate options, a given pair of routers may exchange label information. The labels exchanged over a session are valid only during the lifetime of the session and routers release them when session is closed.

Forwarding Equivalence Class

A Forwarding Equivalence Class (FEC) section defines a set of packets that are forwarded on the same path by the MPLS network. Two common methods to define FEC are by advertising the IPv4 routes using:

- **Host Address** The LSR uses the address of the destination host to create this FEC. This means that all the packets going to this destination will take the same LSP.
- **Prefix** The LSR uses destination prefix to create this FEC. This means that all the packets take the LSP corresponding to the longest matching prefix.

Label Generation

An LDP Label is a 20-bit number the LSR uses to forward a packet to its destination. When an LSR creates a new FEC, the router generates new labels and distributes them to its peers. A router keeps both incoming and outgoing labels in its database.

Label Distribution Modes

The OcNOS LDP implementation supports two label distribution modes:

- **Downstream Unsolicited** In this mode, next hop LSRs distribute labels to peers without waiting for a label request.
- **Downstream on Demand** In this mode, a LSR distributes a label to a peer only if there is a pending label request from the peer.

Label Retention Mode

The OcNOS LDP implementation supports two label retention modes:

- **Liberal Retention Mode** In this mode, the LSR retains all labels received from all sources. This mode helps in fast LSP setup in case of a change in next hop.
- **Conservative Retention Mode** In this mode, the LSR retains only those labels received from peers that are the next hop for a given FEC. This mode is used by LSRs that have a constraint on the number of labels that it can retain at any given time.

LSP Control

LSPs can be set up in the following two ways:

- **Ordered Control** In this mode, an LSR distributes a label for a FEC to its peer only if it has a corresponding label from its next hop or it is the egress node.
- **Independent Control** In this mode, an LSR may distribute a label to its peers without waiting for a corresponding label from its next hop.

Loop Detection

Loop detection can be enabled to detect routing loops in LSPs. There are two methods supported for the loop detection mechanism:

- **Hop Count** During setup of an LSP, the LSP passes hop count with the LSP setup messages. This hop count is incriminated by each node router participating in LSP establishment. If the hop count exceeds the maximum configured value, the LSP setup process is stopped and a notification message is passed back to the message originator.
- **Path Vector** A path vector contains a list of LSR identifiers. This is passed as a part of LSP setup messages. Each LSR participating in the LSP establishment adds its own LSR identifier to the path vector. If an LSR finds its own identifier in the path vector, it drops the message and sends a message back to the originator.

The use of these messages ensures that a loop is detected while establishing a label switched path and before any data is passed over that LSP.

Configure LDP

The `enable-ldp ipv4` command are used to enable LDP for IPv4, on a specified interface, as follows:

- `enable-ldp ipv4` enables only IPv4 on the interface

For the examples covered in this section, the command `enable-ldp ipv4` is used.

Enable Label Switching

Running LDP on a system requires the following tasks:

1. Enabling label-switching on the interface on NSM.
2. Enabling LDP on an interface in the LDP daemon.
3. Running an IGP (Internal Gateway Protocol), for example, OSPF, to distribute reachability information within the MPLS cloud.
4. Configuring the transport address.

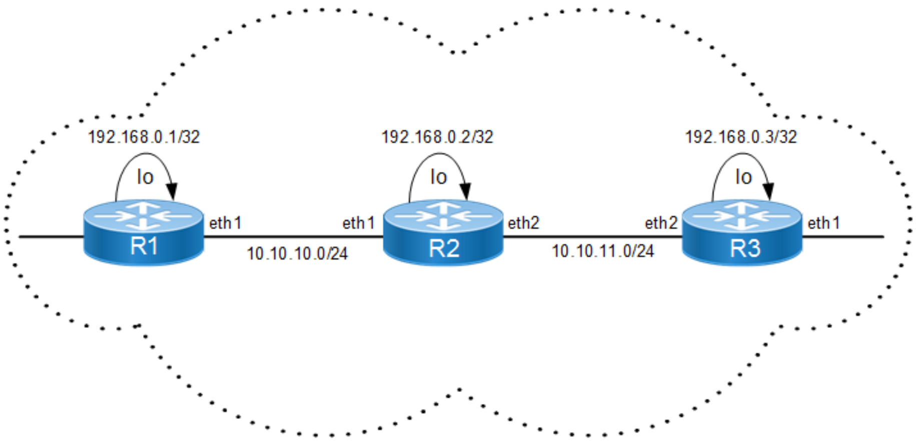


Figure 6-1: Basic LDP Topology

R1

NSM

`#configure terminal`	Enter configure mode.
`(config)#interface eth1`	Specify the interface `(eth1)` to be configured.
`(config-if)#label-switching`	Enable label switching on interface `eth1`.
`(config-if)#exit`	Exit interface mode.
`(config)#interface lo`	Specify the loopback (`lo`) interface to be configured.
`(config-if)#ip address 192.168.0.1/32`	Set the IP address of the loopback interface to `192.168.0.1/32`.

LDP

`(config)#router ldp`	Enter `Router` mode for LDP.
`(config-router)#router-id 192.168.0.1`	Set the router ID to IP address `192.168.0.1`.
`(config-router)#transport-address ipv4 192.168.0.1`	Configure the transport address to be used for a TCP session over which LDP will run on an IPv4 interface. **Note**: It is preferable to use the loopback address as transport address. In addition, use the parameter “ipv6” if you are configuring an IPv6 interface.
`(config-router)#exit`	Exit the `Router` mode and return to the `Configure` mode.

`(config)#interface eth1`	Enter interface mode.
`(config-if)#enable-ldp ipv4`	Enable LDP on `eth1.`
`(config-if)#exit`	Exit interface mode.

OSPF

`(config)#router ospf 100`	Configure the routing process and specify the Process ID (100). The Process ID should be a unique positive integer identifying the routing process.
`(config-router)#network 10.10.10.0/24 area 0` `(config-router)#network 192.168.0.1/32 area 0`	Define the interface on which OSPF runs and associate the area ID `(0)` with the interface.

R2

NSM

`#configure terminal`	Enter configure mode.
`(config)#interface lo`	Specify the loopback (`lo`) interface to be configured.
`(config-if)#ip address 192.168.0.2/32`	Set the IP address of the loopback interface to `192.168.0.2/32`.
`(config-if)#exit`	Exit interface mode.
`(config)#interface eth1`	Specify the interface `(eth1)` to be configured.
`(config-if)#label-switching`	Enable label switching on interface `eth1`.
`(config-if)#exit`	Exit interface mode.
`(config)#interface eth2`	Specify the interface `(eth2)` to be configured.
`(config-if)#label-switching`	Enable label switching on interface `eth2.`
`(config-if)#exit`	Exit interface mode.

LDP

`(config)#router ldp`	Enter `Router` mode.
`(config-router)#router-id 192.168.0.2`	Set the router ID to IP address `192.168.0.2.`
`(config-router)#transport-address ipv4 192.168.0.2`	Configure the transport address to be used for a TCP session over which LDP will run on an IPv4 interface. **Note**: It is preferable to use the loopback address as transport address. In addition, use the parameter “ipv6” if you are configuring an IPv6 interface.
`(config-router)#exit`	Exit `Router` mode and return to `Configure` mode.
`(config)#interface eth1`	Specify the interface `(eth1)` to be configured.
`(config-if)#enable-ldp ipv4`	Enable LDP on a specified interface (`eth1`).
`(config-if)#exit`	Exit interface mode.
`(config)#interface eth2`	Specify the interface `(eth2)` to be configured.

`(config-if)#enable-ldp ipv4`	Enable LDP on a specified interface (`eth2`).
`(config-if)#exit`	Exit interface mode.

OSPF

`(config)#router ospf 100`	Configure the routing process and specify the Process ID (100). The Process ID should be a unique positive integer identifying the routing process.

`(config-router)#network 10.10.10.0/24 area 0`
`(config-router)#network 10.10.11.0/24 area 0`
`(config-router)#network 192.168.0.2/32 area 0`
	Define the interfaces on which OSPF runs and associate the area ID (`0`) with them.

R3

NSM

`#configure terminal`	Enter configure mode.
`(config)#interface lo`	Specify the loopback (`lo`) interface to be configured.
`(config-if)#ip address 192.168.0.3/32`	Set the IP address of the loopback interface to `192.168.0.3/32`.
`(config-if)#exit`	Exit interface mode.
`(config)#interface eth2`	Specify the interface (`eth2`) to be configured.
`(config-if)#label-switching`	Enable label switching on interface `eth2`.
`(config-if)#exit`	Exit interface mode.

LDP

`(config)#router ldp`	Enter `Router` mode.
`(config-router)#router-id 192.168.0.3`	Set the router ID for IP address `192.168.0.3`.
`(config-router)#transport-address ipv4 192.168.0.3`	Configure the transport address to be used for a TCP session over which LDP will run on an IPv4 interface. **Note**: It is preferable to use the loopback address as transport address. In addition, use the parameter “ipv6” if you are configuring an IPv6 interface.
`(config-router)#exit`	Exit the `Router` mode and return to the `Configure` mode.
`(config)#interface eth2`	Enter interface mode.
`(config-if)#enable-ldp ipv4`	Enable LDP on `eth2`.
`(config-if)#exit`	Exit interface mode.

OSPF

`(config)#router ospf 100`	Configure the routing process and specify the Process ID (100). The Process ID should be a unique positive integer identifying the routing process.
`(config-router)#network 10.10.11.0/24 area 0` `(config-router)#network 192.168.0.3/32 area 0`	Define the interfaces on which OSPF runs and associate the area ID `(0)` with them.

LDP MD5 Authentication

LDP MD5 configuration enables LDP MD5 password authentication on a per-peer basis.

Direct LDP Session

In this example, MD5 authentication is configured for a direct LDP session.

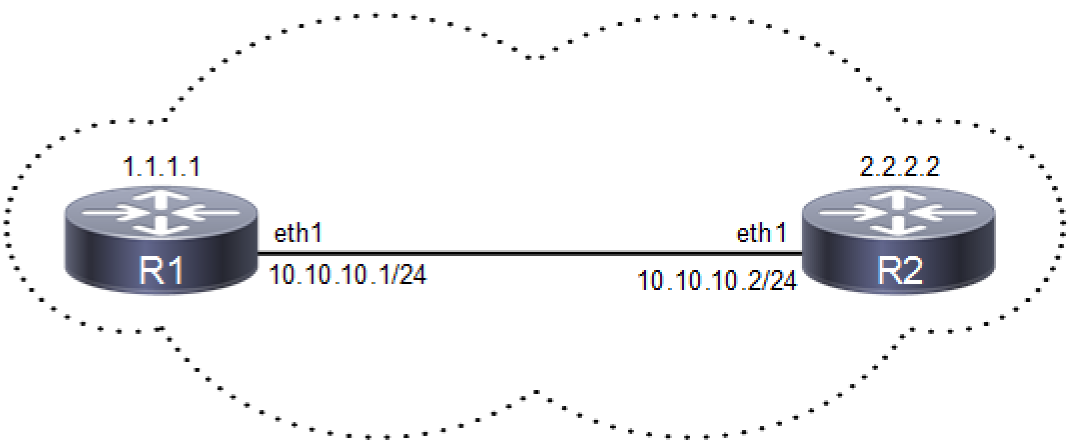


Figure 6-2: Topology for Direct Session MD5

R1

`#configure terminal`	Enter configure mode.
`(config)#router ldp`	Enter `Router` mode.
`(config-router)#neighbor 10.10.10.2 auth md5 password 0 pwd1`	Configure the MD5 authentication and password, `pwd1`, for the neighbor, `10.10.10.2`.
`(config-router)#exit`	Exit the `Router` mode and return to the `Configure` mode.
`(config)#interface eth1`	Specify the interface `(eth1)` to be configured.
`(config-if)#label-switching`	Enable label switching on interface `eth1`.
`(config-if)#enable-ldp ipv4`	Enable LDP on interface `eth1`.
`(config-if)#exit`	Exit interface mode.

R2

`#configure terminal`	Enter configure mode.
`(config)#router ldp`	Enter `Router` mode.
`(config-router)#neighbor 10.10.10.1 auth md5 password 0 pwd1`	Configure the MD5 authentication and password, `pwd1`, for the neighbor, `10.10.10.1`.
`(config-router)#exit`	Exit the `Router` mode and return to the `Configure` mode.
`(config)#interface eth1`	Specify the interface `(eth1)` to be configured.
`(config-if)#label-switching`	Enable label switching on interface `eth1`.
`(config-if)#enable-ldp ipv4`	Enable LDP on interface `eth1`.
`(config-if)#exit`	Exit interface mode.

Configure LDP MD5 for Targeted LDP Session

In this example, MD5 authentication is configured for the targeted LDP session established between R1 and R3.

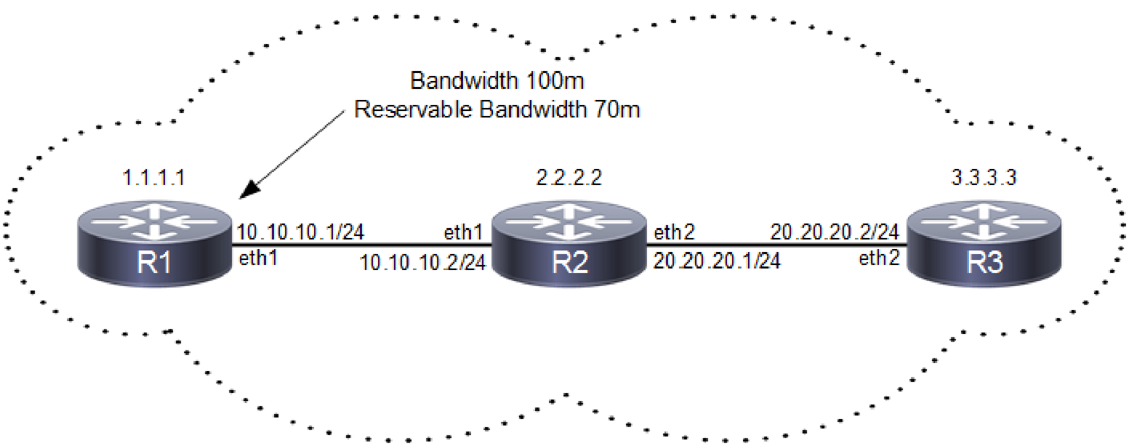


Figure 6-3: Topology for Targeted Session MD5

R1

`#configure terminal`	Enter configure mode.
`(config)#router ldp`	Enter `Router` mode.
`(config-router)#neighbor 10.10.10.2 auth md5 password 0 pwd1`	Configure the MD5 authentication and password, `pwd1`, for the neighbor, `10.10.10.2`.
`(config-router)#targeted-peer ipv4 3.3.3.3`	Configure the targeted peer IP address (R3 loopback address).
(config-router-targeted-peer)#exit	Exit targeted peer mode.
`(config-router)#neighbor 3.3.3.3 auth md5 password 0 pwd2`	Configure the MD5 authentication and password, `pwd2`, for the targeted peer, `3.3.3.3`.
`(config-router)#exit`	Exit the `Router` mode and return to the `Configure` mode.
`(config)#interface eth1`	Specify the interface `(eth1)` to be configured.

(config-if)#label-switching	Enable label switching on interface eth1.
(config-if)#enable-ldp ipv4	Enable LDP on interface eth1.
(config-if)#exit	Exit interface mode.

R2

#configure terminal	Enter configure mode.
(config)#router ldp	Enter Router mode to enable LDP.
(config-router)#exit	Exit the Router mode and return to the Configure mode.
(config)#interface eth1	Specify the interface (eth1) to be configured.
(config-if)#label-switching	Enable label switching on interface eth1.
(config-if)#enable-ldp ipv4	Enable LDP on interface eth1.
(config-if)#exit	Exit interface mode.
(config)#interface eth2	Specify the interface (eth2) to be configured.
(config-if)#label-switching	Enable label switching on interface eth2.
(config-if)#enable-ldp ipv4	Enable LDP on interface eth2.
(config-if)#exit	Exit interface mode.

R3

#configure terminal	Enter configure mode.
(config)#router ldp	Enter Router mode.
(config-router)#targeted-peer ipv4 1.1.1.1	Configure the targeted peer IP address (R1 loopback address).
(config-router-targeted-peer)#exit	Exit targeted peer mode.
(config-router)#neighbor 1.1.1.1 auth md5 password 0 pwd2	Configure the MD5 authentication and password, pwd2, for the targeted peer, 1.1.1.1.
(config-router)#exit	Exit the Router mode and return to the Configure mode.
(config)#interface eth1	Specify the interface (eth1) to be configured.
(config-if)#label-switching	Enable label switching on interface eth1.
(config-if)#enable-ldp ipv4	Enable LDP on interface eth1.
(config-if)#exit	Exit interface mode.

Removing MD5 Authentication for LDP Session

This example shows removing the MD5 authentication configuration from an LDP session.

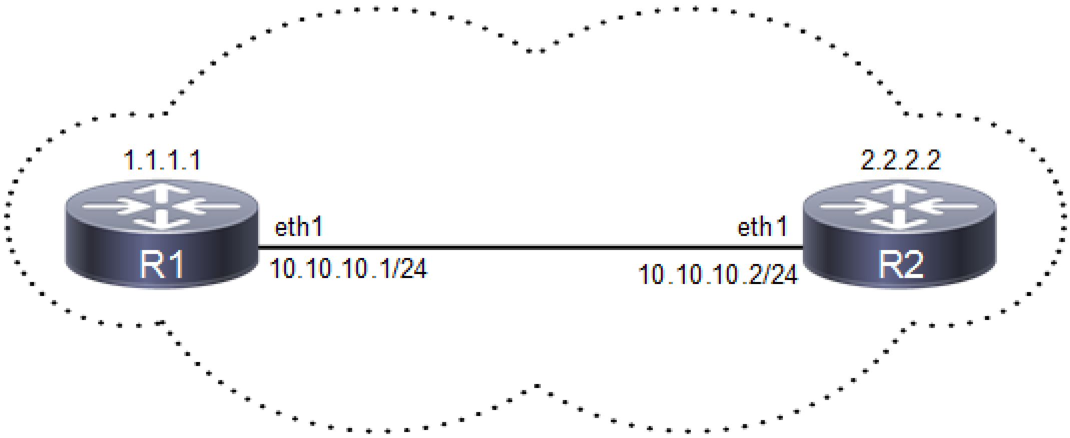


Figure 6-4: LDP Session Topology

R1

#configure terminal	Enter configure mode.
(config)#router ldp	Enter Router mode.
(config-router)#no neighbor 10.10.10.2 auth md5 password 0	Remove MD5 authentication for the neighbor, 10.10.10.2.
(config-router)#exit	Exit the Router mode and return to the Configure mode.

R2

#configure terminal	Enter configure mode.
(config)#router ldp	Enter Router mode.
(config-router)#no neighbor 10.10.10.1 auth md5 password 0	Remove MD5 authentication for the neighbor, 10.10.10.1.
(config-router)#exit	Exit the Router mode and return to the Configure mode.

Validation for LDP Session Count

This example shows the number of configured LDP basic neighbors and targeted neighbors count.

```
 #show ldp session count
--------------------------------------------
 Multicast Peers       : 1           [UP: 1]
 Targeted Peers        : 1           [UP: 1]
 Total Sessions        : 2           [UP: 2]
--------------------------------------------

 #show ldp targeted-peer count
 -------------------------------------------------
 Num Targeted Peers: 500          [UP: 500]
 -------------------------------------------------
```

Validation for FTN, SWAP, and POP Entries

This example shows forwarding table entries, SWAP entries and POP entries for IPV4 and IPV6 prefixes.

```
#show mpls forwarding-table count
---------------------------------------------
Num FTNs         : 3          [UP: 3, INSTALLED: 3]
  Primary FTNs   : 3          [UP: 3, INSTALLED: 3]
  Secondary FTNs : 0          [UP: 0, INSTALLED: 0]
---------------------------------------------
---------------------------------------------
Num IPV6 FTNs         : 0          [UP: 0, INSTALLED: 0]
  Primary IPV6 FTNs   : 0          [UP: 0, INSTALLED: 0]
  Secondary IPV6 FTNs : 0          [UP: 0, INSTALLED: 0]
---------------------------------------------

#show mpls ilm-table count
--------------------------------------------
Num ILMs         : 3          [UP: 3, INSTALL: 3]
  Swap Entries   : 3          [UP: 3, INSTALL: 3]
  Pop Entries    : 0          [UP: 0, INSTALL: 0]
  VC Pop Entries : 0          [UP: 0]
--------------------------------------------
```

MPLS LDP PING and TRACEROUTE

This example shows MPLS ping and trace route for LDP

```
#show ip ospf neighbor
Total number of full neighbors: 1
OSPF process 0 VRF(default):
Neighbor ID     Pri   State            Dead Time   Address
Interface          Instance ID
43.43.43.43       1   Full/DR          00:00:33    21.21.21.43
xe21                  0
RTR-29#show ldp session
Peer IP Address           IF Name    My Role    State      KeepAlive
43.43.43.43               xe21       Passive   OPERATIONAL   30

#show mpls  forwarding-table
Codes: > - installed FTN, * - selected FTN, p - stale FTN,
       B - BGP FTN, K - CLI FTN,
       L - LDP FTN, R - RSVP-TE FTN, S - SNMP FTN, I - IGP-Shortcut,
       U - unknown FTN, O - SR-OSPF FTN, i - SR-ISIS FTN, k - SR-CLI FTN

Code    FEC                FTN-ID    Tunnel-id   Pri   LSP-Type        Out-
Label    Out-Intf        Nexthop
L>      43.43.43.43/32      19        0           Yes   LSP_DEFAULT
0           xe21          21.21.21.43

#ping mpls ldp 43.43.43.43/32 detail
Sending 5 MPLS Echos to 43.43.43.43, timeout is 5 seconds
```



```
Codes:
'!' - Success, 'Q' - request not sent, '.' - timeout,
'x' - Retcode 0, 'M' - Malformed Request, 'm' - Errored TLV,
'N' - LBL Mapping Err, 'D' - DS Mismatch,
'U' - Unknown Interface, 'R' - Transit (LBL Switched),
'B' - IP Forwarded, 'F' No FEC Found, 'f' - FEC Mismatch,
'P' - Protocol Error, 'X' - Unknown code,
'Z' - Reverse FEC Validation Failed

Type 'Ctrl+C' to abort
! seq_num = 1 43.43.43.43 1.73 ms
! seq_num = 2 43.43.43.43 1.46 ms
! seq_num = 3 43.43.43.43 0.64 ms
! seq_num = 4 43.43.43.43 0.65 ms
! seq_num = 5 43.43.43.43 0.62 ms

Success Rate is 100.00 percent (5/5)
round-trip min/avg/max = 0.62/1.18/1.73

#trace mpls ldp 43.43.43.43/32 detail
Tracing MPLS Label Switched Path to 43.43.43.43, timeout is 5 seconds
Codes:
'!' - Success, 'Q' - request not sent, '.' - timeout,
'x' - Retcode 0, 'M' - Malformed Request, 'm' - Errored TLV,
'N' - LBL Mapping Err, 'D' - DS Mismatch,
'U' - Unknown Interface, 'R' - Transit (LBL Switched),
'B' - IP Forwarded, 'F' No FEC Found, 'f' - FEC Mismatch,
'P' - Protocol Error, 'X' - Unknown code,
'Z' - Reverse FEC Validation Failed
Type 'Ctrl+C' to abort
  0 21.21.21.29 [Labels:  0]
! 1 43.43.43.43 0.69 ms

#ping mpls ldp 43.43.43.43/32 detail interval 5000 rep
reply-mode  repeat
#ping mpls ldp 43.43.43.43/32 detail interval 5000 repeat 50
Sending 50 MPLS Echos to 43.43.43.43, timeout is 5 seconds

Codes:
'!' - Success, 'Q' - request not sent, '.' - timeout,
'x' - Retcode 0, 'M' - Malformed Request, 'm' - Errored TLV,
'N' - LBL Mapping Err, 'D' - DS Mismatch,
'U' - Unknown Interface, 'R' - Transit (LBL Switched),
'B' - IP Forwarded, 'F' No FEC Found, 'f' - FEC Mismatch,
'P' - Protocol Error, 'X' - Unknown code,
'Z' - Reverse FEC Validation Failed

Type 'Ctrl+C' to abort

! seq_num = 1 43.43.43.43 0.70 ms
! seq_num = 2 43.43.43.43 0.73 ms
! seq_num = 3 43.43.43.43 0.71 ms
Success Rate is 100.00 percent (3/3)
round-trip min/avg/max = 0.70/0.71/0.73
```

LDP Session Protection

LDP Session Protection is an optimization feature. It is used when directly connected LDP peer sessions (via multicast) become unavailable but still have IP reachability over a different path. LDP bindings are kept in the LIB to save time from full synchronization when the direct connections comes back up.

There are two types of LDP connections:

- Direct LDP Session - directly connected LSR, one hop away.
- Targeted LDP Session - not directly connected LSR, multiple hops away.

By default if the directly connected LDP session loses connectivity to its peer, all bindings are flushed from the LIB. When interfaces come up and LDP sessions are re-established, LDP has to synchronize its label bindings.

LDP Session Protection is an optimization, when enabled, will not flush the LIB when direct LDP sessions go down. As long as there exists another path to the LDP Peer, it will maintain the LIB synchronized using Targeted LDP Session. IGP will cause a reroute, but the label bindings will still be present from the old peer. When interfaces come back up, LDP will not need to synchronize since it maintains the state using the targeted sessions.

1. Running LDP Session Protection on a system requires the following tasks:
2. Enabling label-switching on the interface on NSM.
3. Enabling LDP on an interface in the LDP daemon.
4. Running an IGP (Internal Gateway Protocol), for example, OSPF, to distribute reachability information within the MPLS cloud.
5. Configuring the transport address.
6. Configuring LDP Session Protection.

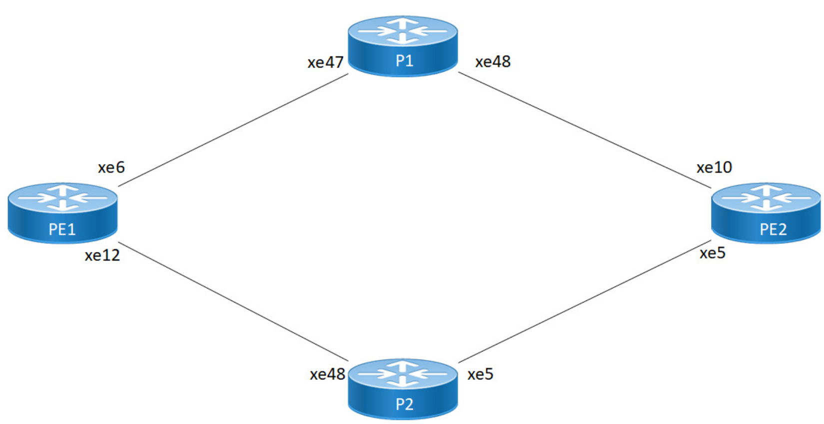


Figure 6-5: Basic LDP Topology

PE1

NSM:

`#configure terminal`	Enter configure mode.
`(config)#interface xe6`	Specify the interface (xe6) to be configured.
`(config-if)#ip address 10.10.10.1/24`	Configure IPv4 address for xe6
`(config-if)#label-switching`	Enable label switching on interface xe6.

(config)#interface xe12	Specify the interface (xe12) to be configured.
(config-if)#ip address 30.30.30.1/24	Configure IPv4 address for xe12
(config-if)#label-switching	Enable label switching on interface xe12.
(config-if)#exit	Exit interface mode.
(config)#interface lo	Specify the loopback (lo) interface to be configured.
(config-if)#ip address 1.1.1.1/32	Set the IP address of the loopback interface to 1.1.1.1/32.
(config-if)#commit	Commit the transaction.

LDP:

(config)#router ldp	Enter Router mode for LDP.
(config-router)#router-id 1.1.1.1	Set the router ID to IP address 1.1.1.1
(config-router)#transport-address ipv4 1.1.1.1	Configure the transport address to be used for a TCP session over which LDP will run on an IPv4 interface. Note: It is preferable to use the loopback address as transport address. In addition, use the parameter "ipv6" if you are configuring an IPv6 interface.
(config-router)#exit	Exit the Router mode and return to the Configure mode.
(config)#interface xe6	Enter interface mode.
(config-if)#enable-ldp ipv4	Enable LDP on xe6.
(config)#interface xe12	Enter interface mode.
(config-if)#enable-ldp ipv4	Enable LDP on xe12.
(config-if)#commit	Commit the transaction.

OSPF:

(config)#router ospf 1	Configure the routing process and specify the Process ID (1). The Process ID should be a unique positive integer identifying the routing process.
(config-router)#ospf router-id 1.1.1.1	Configure Router ID
(config-router)#network 1.1.1.1/32 area 0	Define the interface on which OSPF runs and associate the area ID (0) with the interface.
(config-router)#network 10.10.10.1/24 area 0	Define the interface on which OSPF runs and associate the area ID (0) with the interface.
(config-router)#network 30.30.30.1/24 area 0	Define the interface on which OSPF runs and associate the area ID (0) with the interface.
(config-router)#commit	Commit the transaction.

P1

NSM:

#configure terminal	Enter configure mode.
(config)#interface xe47	Specify the interface (xe47) to be configured.
(config-if)#ip address 10.10.10.2/24	Configure IPv4 address for xe47
(config-if)#label-switching	Enable label switching on interface xe47.

(config)#interface xe48	Specify the interface (xe48) to be configured.
(config-if)#ip address 20.20.20.1/24	Configure IPv4 address for xe48
(config-if)#label-switching	Enable label switching on interface xe48.
(config-if)#exit	Exit interface mode.
(config)#interface lo	Specify the loopback (lo) interface to be configured.
(config-if)#ip address 2.2.2.2/32	Set the IP address of the loopback interface to 2.2.2.2/32.
(config-if)#commit	Commit the transaction.

LDP:

(config)#router ldp	Enter Router mode for LDP.
(config-router)#router-id 2.2.2.2	Set the router ID to IP address 2.2.2.2
(config-router)#transport-address ipv4 2.2.2.2	Configure the transport address to be used for a TCP session over which LDP will run on an IPv4 interface. Note: It is preferable to use the loopback address as transport address. In addition, use the parameter "ipv6" if you are configuring an IPv6 interface.
(config-router)#exit	Exit the Router mode and return to the Configure mode.
(config)#interface xe47	Enter interface mode.
(config-if)#enable-ldp ipv4	Enable LDP on xe47.
(config)#interface xe48	Enter interface mode.
(config-if)#enable-ldp ipv4	Enable LDP on xe48.
(config-if)#commit	Commit the transaction.

OSPF:

(config)#router ospf 1	Configure the routing process and specify the Process ID (1). The Process ID should be a unique positive integer identifying the routing process.
(config-router)#ospf router-id 2.2.2.2	Configure Router ID
(config-router)#network 2.2.2.2/32 area 0	Define the interface on which OSPF runs and associate the area ID (0) with the interface.
(config-router)#network 10.10.10.2/24 area 0	Define the interface on which OSPF runs and associate the area ID (0) with the interface.
(config-router)#network 20.20.20.1/24 area 0	Define the interface on which OSPF runs and associate the area ID (0) with the interface.
(config-router)#commit	Commit the transaction.

P2

NSM:

#configure terminal	Enter configure mode.
(config)#interface xe48	Specify the interface (xe48) to be configured.
(config-if)#ip address 30.30.30.2/24	Configure IPv4 address for xe48

(config-if)#label-switching	Enable label switching on interface xe48.
(config)#interface xe5	Specify the interface (xe5) to be configured.
(config-if)#ip address 40.40.40.1/24	Configure IPv4 address for xe5
(config-if)#label-switching	Enable label switching on interface xe5.
(config-if)#exit	Exit interface mode.
(config)#interface lo	Specify the loopback (lo) interface to be configured.
(config-if)#ip address 4.4.4.4/32	Set the IP address of the loopback interface to 4.4.4.4/32.
(config-if)#commit	Commit the transaction.

LDP:

(config)#router ldp	Enter Router mode for LDP.
(config-router)#router-id 4.4.4.4	Set the router ID to IP address 4.4.4.4
(config-router)#transport-address ipv4 4.4.4.4	Configure the transport address to be used for a TCP session over which LDP will run on an IPv4 interface. Note: It is preferable to use the loopback address as transport address. In addition, use the parameter "ipv6" if you are configuring an IPv6 interface.
(config-router)#exit	Exit the Router mode and return to the Configure mode.
(config)#interface xe48	Enter interface mode.
(config-if)#enable-ldp ipv4	Enable LDP on xe48.
(config)#interface xe5	Enter interface mode.
(config-if)#enable-ldp ipv4	Enable LDP on xe5.
(config-if)#commit	Commit the transaction.

OSPF:

(config)#router ospf 1	Configure the routing process and specify the Process ID (1). The Process ID should be a unique positive integer identifying the routing process.
(config-router)#ospf router-id 4.4.4.4	Configure Router ID
(config-router)#network 4.4.4.4/32 area 0	Define the interface on which OSPF runs and associate the area ID (0) with the interface.
(config-router)#network 20.20.20.2/24 area 0	Define the interface on which OSPF runs and associate the area ID (0) with the interface.
(config-router)#network 30.30.30.1/24 area 0	Define the interface on which OSPF runs and associate the area ID (0) with the interface.
(config-router)#commit	Commit the transaction.

PE2

NSM:

#configure terminal	Enter configure mode.
(config)#interface xe10	Specify the interface (xe10) to be configured.

(config-if)#ip address 20.20.20.2/24	Configure IPv4 address for xe10
(config-if)#label-switching	Enable label switching on interface xe10.
(config)#interface xe5	Specify the interface (xe5) to be configured.
(config-if)#ip address 40.40.40.2/24	Configure IPv4 address for xe5
(config-if)#label-switching	Enable label switching on interface xe5.
(config-if)#exit	Exit interface mode.
(config)#interface lo	Specify the loopback (lo) interface to be configured.
(config-if)#ip address 3.3.3.3/32	Set the IP address of the loopback interface to 3.3.3.3/32.
(config-if)#commit	Commit the transaction.

LDP:

(config)#router ldp	Enter Router mode for LDP.
(config-router)#router-id 3.3.3.3	Set the router ID to IP address 3.3.3.3
(config-router)#transport-address ipv4 3.3.3.3	Configure the transport address to be used for a TCP session over which LDP will run on an IPv4 interface. Note: It is preferable to use the loopback address as transport address. In addition, use the parameter "ipv6" if you are configuring an IPv6 interface.
(config-router)#exit	Exit the Router mode and return to the Configure mode.
(config)#interface xe10	Enter interface mode.
(config-if)#enable-ldp ipv4	Enable LDP on xe10.
(config)#interface xe5	Enter interface mode.
(config-if)#enable-ldp ipv4	Enable LDP on xe5.
(config-if)#commit	Commit the transaction.

OSPF:

(config)#router ospf 1	Configure the routing process and specify the Process ID (1). The Process ID should be a unique positive integer identifying the routing process.
(config-router)#ospf router-id 3.3.3.3	Configure Router ID
(config-router)#network 3.3.3.3/32 area 0	Define the interface on which OSPF runs and associate the area ID (0) with the interface.
(config-router)#network 20.20.20.2/24 area 0	Define the interface on which OSPF runs and associate the area ID (0) with the interface.
(config-router)#network 40.40.40.2/24 area 0	Define the interface on which OSPF runs and associate the area ID (0) with the interface.
(config-router)#commit	Commit the transaction.

Validation

Without session protection Enabled

Verify that session protection status is not shown when session protection not enabled.

```
PE1#show ip route
Codes: K - kernel, C - connected, S - static, R - RIP, B - BGP
       O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2,
       ia - IS-IS inter area, E - EVPN,
       v - vrf leaked
       * - candidate default

IP Route Table for VRF "default"
C            1.1.1.1/32 is directly connected, lo, 00:04:22
O            2.2.2.2/32 [110/2] via 10.10.10.2, xe12, 00:03:03
O            3.3.3.3/32 [110/3] via 10.10.10.2, xe12, 00:02:49
O            4.4.4.4/32 [110/31] via 30.30.30.2, xe6, 00:02:17
C            10.10.10.0/24 is directly connected, xe12, 00:03:48
O            20.20.20.0/24 [110/2] via 10.10.10.2, xe12, 00:03:03
C            30.30.30.0/24 is directly connected, xe6, 00:03:02
O            40.40.40.0/24 [110/31] via 30.30.30.2, xe6, 00:02:17
C            127.0.0.0/8 is directly connected, lo, 00:04:22

Gateway of last resort is not set

PE1#show ldp session
Peer IP Address           IF Name    My Role    State      KeepAlive  UpTime
4.4.4.4                   xe6        Passive   OPERATIONAL   30    00:02:25
2.2.2.2                   xe12       Passive   OPERATIONAL   30    00:03:11
PE1#show ldp targeted-peers
PE1#show ldp session 2.2.2.2
Session state         : OPERATIONAL
Session role          : Passive
TCP Connection        : Established
IP Address for TCP    : 2.2.2.2
Interface being used  : xe12
Peer LDP ID           : 2.2.2.2:0
Peer LDP Password     : Not Set
Adjacencies           : 10.10.10.2
Advertisement mode    : Downstream Unsolicited
Label retention mode  : Liberal
Graceful Restart      : Not Capable
Keepalive Timeout     : 30
Reconnect Interval    : 15
Address List received : 2.2.2.2
                        10.10.10.2
                        20.20.20.1
                        254.128.0.0
Received Labels :       Fec               Label           Maps To
                IPV4:3.3.3.3/32        52480           24963
                IPV4:20.20.20.0/24     impl-null       24964
                IPV4:10.10.10.0/24     impl-null       none
```

```
                IPV4:2.2.2.2/32        impl-null       24962
Sent Labels :   Fec                    Label           Maps To
                IPV4:40.40.40.0/24     24961           impl-null
                IPV4:4.4.4.4/32        24960           impl-null
                IPV4:30.30.30.0/24     impl-null       none
                IPV4:10.10.10.0/24     impl-null       none
                IPV4:1.1.1.1/32        impl-null       none
PE1#show mpls forwarding-table
Codes: > - installed FTN, * - selected FTN, p - stale FTN,
       B - BGP FTN, K - CLI FTN, t - tunnel, P - SR Policy FTN,
       L - LDP FTN, R - RSVP-TE FTN, S - SNMP FTN, I - IGP-Shortcut,
       U - unknown FTN, O - SR-OSPF FTN, i - SR-ISIS FTN, k - SR-CLI FTN
(m) - FTN mapped over multipath transport

Code    FEC               FTN-ID   Nhlfe-ID  Tunnel-id   Pri   LSP-Type    Out-Label
Out-Intf    ELC   Nexthop
   L>   2.2.2.2/32         1        2         -          Yes   LSP_DEFAULT  3
xe12        No    10.10.10.2
   L>   3.3.3.3/32         3        5         -          Yes   LSP_DEFAULT  52480
xe12        No    10.10.10.2
   L>   4.4.4.4/32         4        7         -          Yes   LSP_DEFAULT  3
xe6         No    30.30.30.2
   L>   20.20.20.0/24      2        3         -          Yes   LSP_DEFAULT  3
xe12        No    10.10.10.2
   L>   40.40.40.0/24      5        8         -          Yes   LSP_DEFAULT  3
xe6         No    30.30.30.2

PE1#show mpls ftn-table
 Primary FTN entry with FEC: 2.2.2.2/32, id: 1, row status: Active, Tunnel-Policy: N/A
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP:
none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A, Color: 0
     Cross connect ix: 1, in intf: - in label: 0 out-segment ix: 1
      Owner: N/A, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 1, owner: N/A, Stale: NO, out intf: xe12, out label: 3
    Nexthop addr: 10.10.10.2        cross connect ix: 1, op code: Push


 Primary FTN entry with FEC: 3.3.3.3/32, id: 3, row status: Active, Tunnel-Policy: N/A
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP:
none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A, Color: 0
     Cross connect ix: 2, in intf: - in label: 0 out-segment ix: 4
      Owner: LDP, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 4, owner: LDP, Stale: NO, out intf: xe12, out label: 52480
    Nexthop addr: 10.10.10.2        cross connect ix: 2, op code: Push


 Primary FTN entry with FEC: 4.4.4.4/32, id: 4, row status: Active, Tunnel-Policy: N/A
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP:
none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A, Color: 0
```



```
     Cross connect ix: 4, in intf: - in label: 0 out-segment ix: 6
      Owner: N/A, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 6, owner: N/A, Stale: NO, out intf: xe6, out label: 3
    Nexthop addr: 30.30.30.2        cross connect ix: 4, op code: Push


 Primary FTN entry with FEC: 20.20.20.0/24, id: 2, row status: Active, Tunnel-Policy: N/
A
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP:
none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A, Color: 0
     Cross connect ix: 1, in intf: - in label: 0 out-segment ix: 1
      Owner: N/A, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 1, owner: N/A, Stale: NO, out intf: xe12, out label: 3
    Nexthop addr: 10.10.10.2        cross connect ix: 1, op code: Push


 Primary FTN entry with FEC: 40.40.40.0/24, id: 5, row status: Active, Tunnel-Policy: N/
A
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP:
none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A, Color: 0
     Cross connect ix: 4, in intf: - in label: 0 out-segment ix: 6
      Owner: N/A, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 6, owner: N/A, Stale: NO, out intf: xe6, out label: 3
    Nexthop addr: 30.30.30.2        cross connect ix: 4, op code: Push


PE1#show mpls ilm-table
Codes: > - installed ILM, * - selected ILM, p - stale ILM
        K - CLI ILM, T - MPLS-TP, s - Stitched ILM
       S - SNMP, L - LDP, R - RSVP, C - CRLDP
       B - BGP , K - CLI , V - LDP_VC, I - IGP_SHORTCUT
       O - OSPF/OSPF6 SR, i - ISIS SR, k - SR CLI
       P - SR Policy, U - unknown

Code    FEC/VRF/L2CKT    ILM-ID     In-Label    Out-Label   In-Intf    Out-Intf/VRF
Nexthop                   LSP-Type
   L>   3.3.3.3/32        4          24963       52480       N/A        xe12
10.10.10.2                LSP_DEFAULT
   L>   40.40.40.0/24     2          24961       3           N/A        xe6
30.30.30.2                LSP_DEFAULT
   L>   4.4.4.4/32        1          24960       3           N/A        xe6
30.30.30.2                LSP_DEFAULT
   L>   2.2.2.2/32        3          24962       3           N/A        xe12
10.10.10.2                LSP_DEFAULT
   L>   20.20.20.0/24     5          24964       3           N/A        xe12
10.10.10.2                LSP_DEFAULT

PE1#show ldp fec
LSR codes    : E/N - LSR is egress/non-egress for this FEC,
               L - LSR received a label for this FEC,
               > - LSR will use this route for the FEC
```

```
FEC                 Code    Session             Out Label   ELC   Nexthop Addr
1.1.1.1/32          E >     non-existent        none        No    connected
2.2.2.2/32          NL>     2.2.2.2             impl-null   No    10.10.10.2
3.3.3.3/32          NL      4.4.4.4             24325       No    no nexthop
                    NL>     2.2.2.2             52480       No    10.10.10.2
4.4.4.4/32          NL>     4.4.4.4             impl-null   No    30.30.30.2
10.10.10.0/24       NL      2.2.2.2             impl-null   No    connected
                    E >     non-existent        none        No    connected
20.20.20.0/24       NL      4.4.4.4             24326       No    no nexthop
                    NL>     2.2.2.2             impl-null   No    10.10.10.2
30.30.30.0/24       NL      4.4.4.4             impl-null   No    connected
                    E >     non-existent        none        No    connected
40.40.40.0/24       NL>     4.4.4.4             impl-null   No    30.30.30.2
```

Configure Session Protection:

Note: Recommended to configure both ends.

Configure session protection under LDP in both nodes.

PE1

`(config)#router ldp`	Enter Router mode for LDP.
`(config-router)# session-protection`	Session-protection protect label indefinitely if no timer mentioned.
`(config-router)# commit`	Commit and exit

P1

`(config)#router ldp`	Enter Router mode for LDP.
`(config-router)# session-protection`	Session-protection protect label indefinitely if no timer mentioned.
`(config-router)# commit`	Commit and exit

Validation

After session protection command Enabled

Verify that session protection status shown once session protection enabled in both peer nodes.

```
PE1#show ldp session
Peer IP Address            IF Name     My Role    State       KeepAlive  UpTime
4.4.4.4                    xe6         Passive   OPERATIONAL    30    00:05:46
2.2.2.2                    xe12        Passive   OPERATIONAL    30    00:06:32
PE1#show ldp targeted-peers
IP Address            Interface
2.2.2.2               xe12
4.4.4.4               xe6
PE1#show ldp session 2.2.2.2
```



```
Session state          : OPERATIONAL
Session role           : Passive
TCP Connection         : Established
IP Address for TCP     : 2.2.2.2
Interface being used   : xe12
Peer LDP ID            : 2.2.2.2:0
Peer LDP Password      : Not Set
Adjacencies            : 10.10.10.2
                         2.2.2.2
Advertisement mode     : Downstream Unsolicited
Label retention mode   : Liberal
Graceful Restart       : Not Capable
Keepalive Timeout      : 30
Reconnect Interval     : 15
Session protection     : Ready
Address List received : 2.2.2.2
                         10.10.10.2
                         20.20.20.1
                         254.128.0.0
Received Labels :        Fec                Label           Maps To
                IPV4:3.3.3.3/32         52480           24963
                IPV4:20.20.20.0/24      impl-null       24964
                IPV4:10.10.10.0/24      impl-null       none
                IPV4:2.2.2.2/32         impl-null       24962
Sent Labels :   Fec                     Label           Maps To
                IPV4:40.40.40.0/24      24961           impl-null
                IPV4:4.4.4.4/32         24960           impl-null
                IPV4:30.30.30.0/24      impl-null       none
                IPV4:10.10.10.0/24      impl-null       none
                IPV4:1.1.1.1/32         impl-null       none
PE1#show mpls forwarding-table
Codes: > - installed FTN, * - selected FTN, p - stale FTN,
       B - BGP FTN, K - CLI FTN, t - tunnel, P - SR Policy FTN,
       L - LDP FTN, R - RSVP-TE FTN, S - SNMP FTN, I - IGP-Shortcut,
       U - unknown FTN, O - SR-OSPF FTN, i - SR-ISIS FTN, k - SR-CLI FTN
(m) - FTN mapped over multipath transport

Code    FEC               FTN-ID    Nhlfe-ID  Tunnel-id   Pri   LSP-Type    Out-Label
Out-Intf    ELC   Nexthop
   L>   2.2.2.2/32          1         2         -          Yes   LSP_DEFAULT  3
xe12        No    10.10.10.2
   L>   3.3.3.3/32          3         5         -          Yes   LSP_DEFAULT  52480
xe12        No    10.10.10.2
   L>   4.4.4.4/32          4         7         -          Yes   LSP_DEFAULT  3
xe6         No    30.30.30.2
   L>   20.20.20.0/24       2         3         -          Yes   LSP_DEFAULT  3
xe12        No    10.10.10.2
   L>   40.40.40.0/24       5         8         -          Yes   LSP_DEFAULT  3
xe6         No    30.30.30.2
PE1#show mpls ilm-table
Codes: > - installed ILM, * - selected ILM, p - stale ILM
        K - CLI ILM, T - MPLS-TP, s - Stitched ILM
```

```
       S - SNMP, L - LDP, R - RSVP, C - CRLDP
       B - BGP , K - CLI , V - LDP_VC, I - IGP_SHORTCUT
       O - OSPF/OSPF6 SR, i - ISIS SR, k - SR CLI
       P - SR Policy, U - unknown

Code    FEC/VRF/L2CKT    ILM-ID     In-Label    Out-Label   In-Intf    Out-Intf/VRF
Nexthop                   LSP-Type
   L>   3.3.3.3/32        4          24963       52480       N/A        xe12
10.10.10.2                LSP_DEFAULT
   L>   40.40.40.0/24     2          24961       3           N/A        xe6
30.30.30.2                LSP_DEFAULT
   L>   4.4.4.4/32        1          24960       3           N/A        xe6
30.30.30.2                LSP_DEFAULT
   L>   2.2.2.2/32        3          24962       3           N/A        xe12
10.10.10.2                LSP_DEFAULT
   L>   20.20.20.0/24     5          24964       3           N/A        xe12
10.10.10.2                LSP_DEFAULT
PE1#show mpls ftn-table
 Primary FTN entry with FEC: 2.2.2.2/32, id: 1, row status: Active, Tunnel-Policy: N/A
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP:
none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A, Color: 0
     Cross connect ix: 1, in intf: - in label: 0 out-segment ix: 1
      Owner: N/A, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 1, owner: N/A, Stale: NO, out intf: xe12, out label: 3
    Nexthop addr: 10.10.10.2        cross connect ix: 1, op code: Push


 Primary FTN entry with FEC: 3.3.3.3/32, id: 3, row status: Active, Tunnel-Policy: N/A
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP:
none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A, Color: 0
     Cross connect ix: 2, in intf: - in label: 0 out-segment ix: 4
      Owner: LDP, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 4, owner: LDP, Stale: NO, out intf: xe12, out label: 52480
    Nexthop addr: 10.10.10.2        cross connect ix: 2, op code: Push


 Primary FTN entry with FEC: 4.4.4.4/32, id: 4, row status: Active, Tunnel-Policy: N/A
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP:
none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A, Color: 0
     Cross connect ix: 4, in intf: - in label: 0 out-segment ix: 6
      Owner: N/A, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 6, owner: N/A, Stale: NO, out intf: xe6, out label: 3
    Nexthop addr: 30.30.30.2        cross connect ix: 4, op code: Push


 Primary FTN entry with FEC: 20.20.20.0/24, id: 2, row status: Active, Tunnel-Policy: N/
A
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP:
none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A, Color: 0
```



```
     Cross connect ix: 1, in intf: - in label: 0 out-segment ix: 1
      Owner: N/A, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 1, owner: N/A, Stale: NO, out intf: xe12, out label: 3
    Nexthop addr: 10.10.10.2        cross connect ix: 1, op code: Push


 Primary FTN entry with FEC: 40.40.40.0/24, id: 5, row status: Active, Tunnel-Policy: N/
A
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP:
none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A, Color: 0
     Cross connect ix: 4, in intf: - in label: 0 out-segment ix: 6
      Owner: N/A, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 6, owner: N/A, Stale: NO, out intf: xe6, out label: 3
    Nexthop addr: 30.30.30.2        cross connect ix: 4, op code: Push


PE1#show ldp fec
LSR codes    : E/N - LSR is egress/non-egress for this FEC,
               L - LSR received a label for this FEC,
               > - LSR will use this route for the FEC
FEC                 Code    Session             Out Label   ELC   Nexthop Addr
1.1.1.1/32          E >     non-existent        none        No    connected
2.2.2.2/32          NL>     2.2.2.2             impl-null   No    10.10.10.2
3.3.3.3/32          NL      4.4.4.4             24325       No    no nexthop
                    NL>     2.2.2.2             52480       No    10.10.10.2
4.4.4.4/32          NL>     4.4.4.4             impl-null   No    30.30.30.2
10.10.10.0/24       NL      2.2.2.2             impl-null   No    connected
                    E >     non-existent        none        No    connected
20.20.20.0/24       NL      4.4.4.4             24326       No    no nexthop
                    NL>     2.2.2.2             impl-null   No    10.10.10.2
30.30.30.0/24       NL      4.4.4.4             impl-null   No    connected
                    E >     non-existent        none        No    connected
40.40.40.0/24       NL>     4.4.4.4             impl-null   No    30.30.30.2


P1#show ldp session
Peer IP Address           IF Name    My Role    State      KeepAlive  UpTime
3.3.3.3                   xe5        Passive   OPERATIONAL   30    00:05:40
1.1.1.1                   xe48       Active    OPERATIONAL   30    00:06:43
P1#show ldp targeted-peers
IP Address          Interface
1.1.1.1             xe48
3.3.3.3             xe5

P1#show ldp session 1.1.1.1
Session state         : OPERATIONAL
Session role          : Active
TCP Connection        : Established
IP Address for TCP    : 1.1.1.1
Interface being used  : xe48
```

```
Peer LDP ID            : 1.1.1.1:0
Peer LDP Password      : Not Set
Adjacencies            : 10.10.10.1
                         1.1.1.1
Advertisement mode     : Downstream Unsolicited
Label retention mode   : Liberal
Graceful Restart       : Not Capable
Keepalive Timeout      : 30
Reconnect Interval     : 15
Session protection     : Ready
Address List received : 1.1.1.1
                         10.10.10.1
                         30.30.30.1
                         254.128.0.0
Received Labels :        Fec                Label            Maps To
                 IPV4:4.4.4.4/32         24960            52482
                 IPV4:40.40.40.0/24      24961            52484
                 IPV4:30.30.30.0/24      impl-null        52483
                 IPV4:10.10.10.0/24      impl-null        none
                 IPV4:1.1.1.1/32         impl-null        52481
Sent Labels :    Fec                     Label            Maps To
                 IPV4:3.3.3.3/32         52480            impl-null
                 IPV4:20.20.20.0/24      impl-null        none
                 IPV4:10.10.10.0/24      impl-null        none
                 IPV4:2.2.2.2/32         impl-null        none

P1#show mpls forwarding-table
Codes: > - installed FTN, * - selected FTN, p - stale FTN,
       B - BGP FTN, K - CLI FTN, t - tunnel,
       L - LDP FTN, R - RSVP-TE FTN, S - SNMP FTN, I - IGP-Shortcut,
       U - unknown FTN

Code    FEC               FTN-ID    Nhlfe-ID  Tunnel-id   Pri   LSP-Type     Out-Label
Out-Intf    ELC   Nexthop
   L>   1.1.1.1/32         1         2         -          Yes   LSP_DEFAULT  3
xe48        No    10.10.10.1
   L>   3.3.3.3/32         5         9         -          Yes   LSP_DEFAULT  3
xe5         No    20.20.20.2
   L>   4.4.4.4/32         3         5         -          Yes   LSP_DEFAULT  24960
xe48        No    10.10.10.1
   L>   30.30.30.0/24      2         3         -          Yes   LSP_DEFAULT  3
xe48        No    10.10.10.1
   L>   40.40.40.0/24      4         7         -          Yes   LSP_DEFAULT  24961
xe48        No    10.10.10.1


P1#show mpls ilm-table
Codes: > - installed ILM, * - selected ILM, p - stale ILM
        K - CLI ILM, T - MPLS-TP, s - Stitched ILM
       S - SNMP, L - LDP, R - RSVP, C - CRLDP
       B - BGP , K - CLI , V - LDP_VC, I - IGP_SHORTCUT
       U - unknown
```



```
Code    FEC/VRF/L2CKT    ILM-ID     In-Label    Out-Label   In-Intf    Out-Intf/VRF
Nexthop                   LSP-Type
   L>   30.30.30.0/24      4          52483       3           N/A        xe48
10.10.10.1                LSP_DEFAULT
   L>   1.1.1.1/32         2          52481       3           N/A        xe48
10.10.10.1                LSP_DEFAULT
   L>   3.3.3.3/32         1          52480       3           N/A        xe5
20.20.20.2                LSP_DEFAULT
   L>   4.4.4.4/32         3          52482       24960       N/A        xe48
10.10.10.1                LSP_DEFAULT
   L>   40.40.40.0/24      5          52484       24961       N/A        xe48
10.10.10.1                LSP_DEFAULT
P1#show mpls ftn-table
 Primary FTN entry with FEC: 1.1.1.1/32, id: 1, row status: Active
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP:
none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A
     Cross connect ix: 1, in intf: - in label: 0 out-segment ix: 1
      Owner: N/A, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 1, owner: N/A, Stale: NO, out intf: xe48, out label: 3
    Nexthop addr: 10.10.10.1        cross connect ix: 1, op code: Push


 Primary FTN entry with FEC: 3.3.3.3/32, id: 5, row status: Active
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP:
none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A
     Cross connect ix: 5, in intf: - in label: 0 out-segment ix: 8
      Owner: N/A, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 8, owner: N/A, Stale: NO, out intf: xe5, out label: 3
    Nexthop addr: 20.20.20.2        cross connect ix: 5, op code: Push


 Primary FTN entry with FEC: 4.4.4.4/32, id: 3, row status: Active
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP:
none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A
     Cross connect ix: 3, in intf: - in label: 0 out-segment ix: 4
      Owner: LDP, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 4, owner: LDP, Stale: NO, out intf: xe48, out label: 24960
    Nexthop addr: 10.10.10.1        cross connect ix: 3, op code: Push


 Primary FTN entry with FEC: 30.30.30.0/24, id: 2, row status: Active
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP:
none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A
     Cross connect ix: 1, in intf: - in label: 0 out-segment ix: 1
      Owner: N/A, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 1, owner: N/A, Stale: NO, out intf: xe48, out label: 3
    Nexthop addr: 10.10.10.1        cross connect ix: 1, op code: Push
```

```
 Primary FTN entry with FEC: 40.40.40.0/24, id: 4, row status: Active
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP: 
none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A
     Cross connect ix: 4, in intf: - in label: 0 out-segment ix: 6
      Owner: LDP, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 6, owner: LDP, Stale: NO, out intf: xe48, out label: 24961
    Nexthop addr: 10.10.10.1        cross connect ix: 4, op code: Push


P1#show ldp fec
LSR codes    : E/N - LSR is egress/non-egress for this FEC,
               L - LSR received a label for this FEC,
               > - LSR will use this route for the FEC
FEC                 Code    Session            Out Label   ELC   Nexthop Addr
1.1.1.1/32          NL>     1.1.1.1            impl-null   No    10.10.10.1
2.2.2.2/32          E >     non-existent       none        No    connected
3.3.3.3/32          NL>     3.3.3.3            impl-null   No    20.20.20.2
4.4.4.4/32          NL>     1.1.1.1            24960       No    10.10.10.1
10.10.10.0/24       NL      1.1.1.1            impl-null   No    connected
                    E >     non-existent       none        No    connected
20.20.20.0/24       NL      3.3.3.3            impl-null   No    connected
                    E >     non-existent       none        No    connected
30.30.30.0/24       NL>     1.1.1.1            impl-null   No    10.10.10.1
40.40.40.0/24       NL      3.3.3.3            impl-null   No    no nexthop
                    NL>     1.1.1.1            24961       No    10.10.10.1
```

Perform Link failure and check labels are retained until peer is reachable through alternate path.

(config)#interface xe12	Enter interface mode.
(config-if)#shutdown	Shutdown the link.
(config)#commit	commit.

Validation

After link down

```
PE1#show ip route
Codes: K - kernel, C - connected, S - static, R - RIP, B - BGP
       O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2,
       ia - IS-IS inter area, E - EVPN,
       v - vrf leaked
       * - candidate default

IP Route Table for VRF "default"
```



```
C            1.1.1.1/32 is directly connected, lo, 00:14:17
O            2.2.2.2/32 [110/33] via 30.30.30.2, xe6, 00:03:38
O            3.3.3.3/32 [110/32] via 30.30.30.2, xe6, 00:03:38
O            4.4.4.4/32 [110/31] via 30.30.30.2, xe6, 00:12:12
O            20.20.20.0/24 [110/32] via 30.30.30.2, xe6, 00:03:38
C            30.30.30.0/24 is directly connected, xe6, 00:12:57
O            40.40.40.0/24 [110/31] via 30.30.30.2, xe6, 00:12:12
    C            127.0.0.0/8 is directly connected, lo, 00:14:17
PE1#show ldp session
Peer IP Address           IF Name    My Role    State      KeepAlive  UpTime
4.4.4.4                   xe6        Passive   OPERATIONAL   30    00:10:10
2.2.2.2                   xe6        Passive   OPERATIONAL   30    00:10:56
PE1#show ldp targeted-peers
IP Address          Interface
2.2.2.2             xe6
4.4.4.4             xe6/
PE1#show ldp session 2.2.2.2
Session state         : OPERATIONAL
Session role          : Passive
TCP Connection        : Established
IP Address for TCP    : 2.2.2.2
Interface being used  : xe6
Peer LDP ID           : 2.2.2.2:0
Peer LDP Password     : Not Set
Adjacencies           : 2.2.2.2
Advertisement mode    : Downstream Unsolicited
Label retention mode  : Liberal
Graceful Restart      : Not Capable
Keepalive Timeout     : 30
Reconnect Interval    : 15
Session protection    : Protecting
Address List received : 2.2.2.2
                        20.20.20.1
                        254.128.0.0
Received Labels :       Fec               Label           Maps To
                IPV4:3.3.3.3/32         52480           none
                IPV4:20.20.20.0/24      impl-null       none
                IPV4:10.10.10.0/24      impl-null       none
                IPV4:2.2.2.2/32         impl-null       none
Sent Labels :   Fec                     Label           Maps To
                IPV4:40.40.40.0/24      24961           impl-null
                IPV4:4.4.4.4/32         24960           impl-null
                IPV4:30.30.30.0/24      impl-null       none
                IPV4:10.10.10.0/24      impl-null       none
                    IPV4:1.1.1.1/32         impl-null       none

PE1#show mpls forwarding-table
Codes: > - installed FTN, * - selected FTN, p - stale FTN,
       B - BGP FTN, K - CLI FTN, t - tunnel, P - SR Policy FTN,
       L - LDP FTN, R - RSVP-TE FTN, S - SNMP FTN, I - IGP-Shortcut,
```

```
      U - unknown FTN, O - SR-OSPF FTN, i - SR-ISIS FTN, k - SR-CLI FTN
(m) - FTN mapped over multipath transport

Code    FEC               FTN-ID    Nhlfe-ID  Tunnel-id   Pri   LSP-Type     Out-Label
Out-Intf    ELC   Nexthop
   L>   2.2.2.2/32         3         9        -          Yes   LSP_DEFAULT  24321
xe6         No    30.30.30.2
   L>   3.3.3.3/32         1         2        -          Yes   LSP_DEFAULT  24325
xe6         No    30.30.30.2
   L>   4.4.4.4/32         4         7        -          Yes   LSP_DEFAULT  3
xe6         No    30.30.30.2
   L>   20.20.20.0/24      2         4        -          Yes   LSP_DEFAULT  24326
xe6         No    30.30.30.2
   L>   40.40.40.0/24      5         8        -          Yes   LSP_DEFAULT  3
xe6         No    30.30.30.2

PE1#show mpls ftn-table
 Primary FTN entry with FEC: 2.2.2.2/32, id: 3, row status: Active, Tunnel-Policy: N/A
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP:
none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A, Color: 0
     Cross connect ix: 3, in intf: - in label: 0 out-segment ix: 5
      Owner: LDP, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 5, owner: LDP, Stale: NO, out intf: xe6, out label: 24321
    Nexthop addr: 30.30.30.2        cross connect ix: 3, op code: Push


 Primary FTN entry with FEC: 3.3.3.3/32, id: 1, row status: Active, Tunnel-Policy: N/A
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP:
none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A, Color: 0
     Cross connect ix: 1, in intf: - in label: 0 out-segment ix: 1
      Owner: LDP, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 1, owner: LDP, Stale: NO, out intf: xe6, out label: 24325
    Nexthop addr: 30.30.30.2        cross connect ix: 1, op code: Push


 Primary FTN entry with FEC: 4.4.4.4/32, id: 4, row status: Active, Tunnel-Policy: N/A
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP:
none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A, Color: 0
     Cross connect ix: 4, in intf: - in label: 0 out-segment ix: 6
      Owner: N/A, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 6, owner: N/A, Stale: NO, out intf: xe6, out label: 3
    Nexthop addr: 30.30.30.2        cross connect ix: 4, op code: Push


 Primary FTN entry with FEC: 20.20.20.0/24, id: 2, row status: Active, Tunnel-Policy: N/
A
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP:
none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A, Color: 0
     Cross connect ix: 2, in intf: - in label: 0 out-segment ix: 3
```

```
      Owner: LDP, Persistent: No, Admin Status: Up, Oper Status: Up
        Out-segment with ix: 3, owner: LDP, Stale: NO, out intf: xe6, out label: 24326
    Nexthop addr: 30.30.30.2        cross connect ix: 2, op code: Push


 Primary FTN entry with FEC: 40.40.40.0/24, id: 5, row status: Active, Tunnel-Policy: N/
A
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP:
none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A, Color: 0
     Cross connect ix: 4, in intf: - in label: 0 out-segment ix: 6
      Owner: N/A, Persistent: No, Admin Status: Up, Oper Status: Up
        Out-segment with ix: 6, owner: N/A, Stale: NO, out intf: xe6, out label: 3
    Nexthop addr: 30.30.30.2        cross connect ix: 4, op code: Push


PE1#show mpls ilm-table
Codes: > - installed ILM, * - selected ILM, p - stale ILM
        K - CLI ILM, T - MPLS-TP, s - Stitched ILM
       S - SNMP, L - LDP, R - RSVP, C - CRLDP
       B - BGP , K - CLI , V - LDP_VC, I - IGP_SHORTCUT
       O - OSPF/OSPF6 SR, i - ISIS SR, k - SR CLI
       P - SR Policy, U - unknown

Code    FEC/VRF/L2CKT    ILM-ID     In-Label    Out-Label   In-Intf    Out-Intf/VRF
Nexthop                    LSP-Type
   L>   40.40.40.0/24      2          24961       3           N/A        xe6
30.30.30.2                 LSP_DEFAULT
   L>   4.4.4.4/32         1          24960       3           N/A        xe6
30.30.30.2                 LSP_DEFAULT

P1#show ldp session
Peer IP Address            IF Name    My Role    State      KeepAlive  UpTime
3.3.3.3                    xe5        Passive   OPERATIONAL   30    00:11:12
1.1.1.1                    xe5        Active    OPERATIONAL   30    00:12:15
P1#show ldp targeted-peers
IP Address           Interface
1.1.1.1             xe5
    3.3.3.3             xe5

P1#show ldp session 1.1.1.1
Session state          : OPERATIONAL
Session role           : Active
TCP Connection         : Established
IP Address for TCP     : 1.1.1.1
Interface being used   : xe5
Peer LDP ID            : 1.1.1.1:0
Peer LDP Password      : Not Set
Adjacencies            : 1.1.1.1
Advertisement mode     : Downstream Unsolicited
Label retention mode   : Liberal
```

```
Graceful Restart      : Not Capable
Keepalive Timeout     : 30
Reconnect Interval    : 15
Session protection    : Protecting
Address List received : 1.1.1.1
                        30.30.30.1
                        254.128.0.0
Received Labels :       Fec              Label           Maps To
                IPV4:4.4.4.4/32        24960           52482
                IPV4:40.40.40.0/24     24961           52484
                IPV4:30.30.30.0/24     impl-null       52483
                IPV4:10.10.10.0/24     impl-null       none
                IPV4:1.1.1.1/32        impl-null       52481
Sent Labels :   Fec                    Label           Maps To
                IPV4:3.3.3.3/32        52480           impl-null
                IPV4:20.20.20.0/24     impl-null       none
                IPV4:10.10.10.0/24     impl-null       none
                    IPV4:2.2.2.2/32        impl-null       none

P1#show mpls forwarding-table
Codes: > - installed FTN, * - selected FTN, p - stale FTN,
       B - BGP FTN, K - CLI FTN, t - tunnel,
       L - LDP FTN, R - RSVP-TE FTN, S - SNMP FTN, I - IGP-Shortcut,
       U - unknown FTN

Code    FEC              FTN-ID   Nhlfe-ID  Tunnel-id   Pri   LSP-Type    Out-Label
Out-Intf    ELC   Nexthop
   L>   1.1.1.1/32         2        3         -          Yes   LSP_DEFAULT  24965
xe5         No    20.20.20.2
   L>   3.3.3.3/32         5        9         -          Yes   LSP_DEFAULT  3
xe5         No    20.20.20.2
   L>   4.4.4.4/32         3        5         -          Yes   LSP_DEFAULT  24966
xe5         No    20.20.20.2
   L>   30.30.30.0/24      4        7         -          Yes   LSP_DEFAULT  24967
xe5         No    20.20.20.2
   L>   40.40.40.0/24      1        1         -          Yes   LSP_DEFAULT  3
xe5         No    20.20.20.2
P1#show mpls ilm-table
Codes: > - installed ILM, * - selected ILM, p - stale ILM
        K - CLI ILM, T - MPLS-TP, s - Stitched ILM
       S - SNMP, L - LDP, R - RSVP, C - CRLDP
       B - BGP , K - CLI , V - LDP_VC, I - IGP_SHORTCUT
       U - unknown

Code    FEC/VRF/L2CKT    ILM-ID     In-Label    Out-Label   In-Intf    Out-Intf/VRF
Nexthop                   LSP-Type
   L>   4.4.4.4/32        3          52482       Nolabel     N/A        N/A
127.0.0.1                 LSP_DEFAULT
   L>   3.3.3.3/32        1          52480       3           N/A        xe5
20.20.20.2                LSP_DEFAULT
   L>   1.1.1.1/32        2          52481       Nolabel     N/A        N/A
127.0.0.1                 LSP_DEFAULT
```

```
   L>   30.30.30.0/24      4           52483       Nolabel     N/A        N/A
127.0.0.1                 LSP_DEFAULT
   L>   40.40.40.0/24      5           52484       Nolabel     N/A        N/A
127.0.0.1                 LSP_DEFAULT
P1#
P1#show mpls ftn-table
 Primary FTN entry with FEC: 1.1.1.1/32, id: 2, row status: Active
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP: none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A
     Cross connect ix: 1, in intf: - in label: 0 out-segment ix: 2
      Owner: LDP, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 2, owner: LDP, Stale: NO, out intf: xe5, out label: 24965
    Nexthop addr: 20.20.20.2        cross connect ix: 1, op code: Push


 Primary FTN entry with FEC: 3.3.3.3/32, id: 5, row status: Active
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP: none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A
     Cross connect ix: 5, in intf: - in label: 0 out-segment ix: 8
      Owner: N/A, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 8, owner: N/A, Stale: NO, out intf: xe5, out label: 3
    Nexthop addr: 20.20.20.2        cross connect ix: 5, op code: Push


 Primary FTN entry with FEC: 4.4.4.4/32, id: 3, row status: Active
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP: none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A
     Cross connect ix: 3, in intf: - in label: 0 out-segment ix: 4
      Owner: LDP, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 4, owner: LDP, Stale: NO, out intf: xe5, out label: 24966
    Nexthop addr: 20.20.20.2        cross connect ix: 3, op code: Push


 Primary FTN entry with FEC: 30.30.30.0/24, id: 4, row status: Active
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP: none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A
     Cross connect ix: 4, in intf: - in label: 0 out-segment ix: 6
      Owner: LDP, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 6, owner: LDP, Stale: NO, out intf: xe5, out label: 24967
    Nexthop addr: 20.20.20.2        cross connect ix: 4, op code: Push


 Primary FTN entry with FEC: 40.40.40.0/24, id: 1, row status: Active
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP: none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A
     Cross connect ix: 5, in intf: - in label: 0 out-segment ix: 8
      Owner: N/A, Persistent: No, Admin Status: Up, Oper Status: Up
```

```
       Out-segment with ix: 8, owner: N/A, Stale: NO, out intf: xe5, out label: 3
    Nexthop addr: 20.20.20.2        cross connect ix: 5, op code: Push


P1#show ip route
Codes: K - kernel, C - connected, S - static, R - RIP, B - BGP
       O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2,
       ia - IS-IS inter area, E - EVPN,
       v - vrf leaked
       * - candidate default

IP Route Table for VRF "default"
O            1.1.1.1/32 [110/53] via 20.20.20.2, xe5, 00:03:44
C            2.2.2.2/32 is directly connected, lo, 00:14:13
O            3.3.3.3/32 [110/2] via 20.20.20.2, xe5, 00:12:51
O            4.4.4.4/32 [110/52] via 20.20.20.2, xe5, 00:03:44
C            20.20.20.0/24 is directly connected, xe5, 00:13:46
O            30.30.30.0/24 [110/52] via 20.20.20.2, xe5, 00:03:44
O            40.40.40.0/24 [110/51] via 20.20.20.2, xe5, 00:03:44
C            127.0.0.0/8 is directly connected, lo, 00:14:13
```

Bring up the link and check same labels reused.

(config)#interface xe12	Enter interface mode.
(config-if)#no shutdown	Shutdown the link.
(config)#commit	Commit.

Validation

```
PE1#show ldp session
Peer IP Address           IF Name    My Role    State       KeepAlive  UpTime
4.4.4.4                   xe6        Passive   OPERATIONAL   30    00:14:55
2.2.2.2                   xe12       Passive   OPERATIONAL   30    00:15:41
PE1#show ldp targeted-peers
IP Address          Interface
2.2.2.2             xe12
4.4.4.4             xe6

PE1#show ldp session 2.2.2.2
Session state         : OPERATIONAL
Session role          : Passive
TCP Connection        : Established
IP Address for TCP    : 2.2.2.2
Interface being used  : xe12
Peer LDP ID           : 2.2.2.2:0
```

```
Peer LDP Password     : Not Set
Adjacencies           : 10.10.10.2
                        2.2.2.2
Advertisement mode    : Downstream Unsolicited
Label retention mode  : Liberal
Graceful Restart      : Not Capable
Keepalive Timeout     : 30
Reconnect Interval    : 15
Session protection    : Ready
Address List received : 2.2.2.2
                        10.10.10.2
                        20.20.20.1
                        254.128.0.0
Received Labels :       Fec                Label           Maps To
                IPV4:3.3.3.3/32        52480           24966
                IPV4:20.20.20.0/24     impl-null       24967
                IPV4:10.10.10.0/24     impl-null       none
                IPV4:2.2.2.2/32        impl-null       24965
Sent Labels :   Fec                        Label           Maps To
                IPV4:40.40.40.0/24     24961           impl-null
                IPV4:4.4.4.4/32        24960           impl-null
                IPV4:30.30.30.0/24     impl-null       none
                IPV4:10.10.10.0/24     impl-null       none
                IPV4:1.1.1.1/32        impl-null       none

PE1#show mpls forwarding-table
Codes: > - installed FTN, * - selected FTN, p - stale FTN,
       B - BGP FTN, K - CLI FTN, t - tunnel, P - SR Policy FTN,
       L - LDP FTN, R - RSVP-TE FTN, S - SNMP FTN, I - IGP-Shortcut,
       U - unknown FTN, O - SR-OSPF FTN, i - SR-ISIS FTN, k - SR-CLI FTN
(m) - FTN mapped over multipath transport

Code    FEC               FTN-ID   Nhlfe-ID  Tunnel-id   Pri   LSP-Type     Out-Label
Out-Intf    ELC   Nexthop
   L>   2.2.2.2/32         3        9         -           Yes   LSP_DEFAULT  3
xe12        No    10.10.10.2
   L>   3.3.3.3/32         1        2         -           Yes   LSP_DEFAULT  52480
xe12        No    10.10.10.2
   L>   4.4.4.4/32         4        7         -           Yes   LSP_DEFAULT  3
xe6         No    30.30.30.2
   L>   20.20.20.0/24      2        4         -           Yes   LSP_DEFAULT  3
xe12        No    10.10.10.2
   L>   40.40.40.0/24      5        8         -           Yes   LSP_DEFAULT  3
xe6         No    30.30.30.2
PE1#
PE1#show mpls ilm-table
Codes: > - installed ILM, * - selected ILM, p - stale ILM
        K - CLI ILM, T - MPLS-TP, s - Stitched ILM
       S - SNMP, L - LDP, R - RSVP, C - CRLDP
       B - BGP , K - CLI , V - LDP_VC, I - IGP_SHORTCUT
       O - OSPF/OSPF6 SR, i - ISIS SR, k - SR CLI
       P - SR Policy, U - unknown
```

```
Code    FEC/VRF/L2CKT    ILM-ID     In-Label    Out-Label   In-Intf    Out-Intf/VRF
Nexthop                  LSP-Type
   L>   2.2.2.2/32         9          24965       3           N/A        xe12
10.10.10.2               LSP_DEFAULT
   L>   40.40.40.0/24      2          24961       3           N/A        xe6
30.30.30.2               LSP_DEFAULT
   L>   4.4.4.4/32         1          24960       3           N/A        xe6
30.30.30.2               LSP_DEFAULT
   L>   3.3.3.3/32         10         24966       52480       N/A        xe12
10.10.10.2               LSP_DEFAULT
   L>   20.20.20.0/24      11         24967       3           N/A        xe12
10.10.10.2               LSP_DEFAULT
PE1#show mpls ftn-table
 Primary FTN entry with FEC: 2.2.2.2/32, id: 3, row status: Active, Tunnel-Policy: N/A
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP:
none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A, Color: 0
     Cross connect ix: 5, in intf: - in label: 0 out-segment ix: 10
      Owner: N/A, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 10, owner: N/A, Stale: NO, out intf: xe12, out label: 3
    Nexthop addr: 10.10.10.2        cross connect ix: 5, op code: Push


 Primary FTN entry with FEC: 3.3.3.3/32, id: 1, row status: Active, Tunnel-Policy: N/A
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP:
none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A, Color: 0
     Cross connect ix: 6, in intf: - in label: 0 out-segment ix: 11
      Owner: LDP, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 11, owner: LDP, Stale: NO, out intf: xe12, out label: 52480
    Nexthop addr: 10.10.10.2        cross connect ix: 6, op code: Push


 Primary FTN entry with FEC: 4.4.4.4/32, id: 4, row status: Active, Tunnel-Policy: N/A
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP:
none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A, Color: 0
     Cross connect ix: 4, in intf: - in label: 0 out-segment ix: 6
      Owner: N/A, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 6, owner: N/A, Stale: NO, out intf: xe6, out label: 3
    Nexthop addr: 30.30.30.2        cross connect ix: 4, op code: Push


 Primary FTN entry with FEC: 20.20.20.0/24, id: 2, row status: Active, Tunnel-Policy: N/
A
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP:
none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A, Color: 0
     Cross connect ix: 5, in intf: - in label: 0 out-segment ix: 10
      Owner: N/A, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 10, owner: N/A, Stale: NO, out intf: xe12, out label: 3
    Nexthop addr: 10.10.10.2        cross connect ix: 5, op code: Push
```



```
 Primary FTN entry with FEC: 40.40.40.0/24, id: 5, row status: Active, Tunnel-Policy: N/
A
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP:
none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A, Color: 0
     Cross connect ix: 4, in intf: - in label: 0 out-segment ix: 6
      Owner: N/A, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 6, owner: N/A, Stale: NO, out intf: xe6, out label: 3
    Nexthop addr: 30.30.30.2        cross connect ix: 4, op code: Push


P1#show ldp session
Peer IP Address           IF Name    My Role    State      KeepAlive  UpTime
3.3.3.3                   xe5        Passive   OPERATIONAL   30    00:15:30
    1.1.1.1                   xe48       Active    OPERATIONAL   30    00:16:33

P1#show ldp targeted-peers
IP Address          Interface
1.1.1.1             xe48
3.3.3.3             xe5

P1#show ldp session 1.1.1.1
Session state         : OPERATIONAL
Session role          : Active
TCP Connection        : Established
IP Address for TCP    : 1.1.1.1
Interface being used  : xe48
Peer LDP ID           : 1.1.1.1:0
Peer LDP Password     : Not Set
Adjacencies           : 10.10.10.1
                        1.1.1.1
Advertisement mode    : Downstream Unsolicited
Label retention mode  : Liberal
Graceful Restart      : Not Capable
Keepalive Timeout     : 30
Reconnect Interval    : 15
Session protection    : Ready
Address List received : 1.1.1.1
                        10.10.10.1
                        30.30.30.1
                        254.128.0.0
Received Labels :       Fec               Label           Maps To
                IPV4:4.4.4.4/32        24960           52482
                IPV4:40.40.40.0/24     24961           52484
                IPV4:30.30.30.0/24     impl-null       52483
                IPV4:10.10.10.0/24     impl-null       none
                IPV4:1.1.1.1/32        impl-null       52481
Sent Labels :   Fec                    Label           Maps To
                IPV4:3.3.3.3/32        52480           impl-null
```

```
                IPV4:20.20.20.0/24      impl-null       none
                IPV4:10.10.10.0/24      impl-null       none
                    IPV4:2.2.2.2/32         impl-null       none

P1#show mpls forwarding-table
Codes: > - installed FTN, * - selected FTN, p - stale FTN,
       B - BGP FTN, K - CLI FTN, t - tunnel,
       L - LDP FTN, R - RSVP-TE FTN, S - SNMP FTN, I - IGP-Shortcut,
       U - unknown FTN

Code    FEC               FTN-ID    Nhlfe-ID  Tunnel-id   Pri   LSP-Type     Out-Label
Out-Intf    ELC   Nexthop
   L>   1.1.1.1/32         2         3         -          Yes   LSP_DEFAULT  3
xe48        No    10.10.10.1
   L>   3.3.3.3/32         5         9         -          Yes   LSP_DEFAULT  3
xe5         No    20.20.20.2
   L>   4.4.4.4/32         3         5         -          Yes   LSP_DEFAULT  24960
xe48        No    10.10.10.1
   L>   30.30.30.0/24      4         7         -          Yes   LSP_DEFAULT  3
xe48        No    10.10.10.1
   L>   40.40.40.0/24      1         1         -          Yes   LSP_DEFAULT  24961
xe48        No    10.10.10.1
P1#
P1#show mpls ilm-table
Codes: > - installed ILM, * - selected ILM, p - stale ILM
        K - CLI ILM, T - MPLS-TP, s - Stitched ILM
       S - SNMP, L - LDP, R - RSVP, C - CRLDP
       B - BGP , K - CLI , V - LDP_VC, I - IGP_SHORTCUT
       U - unknown

Code    FEC/VRF/L2CKT    ILM-ID     In-Label    Out-Label   In-Intf    Out-Intf/VRF
Nexthop                   LSP-Type
   L>   4.4.4.4/32        3          52482       24960       N/A        xe48
10.10.10.1                LSP_DEFAULT
   L>   1.1.1.1/32        2          52481       3           N/A        xe48
10.10.10.1                LSP_DEFAULT
   L>   3.3.3.3/32        1          52480       3           N/A        xe5
20.20.20.2                LSP_DEFAULT
   L>   40.40.40.0/24     5          52484       24961       N/A        xe48
10.10.10.1                LSP_DEFAULT
   L>   30.30.30.0/24     4          52483       3           N/A        xe48
10.10.10.1                LSP_DEFAULT

P1#show mpls ftn-table
 Primary FTN entry with FEC: 1.1.1.1/32, id: 2, row status: Active
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP:
none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A
     Cross connect ix: 6, in intf: - in label: 0 out-segment ix: 10
      Owner: N/A, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 10, owner: N/A, Stale: NO, out intf: xe48, out label: 3
    Nexthop addr: 10.10.10.1        cross connect ix: 6, op code: Push
```

```
 Primary FTN entry with FEC: 3.3.3.3/32, id: 5, row status: Active
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP: 
none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A
      Cross connect ix: 5, in intf: - in label: 0 out-segment ix: 8
       Owner: N/A, Persistent: No, Admin Status: Up, Oper Status: Up
         Out-segment with ix: 8, owner: N/A, Stale: NO, out intf: xe5, out label: 3
    Nexthop addr: 20.20.20.2        cross connect ix: 5, op code: Push


 Primary FTN entry with FEC: 4.4.4.4/32, id: 3, row status: Active
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP: 
none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A
      Cross connect ix: 7, in intf: - in label: 0 out-segment ix: 11
       Owner: LDP, Persistent: No, Admin Status: Up, Oper Status: Up
         Out-segment with ix: 11, owner: LDP, Stale: NO, out intf: xe48, out label: 24960
    Nexthop addr: 10.10.10.1        cross connect ix: 7, op code: Push


 Primary FTN entry with FEC: 30.30.30.0/24, id: 4, row status: Active
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP: 
none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A
      Cross connect ix: 6, in intf: - in label: 0 out-segment ix: 10
       Owner: N/A, Persistent: No, Admin Status: Up, Oper Status: Up
         Out-segment with ix: 10, owner: N/A, Stale: NO, out intf: xe48, out label: 3
    Nexthop addr: 10.10.10.1        cross connect ix: 6, op code: Push


 Primary FTN entry with FEC: 40.40.40.0/24, id: 1, row status: Active
  Owner: LDP, distance: 0, Action-type: Redirect to LSP, Exp-bits: 0x0, Incoming DSCP: 
none
  Tunnel id: 0, Protected LSP id: 0, Description: N/A
      Cross connect ix: 8, in intf: - in label: 0 out-segment ix: 12
       Owner: LDP, Persistent: No, Admin Status: Up, Oper Status: Up
         Out-segment with ix: 12, owner: LDP, Stale: NO, out intf: xe48, out label: 24961
    Nexthop addr: 10.10.10.1        cross connect ix: 8, op code: Push
```

CHAPTER 7 TCP MSS Configuration for LDP

Overview

Label Distribution Protocol (LDP) uses TCP to establish sessions between the devices. This feature enables the configuration of TCP Maximum Segment Size (MSS) that defines the maximum segment size in a single TCP segment during a communication session. The configuration of the TCP MSS for LDP neighbors helps the neighbors adjust the MSS value of the TCP SYN packet. The configurable MSS range is from 560 to 1440. Configure the TCP MSS through the CLI and NetConf interface.

For more information, refer to the TCP MSS configuration for LDP sessions section in the *OcNOS Key Feature document*, Release 6.4.1.

CHAPTER 8 MPLS LDP-IGP Synchronization

This chapter contains configurations for MPLS LDP-IGP Synchronization.

Overview

Multi-Protocol Label Switching (MPLS) Label Distribution Protocol (LDP) Interior Gateway Protocol (IGP) Synchronization ensures that LDP is fully established before the IGP path is used for switching. In certain networks, there is dependency on the edge-to-edge Label Switched Paths (LSPs) setup by the Label Distribution Protocol (LDP), e.g., networks that are used for Multi-Protocol Label Switching (MPLS) Virtual Private Network (VPN) applications. For such applications, it is not possible to rely on Internet Protocol (IP) forwarding if the MPLS LSP is not operating appropriately. Labelled traffic can be dropped due to presence of black holes in situations where the Interior Gateway Protocol (IGP) is operational on a link but LDP sessions are not up as the label distribution is not completed. While the link could still be used for IP forwarding, it is not useful for MPLS forwarding, for example, MPLS VPN applications or Border Gateway Protocol (BGP) route-free cores.

The MPLS LDP-IGP Synchronization feature ensures that the Label Distribution Protocol (LDP) is fully established before the Interior Gateway Protocol (IGP) path is used for packet forwarding. It is useful for cases in which the router is the ingress and the decision of whether to take the MPLS LSP or IGP path is decided there.

LDP-IGP synchronization is an interface level feature. It can be selectively enabled in the required interfaces. For each interface there are two commands available for synchronization, one each for IS-IS. Once configured the IGP saves the required information, and also notifies LDP. In between the IGP increases the link cost to maximum and sends advertisements to its peer. This discourages its peers from taking routes that pass via it.

When all LDP sessions hosted on the interface become operational, it sends a notification to the IGP. This is termed as LDP convergence. The IGP then advertises normal cost, so that all traffic now coming to the interface takes the MPLS LSP path established by LDP and not be IP routed.

Prerequisites

Only interfaces that are running Open Shortest Path First (OSPF) or Intermediate System-to-Intermediate System (IS-IS) processes are capable of LDP-IGP synchronization. The router must also be running LDP.

Topology

The sample topology diagram is applicable to all configurations in this chapter.

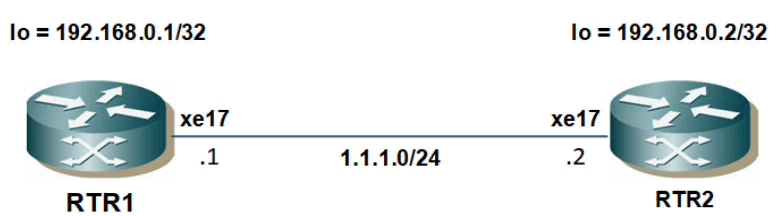


Figure 8-1: Sample Topology for LDP-IGP Synchronization

LDP-IGP Synchronization with OSPF

When IGP synchronization is enabled on OSPF-enabled interfaces, OSPF sends Maximum/Normal cost based on LDP session Down or Up state messages to interfaces until the hold-down-timer expires or synchronization is achieved.

Before configuring LDP-IGP synchronization, the NSM, OSPF and LDP configurations must be completed. The tables below contain examples of how this is done.

RTR1-NSM

`#configure terminal`	Enter configuration mode.
`(config)#interface xe11`	Enter interface mode.
`(config-if)#ip address 10.10.10.1/24`	Configure IPv4 address for xe11.
`(config-if)#label-switching`	Enable label switching on interface xe11.
`(config-if)#exit`	Exit interface mode.
`(config)#interface lo`	Specify the loopback (lo) interface to be configured.
`(config-if)#ip address 1.1.1.1/32 secondary`	Set the IP address of the loopback interface to 1.1.1.1/32.

RTR1-OSPF

`(config)#router ospf 100`	Configure the routing process and specify the Process ID 100. The Process ID should be a unique positive integer identifying the routing process.
`(config-router)# router-id 1.1.1.1`	Configure router id for OSPF
`(config-router)#network 10.10.10.0/24 area 0` `(config-router)#network 1.1.1.1/32 area 0`	Define the interface on which OSPF runs and associate the area ID (0) with the interface.

RTR1-LDP

`(config)#router ldp`	Enter router mode for LDP.
`(config-router)#router-id 1.1.1.1`	Set the router ID to IP address 1.1.1.1.
`(config-router)#transport-address ipv4 1.1.1.1`	Configure the transport address for IPV4 (for IPV6 use ipv6) to be used for a TCP session over which LDP will run. Note: It is preferable to use the loopback address as the transport address.
`(config-router)#exit`	Exit router mode.
`(config)#interface xe11`	Enter interface mode.
`(config-if)#enable-ldp ipv4`	Enable LDP for IPv4 on xe11.
`(config-if)#exit`	Exit interface mode.

RTR2-NSM

`#configure terminal`	Enter configuration mode.
`(config)#interface xe11`	Enter interface mode.
`(config-if)#ip address 10.10.10.2/24`	Configure IPv4 address for xe11.
`(config-if)#label-switching`	Enable label switching on interface xe11.
`(config-if)#exit`	Exit interface mode.
`(config)#interface lo`	Specify the loopback (lo) interface to be configured.
`(config-if)#ip address 2.2.2.2/32 secondary`	Set the IP address of the loopback interface to 2.2.2.2/32.

RTR2-OSPF

`(config)#router ospf 100`	Configure the routing process and specify the Process ID 100. The Process ID should be a unique positive integer identifying the routing process.
`(config-router)# router-id 2.2.2.2`	Configure router id for OSPF
`(config-router)#network 10.10.10.0/24 area 0` `(config-router)#network 2.2.2.2/32 area 0`	Define the interface on which OSPF runs and associate the area ID (0) with the interface.

RTR2-LDP

`(config)#router ldp`	Enter Router mode for LDP.
`(config-router)#router-id 2.2.2.2`	Set the router ID to IP address 2.2.2.2.
`(config-router)#transport-address ipv4 2.2.2.2`	Configure the transport address for IPV4 (for IPV6 use ipv6) to be used for a TCP session over which LDP will run. Note: It is preferable to use the loopback address as transport address.
`(config-router)#exit`	Exit the Router mode and return to the Configure mode.
`(config)#interface xe11`	Enter interface mode.
`(config-if)#enable-ldp ipv4`	Enable LDP for IPv4 on xe11.
`(config-if)#exit`	Exit interface mode.

Validation

```
R1#show ip ospf neighbor

Total number of full neighbors: 1
OSPF process 100 VRF(default):
Neighbor ID     Pri   State           Dead Time   Address         Interface
Instance ID
2.2.2.2          1   Full/DR        00:00:33   10.10.10.2     xe11
0

R2#show ip ospf neighbor
```

```
Total number of full neighbors: 1
OSPF process 100 VRF(default):
Neighbor ID    Pri   State          Dead Time   Address        Interface
Instance ID
1.1.1.1        1  Full/Backup     00:00:31   10.10.10.1     xe11
0
R2#

R1#show ldp session
Peer IP Address          IF Name    My Role    State      KeepAlive  UpTime
2.2.2.2                  xe11       Passive   OPERATIONAL   30    00:06:03

R2#show ldp session
Peer IP Address          IF Name    My Role    State      KeepAlive  UpTime
1.1.1.1                  xe11       Active    OPERATIONAL   30    00:06:31

R1#show ldp adjacency
IP Address      Mode          Intf Name    Holdtime   LDP-Identifier
10.10.10.2      Interface     xe11        15         2.2.2.2:0


R2#show ldp adjacency
IP Address      Mode          Intf Name    Holdtime   LDP-Identifier
10.10.10.1      Interface     xe11        15         1.1.1.1:0

R1#show ip ospf interface
lo is up, line protocol is up
  Internet Address 1.1.1.1/32, Area 0.0.0.0, MTU 16436
  Process ID 100, VRF (default), Router ID 1.1.1.1, Network Type LOOPBACK,
Cost: 1
  Transmit Delay is 1 sec,  State Loopback, TE Metric 1
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
xe11 is up, line protocol is up
  Internet Address 10.10.10.1/24, Area 0.0.0.0, MTU 1500
  Process ID 100, VRF (default), Router ID 1.1.1.1, Network Type BROADCAST,
Cost: 1
  Transmit Delay is 1 sec,  State Backup, Priority 1, TE Metric 1
  Designated Router (ID) 2.2.2.2, Interface Address 10.10.10.2
  Backup Designated Router (ID) 1.1.1.1, Interface Address 10.10.10.1
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:01
  Neighbor Count is 1, Adjacent neighbor count is 1
  Hello received 61 sent 62, DD received 3 sent 6
  LS-Req received 1 sent 1, LS-Upd received 4 sent 5
  LS-Ack received 4 sent 3, Discarded 0
  No authentication

R2#sh ip ospf interface
lo is up, line protocol is up
  Internet Address 2.2.2.2/32, Area 0.0.0.0, MTU 16436
  Process ID 100, VRF (default), Router ID 2.2.2.2, Network Type LOOPBACK,
Cost: 1
  Transmit Delay is 1 sec,  State Loopback, TE Metric 1
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
xe11 is up, line protocol is up
  Internet Address 10.10.10.2/24, Area 0.0.0.0, MTU 1500
  Process ID 100, VRF (default), Router ID 2.2.2.2, Network Type BROADCAST,
Cost: 1
```



```
  Transmit Delay is 1 sec,  State DR, Priority 1, TE Metric 1
  Designated Router (ID) 2.2.2.2, Interface Address 10.10.10.2
  Backup Designated Router (ID) 1.1.1.1, Interface Address 10.10.10.1
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:01
  Neighbor Count is 1, Adjacent neighbor count is 1
  Hello received 62 sent 63, DD received 6 sent 3
  LS-Req received 1 sent 1, LS-Upd received 5 sent 4
  LS-Ack received 3 sent 4, Discarded 0
  No authentication

R1#show mpls ldp igp sync
R1#

R2#show mpls ldp igp sync
R2#
```

LDP-IGP Synchronization

Now that NSM, OSPF and LDP are all enabled, the LDP-IGP synchronization can be configured.

RTR1

(config)#interface xe11	Enter interface mode.
(config-if)#mpls ldp-igp sync ospf holddown-timer 500	Enable LDP-IGP Synchronization for xe11 belonging to an OSPF process and 500 seconds is holddown-timer value for IGP to wait until LDP converges. **OSPF:** This command is part of OSPF Process. Note: Holddown-timer range is 1 to 2147483 seconds. If holddown timer is not configured, IGP waits indefinitely for LDP to converge. Use the command mpls ldp-igp sync ospf to configure without a holddown-timer.
(config-if)#mpls ldp-igp sync-delay 60	Configure time delay in seconds for notification of LDP convergence to IGP. This is not applicable for notification of non-convergence. Range is 5 to 60 seconds. This command is optional. **LDP:** This command is part of LDP Process. **Default:** If not configured the delay is 0 seconds.
(config-if)#exit	Exit interface mode.

RTR2

(config)#interface xe11	Enter interface mode.
(config-if)#mpls ldp-igp sync ospf holddown-timer 500	Enable LDP-IGP Synchronization for interfaces (xe11) belonging to an OSPF process.and 500 secs is Holddown-timer value for IGP to wait until LDP Converge. **OSPF:** This command is part of the OSPF Process.vNote: Holddown-timer range is <1-2147483> seconds. If holddown timer is not configured, IGP waits indefinitely for LDP to converge. Use command mpls ldp-igp sync ospf to configure without a holddown-timer.

`(config-if)#mpls ldp-igp sync-delay 60`	Configure the time delay in seconds for the notification of LDP convergence to IGP. (This is not applicable for notification of non-convergence.) Range is 5 to 60 seconds. This command is optional. **LDP:** This command is part of LDP Process. **Default:** If not configured the delay is 0 seconds.
`(config-if)#exit`	Exit interface mode.

RTR1 Validation

When LDP IGP SYNC is Configured with hold-down and sync-delay timer

```
R1#show ip ospf interface
lo is up, line protocol is up
  Internet Address 1.1.1.1/32, Area 0.0.0.0, MTU 16436
  Process ID 100, VRF (default), Router ID 1.1.1.1, Network Type LOOPBACK,
Cost:
 1
  Transmit Delay is 1 sec,  State Loopback, TE Metric 1
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
xe11 is up, line protocol is up
  Internet Address 10.10.10.1/24, Area 0.0.0.0, MTU 1500
  Process ID 100, VRF (default), Router ID 1.1.1.1, Network Type BROADCAST,
Cost
: 1
  Transmit Delay is 1 sec,  State Backup, Priority 1, TE Metric 1
  LDP-OSPF Sync configured
    Holddown timer : 500 seconds, Remaining time = 0 seconds
  Designated Router (ID) 2.2.2.2, Interface Address 10.10.10.2
  Backup Designated Router (ID) 1.1.1.1, Interface Address 10.10.10.1
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:06
  Neighbor Count is 1, Adjacent neighbor count is 1
  Hello received 178 sent 179, DD received 3 sent 6
  LS-Req received 1 sent 1, LS-Upd received 5 sent 6
  LS-Ack received 5 sent 4, Discarded 0
  No authentication
R1#

R1#show mpls ldp igp sync
xe11 is up, line protocol is up
  LDP configured; LDP-IGP Synchronization enabled.
  Session IP Address : 2.2.2.2
    Sync status: Achieved
    Delay timer: Configured, 60 seconds, Not Running
```

RTR2 Validation

```
R2#show ip ospf interface
lo is up, line protocol is up
  Internet Address 2.2.2.2/32, Area 0.0.0.0, MTU 16436
  Process ID 100, VRF (default), Router ID 2.2.2.2, Network Type LOOPBACK,
Cost:
 1
  Transmit Delay is 1 sec,  State Loopback, TE Metric 1
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
```



```
xe11 is up, line protocol is up
  Internet Address 10.10.10.2/24, Area 0.0.0.0, MTU 1500
  Process ID 100, VRF (default), Router ID 2.2.2.2, Network Type BROADCAST,
Cost
: 1
  Transmit Delay is 1 sec,  State DR, Priority 1, TE Metric 1
  LDP-OSPF Sync configured
    Holddown timer : 500 seconds, Remaining time = 0 seconds
  Designated Router (ID) 2.2.2.2, Interface Address 10.10.10.2
  Backup Designated Router (ID) 1.1.1.1, Interface Address 10.10.10.1
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:01
  Neighbor Count is 1, Adjacent neighbor count is 1
  Hello received 211 sent 211, DD received 6 sent 3
  LS-Req received 1 sent 1, LS-Upd received 8 sent 7
  LS-Ack received 6 sent 7, Discarded 0
  No authentication
R2#

R2#show mpls ldp igp sync
xe11 is up, line protocol is up
  LDP configured; LDP-IGP Synchronization enabled.
  Session IP Address : 1.1.1.1
    Sync status: Achieved
    Delay timer: Configured, 60 seconds, Not Running
```

LDP-IGP Synchronization with IS-IS

When IGP synchronization is enabled on an IS-IS enabled interfaces, IS-IS sends Maximum/Normal cost based on LDP session or Up state on interfaces until hold-down-timer expires or synchronization is achieved.

Before configuring LDP-IGP synchronization, the NSM, IS-IS and LDP configurations must be completed. The tables below contain examples of how this is done.

RTR1-NSM

`#configure terminal`	Enter configuration mode.
`(config)#interface xe11`	Enter interface mode.
`(config-if)#ip address 10.10.10.1/24`	Set the IP address of the xe11 to 10.10.10.1/24.
`(config-if)#label-switching`	Enable label switching on xe11.
`(config-if)#exit`	Exit interface mode.
`(config)#interface lo`	Specify the loopback (lo) interface to be configured.
`(config-if)#ip address 1.1.1.1/32 secondary`	Set the IP address of the loopback interface to 1.1.1.1/32.
`(config-if)#exit`	Exit interface mode.

RTR1-IS-IS

`(config)#router isis 1`	Configure the IS-IS routing instance and specify the TAG (1). The TAG should be a WORD - ISO routing area tag.
`(config-router)#is-type level-1`	Define the IS to the specified level of routing for router.

`(config-router)#net 49.0001.0000.0000.0001.00`	Configure the Network Entity Title (NET) for the instance.
`(config-router)#exit`	Exit the Router mode and return to the Configure mode.
`(config)#interface xe11`	Enter interface mode.
`(config-if)#ip router isis 1`	Configure IS-IS IPv4 routing on the interface with IS-IS tag instance 1.
`(config-if)#isis circuit-type level-1`	Define the circuit type for the interface on which IS-IS runs and associate the level 1.
`(config-if)#exit`	Exit interface mode.
`(config)#interface lo`	Enter interface mode for the loopback interface (lo).
`(config-if)#ip router isis 1`	Configure IS-IS IPv4 routing on the interface with IS-IS tag instance 1.
`(config-if)#isis circuit-type level-1`	Define the circuit type for the interface on which IS-IS runs and associate the level 1.
`(config-if)#exit`	Exit interface mode.

RTR1-LDP

`(config)#router ldp`	Enter Router mode for LDP.
`(config-router)#router-id 1.1.1.1`	Set the router ID to IP address 1.1.1.1.
`(config-router)#transport-address ipv4 1.1.1.1`	Configure the transport address for IPV4 (for IPv6 use an IPv6 address) to use for a TCP session over which LDP will run. Note: It is preferable to use the loopback address as transport address.
`(config-router)#exit`	Exit the Router mode and return to the Configure mode.
`(config)#interface xe11`	Enter interface mode.
`(config-if)#enable-ldp ipv4`	Enable LDP for IPv4 on xe11.
`(config-if)#exit`	Exit interface mode.

RTR2-NSM

`#configure terminal`	Enter configuration mode
`(config)#interface xe11`	Enter interface mode.
`(config-if)#ip address 10.10.10.2/24`	Set the IP address of xe11 to 10.10.10.2/24
`(config-if)#label-switching`	Enable label switching on interface xe11.
`(config-if)#exit`	Exit interface mode.
`(config)#interface lo`	Specify the loopback (lo) interface to be configured.
`(config-if)#ip address 2.2.2.2/32 secondary`	Set the IP address of the loopback interface to 2.2.2.2/32.
`(config-if)#exit`	Exit interface mode.

RTR2-IS-IS

`(config)#router isis 1`	Configure the IS-IS routing instance and specify the TAG as 1. The TAG should be a WORD - ISO routing area tag.
`(config-router)#is-type level-1`	Define the IS to the specified level of routing for router.

(config-router)#net 49.0001.0000.0000.0002.00	Configure the Network Entity Title (NET) for the instance.
(config-router)#exit	Exit the Router mode and return to the Configure mode.
(config)#interface xe11	Enter interface mode.
(config-if)#ip router isis 1	Configure IS-IS IPv4 routing on the interface with is-is tag instance 1.
(config-if)#isis circuit-type level-1	Define the circuit type for the interface on which IS-IS runs and associate the level type (1).
(config-if)#exit	Exit interface mode.
(config)#interface lo	Enter interface mode for the loopback (lo) interface.
(config-if)#ip router isis 1	Configure IS-IS IPv4 routing on the interface with IS-IS tag instance 1.
(config-if)#isis circuit-type level-1	Define the circuit type for the interface on which IS-IS runs and associate the level 1.
(config-if)#exit	Exit interface mode.

RTR2-LDP

(config)#router ldp	Enter Router mode for LDP.
(config-router)#router-id 2.2.2.2	Set the router ID to IP address 2.2.2.2.
(config-router)#transport-address ipv4 2.2.2.2	Configure the transport address for IPv4 (for IPv6 use an IPv6 address) to use for a TCP session over which LDP will run. Note: It is preferable to use the loopback address as transport address.
(config-router)#exit	Exit the Router mode and return to the Configure mode.
(config)#interface xe11	Enter interface mode.
(config-if)#enable-ldp ipv4	Enable LDP for IPv4 on xe11.
(config-if)#exit	Exit interface mode.

Validation

```
R1#show clns neighbors

Total number of L1 adjacencies: 1
Total number of L2 adjacencies: 0
Total number of adjacencies: 1
Tag 1:  VRF : default
System Id      Interface   SNPA                State  Holdtime  Type Protocol
0000.0000.0002 xe11        6cb9.c5cf.da69      Up     24        L1   IS-IS

R2#show clns neighbors

Total number of L1 adjacencies: 1
Total number of L2 adjacencies: 0
Total number of adjacencies: 1
Tag 1:  VRF : default
System Id      Interface   SNPA                State  Holdtime  Type Protocol
0000.0000.0001 xe11        b86a.97d1.24d1      Up     9         L1   IS-IS
```



```
R1#show clns is-neighbors

Tag 1:  VRF : default
System Id      Interface   State  Type Priority  Circuit Id
0000.0000.0002 xe11        Up     L1   64        0000.0000.0001.01

R2#show clns is-neighbors

Tag 1:  VRF : default
System Id      Interface   State  Type Priority  Circuit Id
0000.0000.0001 xe11        Up     L1   64        0000.0000.0001.01

R1#show ldp session
Peer IP Address           IF Name    My Role    State      KeepAlive  UpTime
2.2.2.2                   xe11       Passive   OPERATIONAL   30    00:08:08

R1#show ldp adjacency
IP Address      Mode          Intf Name    Holdtime   LDP-Identifier
10.10.10.2      Interface     xe11        15         2.2.2.2:0

R2#show ldp session
Peer IP Address           IF Name    My Role    State      KeepAlive  UpTime
1.1.1.1                   xe11       Active    OPERATIONAL   30    00:08:24

R2#show ldp adjacency
IP Address      Mode          Intf Name    Holdtime   LDP-Identifier
10.10.10.1      Interface     xe11        15         1.1.1.1:0

R1#show isis interface xe11
xe11 is up, line protocol is up
  Routing Protocol: IS-IS (1)
    Network Type: Broadcast
    Circuit Type: level-1
    Local circuit ID: 0x01
    Extended Local circuit ID: 0x0000271C
    Local SNPA: b86a.97d1.24d1
    IP interface address:
      10.10.10.1/24
    IPv6 interface address:
      fe80::ba6a:97ff:fed1:24d1/64
    Level-1 Metric: 10/10, Priority: 64, Circuit ID: 0000.0000.0001.01
    Number of active level-1 adjacencies: 1
    Level-1 LSP MTU: 1492
    Next IS-IS LAN Level-1 Hello in 792 milliseconds

R2#show isis interface xe11
xe11 is up, line protocol is up
  Routing Protocol: IS-IS (1)
    Network Type: Broadcast
    Circuit Type: level-1
    Local circuit ID: 0x01
    Extended Local circuit ID: 0x0000271B
    Local SNPA: 6cb9.c5cf.da69
    IP interface address:
      10.10.10.2/24
    IPv6 interface address:
      fe80::6eb9:c5ff:fecf:da69/64
```



```
    Level-1 Metric: 10/10, Priority: 64, Circuit ID: 0000.0000.0001.01
    Number of active level-1 adjacencies: 1
    Level-1 LSP MTU: 1492
    Next IS-IS LAN Level-1 Hello in 1 seconds


R1#show isis database detail
Tag 1:  VRF : default
IS-IS Level-1 Link State Database:
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
0000.0000.0001.00-00* 0x00000002   0xB193        516               0/0/0
  Area Address: 49.0001
  NLPID:        0xCC
  IP Address:   10.10.10.1
  Metric:   10         IS 0000.0000.0001.01
  Metric:   10         IP 10.10.10.0 255.255.255.0
  Metric:   10         IP 1.1.1.1 255.255.255.255
0000.0000.0001.01-00* 0x00000001   0x1FBD        516               0/0/0
  Metric:   0          IS 0000.0000.0001.00
  Metric:   0          IS 0000.0000.0002.00
0000.0000.0002.00-00  0x00000002   0x84BA        519               0/0/0
  Area Address: 49.0001
  NLPID:        0xCC
  IP Address:   10.10.10.2
  Metric:   10         IS 0000.0000.0001.01
  Metric:   10         IP 10.10.10.0 255.255.255.0
  Metric:   10         IP 2.2.2.2 255.255.255.255

R2#show isis database detail
Tag 1:  VRF : default
IS-IS Level-1 Link State Database:
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
0000.0000.0001.00-00  0x00000002   0xB193        521               0/0/0
  Area Address: 49.0001
  NLPID:        0xCC
  IP Address:   10.10.10.1
  Metric:   10         IS 0000.0000.0001.01
  Metric:   10         IP 10.10.10.0 255.255.255.0
  Metric:   10         IP 1.1.1.1 255.255.255.255
0000.0000.0001.01-00  0x00000001   0x1FBD        521               0/0/0
  Metric:   0          IS 0000.0000.0001.00
  Metric:   0          IS 0000.0000.0002.00
0000.0000.0002.00-00* 0x00000002   0x84BA        526               0/0/0
  Area Address: 49.0001
  NLPID:        0xCC
  IP Address:   10.10.10.2
  Metric:   10         IS 0000.0000.0001.01
  Metric:   10         IP 10.10.10.0 255.255.255.0
  Metric:   10         IP 2.2.2.2 255.255.255.255



R1#show mpls ldp igp sync
R1#

R2#show mpls ldp igp sync
R2#
```

LDP-IGP SYNC Configuration

Now that NSM, IS-IS and LDP are all enabled, the LDP-IGP synchronization can be configured.

RTR1

`(config)#interface xe11`	Enter interface mode.
`(config-if)#mpls ldp-igp sync isis level-1 holddown-timer 700`	Configure LDP-IGP Synchronization for interface xe11 belonging to an IS-IS process with corresponding IS-IS level.700 seconds is the holddown-timer value for IGP to wait until LDP converges. The values level-1|level-2-only|level-1-2 identify the IS-IS level instance. The interface can be acting on any level, but the sync is applicable only when it matches with the level given in IGP sync command. **IS-IS:** This command is part of ISIS Process. **Default:** Mandatory configuration. No default option. Note: The holddown-timer Range is 1 to 2147483 seconds. If no holddown timer is configured, IGP waits indefinitely for LDP to Converge. Use the command mpls ldp-igp sync is-is <level-type> to configure without a holddown-timer.
`(config-if)#mpls ldp-igp sync-delay 55`	Set the time delay in seconds for the notification of LDP convergence to IGP. This is not applicable for notification of non-convergence. Range is 5 to 60 seconds. This command is optional. **LDP:** This command is part of LDP Process. **Default:** If not configured, the delay is 0 seconds.
`(config-if)#exit`	Exit interface mode.

LDP-IGP SYNC Configuration

Now that NSM, IS-IS and LDP are all enabled, the LDP-IGP synchronization can be configured.

RTR2

(config)#interface xe11	Enter interface mode.
(config-if)#mpls ldp-igp sync isis level-1 holddown-timer 700	Configure LDP-IGP Synchronization for interface xe11 belonging to an IS-IS process with corresponding IS-IS level.700 secs is the holddown-timer value for IGP to wait until LDP converges. The parameters level-1|level-2-only|level-1-2 identify the IS-IS instance level. The interface can be acting on any level, but sync is applicable only when it matches with the level given in IGP sync command. **IS-IS:** This command is part of IS-IS Process. **Default:** Mandatory configuration. No default option. Note: The holddown-timer Range is 1 to 2147483 seconds. If no holddown timer is configured, IGP waits indefinitely for LDP to Converge. Use command mpls ldp-igp sync is-is <level-type> to configure without a holddown-timer.
(config-if)#mpls ldp-igp sync-delay 55	Set the time delay in seconds for notification of LDP convergence to IGP. This is not applicable for notification of non-convergence. Range is 5 to 60 seconds. This command is optional. **LDP:** This command is part of LDP Process. **Default:** If not configured, the delay is 0 seconds.
(config-if)#exit	Exit interface mode.

RTR1 Validation

When LDP IGP SYNC is Configured with hold-down and sync-delay timer

```
R1#show isis interface xe11
xe11 is up, line protocol is up
  Routing Protocol: IS-IS (1)
    Network Type: Broadcast
    Circuit Type: level-1
    Local circuit ID: 0x01
    Extended Local circuit ID: 0x0000271C
    Local SNPA: b86a.97d1.24d1
    IP interface address:
      10.10.10.1/24
    IPv6 interface address:
      fe80::ba6a:97ff:fed1:24d1/64
    LDP-ISIS Sync Configured
      Holddown timer = 700 seconds, Remaining time = 0 seconds
    Level-1 Metric: 10/10, Priority: 64, Circuit ID: 0000.0000.0001.01
    Number of active level-1 adjacencies: 1
    Level-1 LSP MTU: 1492
    Next IS-IS LAN Level-1 Hello in 420 milliseconds
R1#

R1#show mpls ldp igp sync
xe11 is up, line protocol is up
  LDP configured; LDP-IGP Synchronization enabled.
  Session IP Address : 2.2.2.2
```

```
      Sync status: Achieved
      Delay timer: Configured, 55 seconds, Not Running
R1#
```

RTR2 Validation

```
R2#show  isis interface xe11
xe11 is up, line protocol is up
  Routing Protocol: IS-IS (1)
    Network Type: Broadcast
    Circuit Type: level-1
    Local circuit ID: 0x01
    Extended Local circuit ID: 0x0000271B
    Local SNPA: 6cb9.c5cf.da69
    IP interface address:
      10.10.10.2/24
    IPv6 interface address:
      fe80::6eb9:c5ff:fecf:da69/64
    LDP-ISIS Sync Configured
      Holddown timer = 700 seconds, Remaining time = 0 seconds
    Level-1 Metric: 10/10, Priority: 64, Circuit ID: 0000.0000.0001.01
    Number of active level-1 adjacencies: 1
    Level-1 LSP MTU: 1492
    Next IS-IS LAN Level-1 Hello in 4 seconds
R2#
R2#show mpls ldp igp sync
xe11 is up, line protocol is up
  LDP configured; LDP-IGP Synchronization enabled.
  Session IP Address : 1.1.1.1
    Sync status: Achieved
    Delay timer: Configured, 55 seconds, Not Running
```

CHAPTER 9 RSVP Graceful Restart Configuration

Overview

The RSVP-TE graceful restart enables routers to maintain MPLS forwarding state when a link or node failure occurs. In a link failure, control communication is lost between two nodes, however, the nodes do not lose their control or forwarding state. RSVP Graceful restart (GR) is one of the fault-handling mechanism, that protects the forwarding state of the node during failure and helps to reinstate the previous state when the node has recovered.

Topology

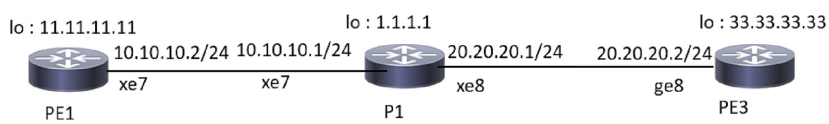


Figure 9-2: RSVP Graceful Restart

Configuration

PE1-NSM

`#configure terminal`	Enter configure mode.
`(config)#interface lo`	Enter interface mode.
`(config-if)#ip address 11.11.11.11/32 secondary`	Set the IP address for the interface.
`(config-if)#exit`	Exit interface mode.
`(config)#interface xe7`	Enter interface mode.
`(config-if)#ip address 10.10.10.2/24`	Set the IP address for the interface.
`(config-if)#label-switching`	Enable label switching on interface `xe7`.
`(config-if)#commit`	Commit the transaction.

PE1-RSVP-TE

`(config)#router rsvp`	Enter `Configure Router` mode.
`(config-router)#exit`	Exit `Router` mode.
`(config)#interface xe7`	Enter interface mode.
`(config-if)#enable-rsvp`	Enable RSVP message exchange on this interface.
`(config-if)#commit`	Commit the transaction.

PE1-OSPF

#configure terminal	Enter configure mode.
(config)#router ospf 100	Configure the Routing process and specify the Process ID (100). The Process ID should be a unique positive integer identifying the routing process.
(config-router)#router-id 11.11.11.11	Configure OSPF router-ID same as loopback interface IP address
(config-router)#network 10.10.10.0/24 area 0	Define the network (10.10.10.0/24) on which OSPF runs and associate the area ID (0).
(config-router)#network 11.11.11.11/32 area 0	Set the IP address of the loopback interface to 11.11.11.11/32.
(config-router)#commit	Commit the transaction.

P - NSM

#configure terminal	Enter configure mode.
(config)#interface lo	Enter interface mode.
(config-if)#ip address 1.1.1.1/32 secondary	Set the IP address for the interface.
(config-if)#exit	Enable label switching on interface lo.
(config)#interface xe7	Enter interface mode.
(config-if)#ip address 10.10.10.1/24	Set the IP address for the interface.
(config-if)#label-switching	Enable label switching on interface xe7.
(config-if)#exit	Exit interface mode.
(config)#interface xe8	Enter interface mode.
(config-if)#ip address 20.20.20.1/24	Set the IP address for the interface.
(config-if)#label-switching	Enable label switching on interface xe7.
(config-if)#commit	Commit the transaction.

P - RSVP-TE

(config)#router rsvp	Enter Configure Router mode.
(config-router)#exit	Exit Router mode.
(config)#interface xe7	Enter interface mode.
(config-if)#enable-rsvp	Enable RSVP message exchange on this interface.
(config-if)#exit	Exit interface mode.
(config)#interface xe8	Enter interface mode.
(config-if)#enable-rsvp	Enable RSVP message exchange on this interface.
(config-if)#commit	Commit the transaction.

P - OSPF

#configure terminal	Enter configure mode.
(config)#router ospf 100	Configure the Routing process and specify the Process ID (100). The Process ID should be a unique positive integer identifying the routing process.
(config-router)#router-id 1.1.1.1	Configure OSPF router-ID same as loopback interface IP address
(config-router)#network 10.10.10.0/24 area 0	Define the first network (10.10.10.0/24) on which OSPF runs and associate the area ID (0).
(config-router)#network 20.20.20.0/24 area 0	Define the second network (20.20.20.0/24) on which OSPF runs and associate the area ID (0).
(config-router)#network 1.1.1.1/32 area 0	Set the IP address of the loopback interface to 1.1.1.1/32.
(config-router)#commit	Commit the transaction.

PE3 - NSM

#configure terminal	Enter configure mode.
(config)#interface lo	Enter interface mode.
(config-if)#ip address 33.33.33.33/32 secondary	Set the IP address for the interface.
(config-if)#exit	Exit interface mode.
(config)#interface ge8	Enter interface mode.
(config-if)#ip address 20.20.20.2/24	Set the IP address for the interface.
(config-if)#label-switching	Enable label switching on interface ge8.
(config-if)#commit	Commit the transaction.

PE3- RSVP-TE

(config)#router rsvp	Enter Configure Router mode.
(config-router)#exit	Exit Router mode.
(config)#interface ge8	Enter interface mode.
(config-if)#enable-rsvp	Enable RSVP message exchange on this interface.
(config-if)#commit	Commit the transaction.

PE3 - OSPF

#configure terminal	Enter configure mode.
(config)#router ospf 100	Configure the Routing process and specify the Process ID (100). The Process ID should be a unique positive integer identifying the routing process.
(config-router)#router-id 33.33.33.33	Configure OSPF router-ID same as loopback interface IP address
(config-router)#network 20.20.20.0/24 area 0	Define the network (20.20.20.0/24) on which OSPF runs and associate the area ID (0).
(config-router)#network 33.33.33.33/32 area 0	Set the IP address of the loopback interface to 33.33.33.33/32.
(config-router)#commit	Commit the transaction.

PE1 - RSVP-Path

#configure terminal	Enter configure mode.
(config)#rsvp-path PE1_to_PE3_via_P1 mpls	Create an RSVP Path and enter the Path mode.
(config-path)#10.10.10.1 strict	Configure this explicit route path as a strict hop.
(config-path)#20.20.20.2 strict	Configure this explicit route path as a strict hop.
(config-path)#exit	Exit Path mode.
#configure terminal	Enter configure mode.
(config)#rsvp-trunk PE1_to_PE3 ipv4	Create an RSVP trunk and enter the Trunk mode.
(config-trunk)#primary path PE1_to_PE3_via_P1	Configure the trunk to use defined path.
(config-trunk)#from 11.11.11.11	Specify ipv4 source point for the LSP.
(config-trunk)#to 33.33.33.33	Specify the IPv4 egress (destination point) for the LSP.
(config-trunk)#commit	Commit the transaction.

PE3 - RSVP-Path

`#configure terminal`	Enter configure mode.
`(config)#rsvp-path PE3_to_PE1_via_P1 mpls`	Create an RSVP Path and enter the `Path` mode.
`(config-path)#20.20.20.1 strict`	Configure this explicit route path as a `strict` hop.
`(config-path)#10.10.10.2 strict`	Configure this explicit route path as a `strict` hop.
`(config-path)#exit`	Exit `Path` mode.
`#configure terminal`	Enter configure mode.
`(config)#rsvp-trunk PE3_to_PE1 ipv4`	Create an RSVP trunk and enter the Trunk mode.
`(config-trunk)#primary path PE3_to_PE1_via_P1`	Configure the trunk to use defined path.
`(config-trunk)#from 33.33.33.33`	Specify the ipv4 source point for LSP
`(config-trunk)#to 11.11.11.11`	Specify the IPv4 egress (destination point) for the LSP.
`(config-trunk)#commit`	Commit the transaction.

PE1 – RSVP-GR

`#configure terminal`	Enter configure mode.
`(config)#router rsvp`	nter the configuration router mode.
`(config-router)#neighbor 10.10.10.1`	Configure the neighbor ip address.
`(config-router)#graceful-restart`	Enable the rsvp-gr.
`(config-router)#commit`	Commit the transaction.

P1 – RSVP-GR

`#configure terminal`	Enter configure mode.
`(config)#router rsvp`	Enter the configuration router mode.
`(config-router)#neighbor 10.10.10.2`	Configure the neighbor ip address.
`(config-router)#neighbor 20.20.20.2`	Configure the neighbor ip address.
`(config-router)#graceful-restart`	Enable the rsvp-gr.
`(config-router)#commit`	Commit the transaction.

PE3 – RSVP-GR

`#configure terminal`	Enter configure mode.
`(config)#router rsvp`	Enter the router configuration mode.
`(config-router)#neighbor 20.20.20.1`	Configure the neighbor ip address.
`(config-router)#graceful-restart`	Enable the rsvp-gr.
`(config-router)#commit`	Commit the transaction.

Validation

Verify the RSVP graceful restart on PE1.

```
PE1#show rsvp graceful-restart
Graceful Restart: Enabled
Advertised Restart Time: 200000 msec
Advertised Recovery Time: 360000 msec
Sending Recovery Time: No
```

```
PE1#show rsvp session
Type  : PRI - Primary, SEC - Secondary, DTR - Detour, BPS - Bypass
State : UP - Up, DN - Down, BU - Backup in Use, SU - Secondary in Use, FS - Forc
ed to Secondary
* indicates the session is active with local repair at one or more nodes
(P) indicates the secondary-priority session is acting as primary

Egress RSVP:
To              From            Tun-ID   LSP-ID   Type    LSPName          State   Uptime    Rt   Style  Labelin  Labelout
11.11.11.11     33.33.33.33     5001     2201     PRI     PE1_to_PE3 ipv4s   UP    00:54:57  1 1  SE        3        -

Total 5 displayed, Up 5, Down 0.
```

Verify after performing RSVP graceful restart on PE1

```
7038-PE1#show mpls forwarding-table
Codes: > - installed FTN, * - selected FTN, p - stale FTN, ! - using backup
       B - BGP FTN, K - CLI FTN, (t) - tunnel, P - SR Policy FTN, (b) - bypass,
       L - LDP FTN, R - RSVP-TE FTN, S - SNMP FTN, I - IGP-Shortcut,
       U - unknown FTN, O - SR-OSPF FTN, i - SR-ISIS FTN, k - SR-CLI FTN
       (m) - FTN mapped over multipath transport, (e) - FTN is ECMP

FTN-ECMP LDP: Disabled

Code     FEC                  FTN-ID     Nhlfe-ID  Tunnel-id    Pri    LSP-Type     Out-Label     Out-Intf     ELC    Nexthop
   L>    1.1.1.1/32           3          4
                                         3         -            Yes    LSP_DEFAULT  3             xe7          No     10.10.10.1
R(t)> p 33.33.33.33/32        20         81        5001         Yes    LSP_DEFAULT  26881         xe7          Yes p  10.10.10.1
```

CHAPTER 10 RSVP Detour Over Ring Topology

Overview

In OcNOS, this feature enhances the routing experience by forming a detour in a ring topology. When a failure or congestion occurs in the primary Label Switched Path (LSP), the detour protects data traffic. The detour formation is a local protection mechanism to minimize data traffic loss.

For more information, see the RSVP Detour Over Ring Topology section in the *OcNOS Key Feature document*, Release 6.4.1.

CHAPTER 11 MPLS OAM Configuration

This chapter contains configuration for MPLS Operations, Administration and Management (OAM).

Overview

MPLS OAM is used to detect forwarding plane failures in an MPLS network. Similar to ICMP echo requests and replies in an IP network, an MPLS network can use MPLS echo requests and replies for checking data plane and control plane operations in the Label Switched Path (LSP). The MPLS traceroute process also provides path details for the LSP.

Topology

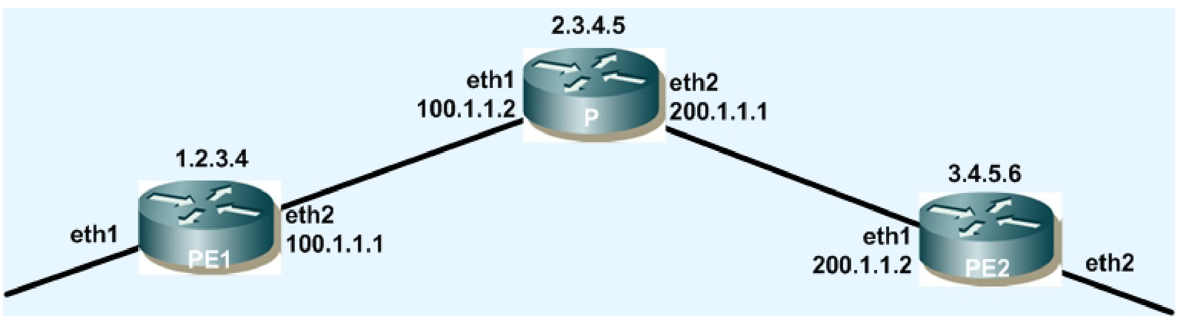


Figure 11-1: Topology for All Configurations

PE1

`#configure terminal`	Enter configure mode.
`(config)#interface lo`	Enter interface mode for loopback.
`(config-if)#ip address 1.2.3.4/32`	Configure the loopback IP address.
`(config-if)#interface eth1`	Enter interface mode.
`(config-if)#ip address 100.1.1.1/24`	Configure the IP address for interface eth1.
`#exit`	Exit interface mode.
`(config)#router ospf 100`	Configure OSPF.
`(config-router)#network 1.2.3.4/32 area 0`	Add loopback IP address to OSPF network.
`(config)-router#network 100.1.1.0/24 area 0`	Add eth1 IP address to OSPF network.

P

`#configure terminal`	Enter configure mode.
`(config)#interface lo`	Enter interface mode for loopback.
`(config-if)#ip address 2.3.4.5/32`	Configure the loopback IP address.

`(config-if)#interface eth1`	Enter interface mode.
`(config-if)#ip address 100.1.1.2/24`	Configure the IP address for interface eth1.
`(config-if)#interface eth2`	Enter interface mode.
`(config-if)#ip address 200.1.1.1/24`	Configure the IP address for interface eth2.
`#exit`	Exit interface mode.
`(config)#router ospf 100`	Configure OSPF.
`(config-router)#network 2.3.4.5/32 area 0`	Add loopback IP address to OSPF network.
`(config)-router#network 100.1.1.0/24 area 0`	Add eth1 IP address to OSPF network.
`(config)-router#network 200.1.1.0/24 area 0`	Add eth2 IP address to OSPF network.

PE2

`#configure terminal`	Enter configure mode.
`(config)#interface lo`	Enter interface mode for loopback.
`(config-if)#ip address 3.4.5.6/32`	Configure the loopback IP address.
`(config-if)#interface eth1`	Enter interface mode.
`(config-if)#ip address 200.1.1.2/24`	Configure the IP address for interface eth2.
`#exit`	Exit interface mode.
`(config)#router ospf 100`	Configure OSPF.
`(config-router)#network 3.4.5.6/32 area 0`	Add loopback IP address to OSPF network.
`(config)-router#network 200.1.1.0/24 area 0`	Add eth1 IP address to OSPF network.

Validation

Router 1

```
#show ip ospf neighbor
OSPF process 100:
Neighbor ID    Pri   State       Dead Time   Address      Interface  InstanceID
2.3.4.5        1    Full/DR      00:00:37    100.1.1.2      eth2        0
```

Router 2

```
#show ip ospf neighbor
OSPF process 100:
Neighbor ID    Pri   State       Dead Time   Address      Interface  InstanceID
1.2.3.4        1   Full/Backup     00:00:37    100.1.1.1      eth1        0
3.4.5.6        1   Full/DR         00:00:34    200.1.1.2      eth2        0
```

Router 3

```
#show ip ospf neighbor
OSPF process 100:
Neighbor ID    Pri   State       Dead Time   Address      Interface  InstanceID
2.3.4.5        1   Full/DR       00:00:37    200.1.1.2      eth1        0
```

VCCV and BFD for Pseudowires

The Virtual Circuit Connectivity Verification (VCCV) mechanism is used to facilitate Operations Administration and Maintenance (OAM) in pseudowires (PW). VCCV defines a set of messages that are sent via a PW data stream to enable management functionalities, such as connectivity and verification. Each VCCV packet contains information about its sequence number and the current value of the transmission counter. When a PW receiver receives a VCCV packet, it records the transmission counter contained in the packet. Each PW receiver also has a local received counter, which counts received PW packets. The PW receiver compares the value of the transmission counter with that of the received counter. Packet losses are detected when the count of transmitted packets is greater than the count of received packets.

Bidirectional Forwarding Detection (BFD) is used as one of the connectivity verification mechanisms in VCCV when continuous monitoring is required for a session. BFD VCCV provides a detection mechanism for pseudowires as well as the OAM functions to use over a PW to check its true operational state.

CC Types

- Type 1: PWE3 Control Word with 0001b as first nibble
- Type 2: MPLS Router Alert Label
- Type 3: MPLS PW Label with TTL == 1

VCCV CV Types

- LSP Ping

BFD CV Types

- Type 1: BFD IP/UDP-encapsulated, for PW Fault Detection only
- Type 2: BFD IP/UDP-encapsulated, for PW Fault Detection and AC/PW Fault Status Signaling
- Type 3: BFD PW-ACH-encapsulated, for PW Fault Detection only
- Type 4: BFD PW-ACH-encapsulated, for PW Fault Detection and AC/PW Fault Status Signaling

VC with Control-word, VCCV and BFD Enabled

PE1

#configure terminal	Enter configure mode.
(config)#router ldp	Enter the Router LDP mode.
(config-router)#pw-status-tlv	Configure PW status TLV for PW status signaling.
(config-router)#targeted-peer ipv4 3.4.5.6	Configure targeted LDP session to PE2 loopback address.
(config-router)#exit	Exit Router LDP mode and return to Configure mode.
(config)#interface eth2	Enter interface mode.
(config-if)#label-switching	Configure label-switching on provider interface PE1.
(config-if)#enable-ldp ipv4	Enable LDP at provider interface PE1.
(config-if)#exit	Exit interface mode.
(config)#mpls l2-circuit test 100 3.4.5.6	Configure PW named “test” with PW-ID 100.
(config-pseudowire)#control-word	Enable Control-word.
(config-pseudowire)#vccv cc-type type-1	Enable VCCV CC-Type as 1.
(config-pseudowire)#vccv cv-type type-3	Enable VCCV CV-Type as 3.
(config-pseduowire)#exit	Exit pseudowire mode.
(config)#bridge 1 protocol ieee vlan-bridge	Specify VLAN for bridge 1.
(config)#interface eth1	Enter interface mode.
(config-if)#switchport	Switch to Layer-2 mode.
(config-if)#switchport mode access	Set the switching characteristics of this interface to Access mode.
(config-if)#mpls-l2-circuit test	Bind the PW to access interface.
(config-if)#exit	Exit interface mode.
(config)#exit	Exit Configure mode.

P

#configure terminal	Enter configure mode.
(config)#router ldp	Enter the Router LDP mode.
(config-router)#pw-status-tlv	Configure PW status TLV for PW status signaling.
(config-router)#exit	Exit Router LDP mode.
(config)#interface eth1	Enter interface mode.
(config-if)#label-switching	Configure label-switching for eth1.
(config-if)#enable-ldp ipv4	Enable LDP for eth1.
(config-if)#exit	Exit interface mode.
(config)#interface eth2	Enter interface mode.
(config-if)#label-switching	Configure label-switching for eth2.
(config-if)#enable-ldp ipv4	Enable LDP for eth2.

(config-if)#exit	Exit interface mode.
(config)#exit	Exit Configure mode.

PE2

#configure terminal	Enter configure mode.
(config)#router ldp	Enter the Router LDP mode.
(config-router)#pw-status-tlv	Configure PW status TLV for PW status signaling.
(config-router)#targeted-peer ipv4 1.2.3.4	Configure targeted LDP session to PE1 loopback address.
(config-router)#exit	Exit Router LDP mode.
(config)#interface eth1	Enter interface mode.
(config-if)#label-switching	Configure label-switching on provider interface of PE2.
(config-if)#enable-ldp ipv4	Enable LDP on the provider interface of PE2.
(config-if)#exit	Exit interface mode.
(config)#mpls l2-circuit test 100 1.2.3.4	Configure PW named “test” with PW-ID 100.
(config-pseudowire)#control-word	Enable Control-word.
(config-pseudowire)#vccv cc-type type-1	Enable VCCV CC-Type as 1.
(config-pseudowire)#vccv cv-type type-3	Enable VCCV CV-Type as 3.
(config-pseduowire)#exit	Exit pseudowire mode.
(config)#bridge 1 protocol ieee vlan-bridge	Specify VLAN for bridge 1.
(config)#interface eth1	Enter interface mode.
(config-if)#switchport	Switch to Layer-2 mode.
(config-if)#switchport mode access	Set the switching characteristics of this interface to Access mode.
(config-if)#mpls-l2-circuit test	Bind the PW to access interface.
(config-if)#exit	Exit interface mode.
(config)#exit	Exit Configure mode.

Manual VC with VCCV and BFD Enabled

PE1

(config)#mpls vpls v1 100	Configure VPLS v1 with id 100 on PE2.
(config)#router ldp	Enter the Router LDP mode.
(config-router)#pw-status-tlv	Configure PW status TLV for PW status signaling.
(config-router)#targeted-peer ipv4 3.4.5.6	Configure targeted LDP session to PE2 loopback address.
(config-router)#exit	Exit Router LDP mode.
(config)#interface eth2	Enter interface mode.
(config-if)#label-switching	Configure label-switching on provider interface of PE1.
(config-if)#enable-ldp ipv4	Enable LDP on the provider interface of PE1.

`(config-if)#exit`	Exit interface mode.
`(config)#mpls l2-circuit test 100 3.4.5.6`	Configure PW named “test” with PW-ID 100.
`(config-pseudowire)#manual-pseudowire`	Enable pseudowire.
`(config-pseudowire)#vccv cc-type type-1`	Enable VCCV CC-Type as 1.
`(config-pseudowire)#vccv cv-type type-3`	Enable VCCV CV-Type as 3.
`(config-pseduowire)#exit`	Exit pseudowire mode.
`(config)#mpls l2-circuit-fib-entry 100 111 222 3.4.5.6 eth2 eth1`	Configure mpls-l2 circuit FIB entry for manual VC.
`(config)#bridge 1 protocol ieee vlan-bridge`	Specify VLAN for bridge 1.
`(config)#interface eth1`	Enter interface mode.
`(config-if)#switchport`	Switch to Layer-2 mode.
`(config-if)#switchport mode access`	Set the switching characteristics of this interface to Access mode.
`(config-if)#mpls-l2-circuit test`	Bind the PW to access interface.
`(config-if)#exit`	Exit interface mode.
`(config)#exit`	Exit `Configure` mode.

P

`#configure terminal`	Enter configure mode.
`(config)#router ldp`	Enter the `Router LDP` mode.
`(config-router)#pw-status-tlv`	Configure PW status TLV for PW status signaling.
`(config-router)#exit`	Exit `Router LDP` mode.
`(config)#interface eth1`	Enter interface mode.
`(config-if)#label-switching`	Configure label-switching.
`(config-if)#enable-ldp ipv4`	Enable LDP.
`(config-if)#exit`	Exit interface mode.
`(config)#interface eth2`	Enter interface mode.
`(config-if)#label-switching`	Configure label-switching.
`(config-if)#enable-ldp ipv4`	Enable LDP.
`(config-if)#exit`	Exit interface mode.
`(config)#exit`	Exit `Configure` mode.

PE2

`#configure terminal`	Enter configure mode.
`(config)#router ldp`	Enter the `Router LDP` mode.
`(config-router)#pw-status-tlv`	Configure PW status TLV for PW status signalling.
`(config-router)#targeted-peer ipv4 1.2.3.4`	Configure targeted LDP session to PE1 loopback address.
`(config-router)#exit`	Exit `Router LDP` mode.

`(config)#interface eth1`	Enter interface mode.
`(config-if)#label-switching`	Configure label-switching on provider interface of PE2.
`(config-if)#enable-ldp ipv4`	Enable LDP on the provider interface of PE2.
`(config-if)#exit`	Exit interface mode.
`(config)#mpls l2-circuit test 100 3.4.5.6`	Configure PW named “test” with PW-ID 100.
`(config-pseudowire)#manual-pseudowire`	Enable pseudowire.
`(config-pseudowire)#vccv cc-type type-1`	Enable VCCV CC-Type as 1.
`(config-pseudowire)#vccv cv-type type-3`	Enable VCCV CV-Type as 3.
`(config-pseduowire)#exit`	Exit pseudowire mode.
`(config)#mpls l2-circuit-fib-entry 100 222 111 1.2.3.4 eth2 eth1`	Configure mpls-l2 circuit FIB entry for the manual VC.
`(config)#bridge 1 protocol ieee vlan-bridge`	Specify the VLAN for bridge 1.
`(config)#interface eth2`	Enter interface mode.
`(config-if)#switchport`	Switch to Layer-2 mode.
`(config-if)#switchport mode access`	Set the switching characteristics of this interface to Access mode.
`(config-if)#mpls-l2-circuit test`	Bind the PW to access interface.
`(config-if)#exit`	Exit interface mode.
`(config)#exit`	Exit `Configure` mode.

Remove VCCV Configuration

PE1

`#configure terminal`	Enter configure mode.
`(config)#no mpls l2-circuit test 100 3.4.5.6 control-word manual`	Remove VC named “test”.
`(config)#exit`	Exit `Configure` mode.

PE2

`#configure terminal`	Enter configure mode.
`(config)#no mpls l2-circuit test 100 1.2.3.4 control-word manual`	Remove VC named “test”.
`(config)#exit`	Exit `Configure` mode.

Validation

Enter the commands listed in the section below.

Verify BFD Session On PE1

```
#show bfd session detail
------------------------------------------------
Session Interface Index: 4     Session Index: 1
Lower Layer: MPLS VCCV    Version : 1  Session Type: Single Hop
Session State : Up
Local Discriminator : 1 Remote Discriminator: 1
VC ID: 100      Incoming VC Label: 53120
Local Address : 1.2.3.4/32      Remote Address: 127.0.0.12/32
Local Port : 49152      Remote Port: 3784
Options :
Diagnostics: None
Timers in Milliseconds
Min Tx: 20  Min Rx: 20  Multiplier: 5
Min echo Rx: 10   Neg Tx: 20
Neg echo intrvl: 10     Neg detect mult: 5
Storage type: 0
Last sess down time: 00:00:00
Sess discontinue time: 00:00:00
Counters values:
Pkt In 000000000001ef3a Pkt Out 0000000000000000
Echo Out 0000000000000000
IPv6 Pkt In 0000000000000000 IPv6 Pkt Out 0000000000000000
IPv6 Echo Out 0000000000000000
UP Count: 1  UPTIME: 00:40:26
NSM-> Client ID: 1 Flags: 4
Number of Sessions:    1
```

Verify VCCV and BFD CV Types in Use

```
#show mpls l2-circuit
MPLS Layer-2 Virtual Circuit: test, id: 100 PW-INDEX: 1
 Endpoint: 3.4.5.6
 Control Word: 1
 MPLS Layer-2 Virtual Circuit Group: none
 Bound to interface: eth1
 Virtual Circuit Type: Ethernet VLAN
 Virtual Circuit is configured as Primary
 Virtual Circuit is configured as Active
 Virtual Circuit runtime mode is active
Local VCCV Capability:
 CC-Types:  Type 1(in use) Type 2 Type 3
 CV-Types:
 LSP ping(in use) BFD IP/UDP-encapsulated, for PW Fault Detection only
 BFD IP/UDP-encapsulated, for PW Fault Detection and AC/PW Fault Status Signaling
 BFD PW-ACH-encapsulated, for PW Fault Detection only
 BFD PW-ACH-encapsulated, for PW Fault Detection and AC/PW Fault Status Signaling (in
use)
```

Verify VCCV Ping on PE1

```
#ping mpls l2-circuit vccv 100 force-explicit-null detail
```



```
Sending 5 MPLS Echos to VC Id : 100, timeout is 5 seconds

Codes:
'!' - Success, 'Q' - request not sent, '.' - timeout,
'x' - Retcode 0, 'M' - Malformed Request, 'm' - Errored TLV,
'N' - LBL Mapping Err, 'D' - DS Mismatch,
'U' - Unknown Interface, 'R' - Transit (LBL Switched),
'B' - IP Forwarded, 'F' No FEC Found, 'f' - FEC Mismatch,
'P' - Protocol Error, 'X' - Unknown code

 Type 'Ctrl+C' to abort

! seq_num = 1 3.4.5.6 0.54 ms
! seq_num = 2 3.4.5.6 2.36 ms
! seq_num = 3 3.4.5.6 0.47 ms
! seq_num = 4 3.4.5.6 2.22 ms
! seq_num = 5 3.4.5.6 0.49 ms

Success Rate is 100.00 percent (5/5)
round-trip min/avg/max = 0.47/1.42/2.36
```

CHAPTER 12 Pseudowire Status

This chapter includes Pseudowire (PW) Status configuration examples. This feature specifies a mechanism to signal Pseudowire (PW) status messages using a PW associated channel (ACh), which is suitable for static PWs where no PW dynamic control plane exits. You can also use this feature when a Terminating Provider Edge (T-PE) needs to send a PW status message directly to a far-end T-PE. This feature allows PW Operations, Administration, and Maintenance (OAM) message mapping and PW redundancy to operate on a static PW.

This configuration section includes information on the configuration of PW status for statically configured end-to-end MPLS PWs and MPLS-TP PWs.

Terminology

`ACh`	Associated Channel
`ACH`	Associated Channel Header
`FEC`	Forwarding Equivalence Class
`LSP`	Label Switching Path
`PE`	Provider Edge
`PW`	Pseudowire
`SS-PW`	Single-Segment Pseudowire
`MS-PW`	Multi-Segment Pseudowire
`S-PE`	Switching Provider Edge Node of MS-PW
`T-PE`	Terminating Provider Edge Node of MS-PW
`OAM`	Operations Administration and Maintenance
`MPLS-TP`	MPLS Transport Profile

Topology

The following topology shows a basic PW topology.

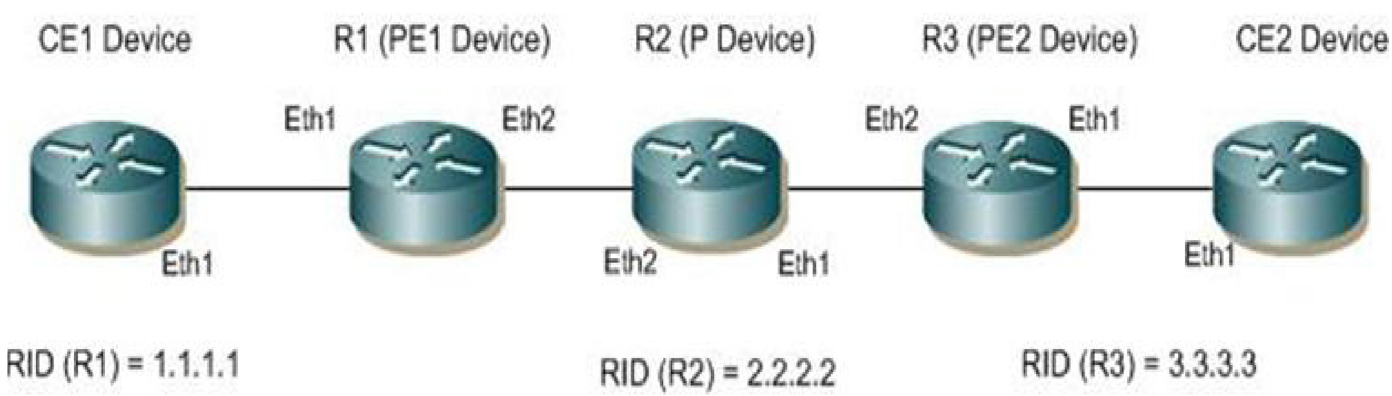


Figure 12-1: PW Topology

PW Status Commands

PW status commands and other related configurations for statically configured MPLS PWs.

```
mpls l2-circuit NAME VC-ID PEER-IP control-word tunnel-id TUNNEL-ID(manual(pw-
status(REFRESH-TIME))
```

Parameter	Description
pw-status	Enables PW status for manual configured PW (Static PW). To disable it, omit this and reconfigure PW.
REFRESH-TIME	Time in seconds after which a PW status is transmitted periodically if an AC fault has occurred. The range is <0-65535>. Default is 600 seconds.

PE1

`#configure terminal`	Enter configure mode.
`(config)#mpls l2-circuit VC1 1 3.3.3.3`	Configure a static VC with name VC1 .
`(config-pseudowire)#control-word`	Enable Control-word.
`(config-pseudowire)#tunnel-id 1`	Enable VCCV CC-Type as 1.
`(config-pseudowire)#manual-pseudowire`	Configure pseudowire manual (no signaling).
`(config-pseduowire)#exit`	Exit pseudowire mode.
`(config)#bridge 1 protocol ieee vlan-bridge`	Configure bridge protocol with bridge group as 1
`(config)#interface eth1`	Enter interface mode.
`(config-if)#switchport`	Configure switchport and switch to Layer2 mode
`(config-if)#bridge-group 1`	Enable the bridge group 1
`(config-if)#switchport mode access`	Configure switchport mode as access
`(config-if)#mpls-l2-circuit VC1 ethernet`	Attach the PW1 to the interface eth1
`(config)#interface lo`	Enter interface mode.
`(config-if)#ip address 1.1.1.1/32`	Set the IP address for the interface
`(config-if)#exit`	Exit interface mode
`(config)#interface eth2`	Enter interface mode.
`(config-if)#ip address 10.1.1.1/24`	Set the IP address for the interface
`(config-if)#label-switching`	Enable label switching on interface eth2
`(config-if)#exit`	Exit interface mode
`(config)#mpls l2-circuit-fib-entry 1 100 1000 3.3.3.3 eth2 eth1`	Configure a FIB Entry for the PW1
`(config)#mpls ftn-entry tunnel-id 1 3.3.3.3/32 200 10.1.1.2 eth2 primary`	Configure a FTN Entry for forward MPLS Tunnel
`(config)#mpls ilm-entry 2222 eth2 pop`	Configure a ILM POP Entry for reverse MPLS Tunnel

P

`#configure terminal`	Enter configure mode.
`(config)#interface lo`	Enter interface mode.
`(config-if)#ip address 2.2.2.2/32`	Set the IP address for the interface
`(config-if)#label-switching`	Enable label switching on interface lo
`(config-if)#exit`	Exit interface mode
`(config)#interface eth1`	Enter interface mode.
`(config-if)#ip address 20.1.1.1/24`	Set the IP address for the interface
`(config-if)#label-switching`	Enable label switching on interface eth1
`(config-if)#exit`	Exit interface mode
`(config)#interface eth2`	Enter interface mode.
`(config-if)#ip address 10.1.1.2/24`	Set the IP address for the interface
`(config-if)#label-switching`	Enable label switching on interface eth2
`(config-if)#exit`	Exit interface mode
`(config)#mpls ilm-entry 200 eth2 swap 2000 eth1 20.1.1.2 3.3.3.3/32`	Configure ILM Swap Entry for forward MPLS Tunnel
`(config)#mpls ilm-entry 111 eth1 swap 2222 eth2 10.1.1.1 1.1.1.1/32`	Configure ILM Swap Entry for reverse MPLS Tunnel

PE2

`#configure terminal`	Enter configure mode.
`(config)#mpls l2-circuit VC1 1 1.1.1.1`	Configure a static VC with name VC1 .
`(config-pseudowire)#control-word`	Enable Control-word.
`(config-pseudowire)#tunnel-id 1`	Enable VCCV CC-Type as 1.
`(config-pseudowire)#manual-pseudowire`	Configure pseudowire manual (no signaling).
`(config-pseduowire)#exit`	Exit pseudowire mode.
`(config)#bridge 1 protocol ieee vlan-bridge`	Configure bridge protocol with bridge group as 1
`(config)#interface eth1`	Enter interface mode.
`(config-if)#switchport`	Configure switchport and switch to Layer2 mode
`(config-if)#bridge-group 1`	Enable the bridge group 1
`(config-if)#switchport mode access`	Configure switchport mode as access
`(config-if)#mpls-l2-circuit VC1 ethernet`	Attach the PW1 to the interface eth1
`(config)#interface lo`	Enter interface mode.
`(config-if)#ip address 3.3.3.3/32`	Set the IP address for the interface
`(config-if)#exit`	Exit interface mode
`(config)#interface eth2`	Enter interface mode.
`(config-if)#ip address 20.1.1.2/24`	Set the IP address for the interface

`(config-if)#label-switching`	Enable label switching on interface eth2
`(config-if)#exit`	Exit interface mode
`(config)#mpls l2-circuit-fib-entry 1 1000 100 1.1.1.1 eth2 eth1`	Configure a FIB Entry for the PW1
`(config)#mpls ftn-entry tunnel-id 2 1.1.1.1/32 111 20.1.1.1 eth2 primary`	Configure a FTN Entry for forward MPLS Tunnel
`(config)#mpls ilm-entry 2000 eth2 pop`	Configure a ILM POP Entry for reverse MPLS Tunnel

Validation

show mpls l2-circuit and show mpls vc-table

PW Status Commands

PW status commands and other related configurations for statically configured MPLS-TP PWs.

```
mpls l2-circuit NAME VC-ID PEER-GLOBAL-ID PEER-NODE-ID PEER-AC-ID GROUP-NAME
(manual (pw-status (REFRESH-TIME))
```

Parameter	Description
pw-status	Enables PW status for manual configured PW (Static PW). To disable it, just omit this and reconfigure PW.
REFRESH-TIME	Specifies the time in seconds after which a PW status will be transmitted periodically if an AC fault has occurred. The range is <0-65535>. Default is 600 seconds.

R1

`#configure terminal`	Enter configure mode.
`(config)#mpls-tp global-id 999 node-id 1.1.1.1`	Configure MPLS-TP Global ID
`(config)#mpls ac-group grp1 2`	Configure MPLS-TP Access Group
`(config)#mpls l2-circuit VC1 1 888 3.3.3.3 456 grp1`	Configure a static VC with name VC1 .
`(config-pseudowire)#control-word`	Enable Control-word.
`(config-pseudowire)#manual-pseudowire`	Configure pseudowire manual (no signaling).
`(config-pseduowire)#exit`	Exit pseudowire mode.
`(config)#bridge 1 protocol ieee vlan-bridge`	Configure bridge protocol with bridge group as 1
`(config)#interface eth1`	Enter interface mode.
`(config-if)#switchport`	Configure switchport and switch to Layer2 mode
`(config-if)#bridge-group 1`	Enable the bridge group 1
`(config-if)#switchport mode access`	Configure switchport mode as access
`(config-if)# mpls-tp service-interface type layer-2 123`	Configure MPLS-TP service interface type

(config-if)#mpls-l2-circuit VC1 ethernet	Attach the PW1 to the interface eth1
(config)#interface eth2	Enter interface mode.
(config-if)# mpls-tp provider-interface 11.11.11.11	Set the interface eth2 as provider interface with local interface id as 11.11.11.11
(config-if)#exit	Exit interface mode
(config)#mpls l2-circuit-fib-entry 1 555 666 tp-tunnel T1 eth1	Configure a FIB Entry for the PW1
(config)#mpls-tp tunnel 1 source 999 1.1.1.1 destination 888 3.3.3.3	Configure a FTN Entry for MPLS Tunnel
(config-tnl)# tunnel-name T1	Configure Tunnel Name
(config-tnl)# tunnel-mode bidirectional	Configure Tunnel Mode as Bidirectional
(config-bidir-tnl)#forward-path nhlfe-entry 1000 eth2	Configure Forward Path nhlfe entry
(config-bidir-tnl)# reverse-path ilm-entry 2000 eth2 pop	Configure Reverse Path ilm pop entry

P

#configure terminal	Enter configure mode.
(config)#mpls-tp global-id 777 node-id 2.2.2.2	Configure MPLS-TP Global ID
(config)#interface eth1	Enter interface mode.
(config-if)# mpls-tp provider-interface 22.22.22.22	Set the interface eth1 as provider interface with local interface id as 22.22.22.22
(config-if)#exit	Exit interface mode
(config)#interface eth2	Enter interface mode.
(config-if)# mpls-tp provider-interface 33.33.33.33	Set the interface eth2 as provider interface with local interface id as 33.33.33.33
(config-if)#exit	Exit interface mode
(config)#mpls l2-circuit-fib-entry 1 555 666 tp-tunnel T1 eth1	Configure a FIB Entry for the PW1
(config)#mpls-tp tunnel 1 source 999 1.1.1.1 destination 888 3.3.3.3	Configure a FTN Entry for MPLS Tunnel
(config-tnl)# tunnel-name T1	Configure Tunnel Name
(config-tnl)# tunnel-mode bidirectional	Configure Tunnel Mode as Bidirectional
(config-bidir-tnl)# forward-path ilm-entry 1000 eth2 swap 1500 eth1	Configure Forward Path nhlfe entry
(config-bidir-tnl)# reverse-path ilm-entry 1500 eth1 swap 2000 eth2	Configure Reverse Path ilm pop entry

PE2

`#configure terminal`	Enter configure mode.
`(config)#mpls-tp global-id 888 node-id 3.3.3.3`	Configure MPLS-TP Global ID
`(config)#mpls ac-group grp1 2`	Configure MPLS-TP Access Group
`(config)#mpls l2-circuit VC1 1 999 1.1.1.1 123 grp1`	Configure a static VC with name VC1 .
`(config-pseudowire)#control-word`	Enable Control-word.
`(config-pseudowire)#manual-pseudowire`	Configure pseudowire manual (no signaling).
`(config-pseduowire)#exit`	Exit pseudowire mode.
`(config)#bridge 1 protocol ieee vlan-bridge`	Configure bridge protocol with bridge group as 1
`(config)#interface eth1`	Enter interface mode.
`(config-if)#switchport`	Configure switchport and switch to Layer2 mode
`(config-if)#bridge-group 1`	Enable the bridge group 1
`(config-if)#switchport mode access`	Configure switchport mode as access
`(config-if)# mpls-tp service-interface type layer-2 456`	Configure MPLS-TP service interface type
`(config-if)#mpls-l2-circuit VC1 ethernet`	Attach the PW1 to the interface eth1
`(config)#interface eth2`	Enter interface mode.
`(config-if)# mpls-tp provider-interface 44.44.44.44`	Set the interface eth2 as provider interface with local interface id as 11.11.11.11
`(config-if)#exit`	Exit interface mode
`(config)#mpls l2-circuit-fib-entry 1 666 555 tp-tunnel T1 eth`	Configure a FIB Entry for the PW1
`(config)#mpls-tp tunnel 1 source 999 1.1.1.1 destination 888 3.3.3.3`	Configure a FTN Entry for MPLS Tunnel
`(config-tnl)# tunnel-name T1`	Configure Tunnel Name
`(config-tnl)# tunnel-mode bidirectional`	Configure Tunnel Mode as Bidirectional
`(config-bidir-tnl)#fforward-path ilm-entry 1500 eth2 pop`	Configure Forward Path nhlfe entry
`(config-bidir-tnl)# reverse-path nhlfe-entry 1500 eth2`	Configure Reverse Path ilm pop entry

Validation

The command “show mpls l2-circuit” includes the PW status related information for Static PW.

```
#show mpls l2-circuit vc1
MPLS Layer-2 Virtual Circuit: test, id: 100 PW-INDEX: 1
Endpoint: 3.4.5.6
Control Word: 1
MPLS Layer-2 Virtual Circuit Group: none
Bound to interface: eth1
Virtual Circuit Type: Ethernet VLAN
```



```
Virtual Circuit is configured as Primary
Virtual Circuit is configured as Active
Virtual Circuit runtime mode is active
STATIC-PW-STATUS: Enabled,
  Local Refresh timer: 30 sec
  Local PW Status:
    Ingress AC Receive Fault
    Egress AC Transmit Fault
  Remote Refresh timer: 40 sec
  Remote PW Status:
    No faults detected
```

CHAPTER 13 PW Redundancy Configuration

This chapter contains configurations for Pseudowire Redundancy. It also provides an overview of Pseudowire concepts.

Overview

In a single-segment pseudowire (SS-PW) application, the PSN (packet switched network) layer usually provides protection for the PW. One way is by using an RSVP LSP with FRR (Fast Reroute) backup; another way is an end-to-end backup LSP (Label Switched Path). However, there are some applications where the backup PW terminates on a different target PE node, so PSN protection methods cannot protect against failure of either the target PE (provider edge) node or a remote Access Circuit (AC). It is also important to an operator that a particular PW is preferred, for example, the one with the least latency.

PW redundancy supports Label Distribution Protocol (LDP) PW and manual switchover between primary PW and secondary PW in MTU-s. In the case of PW applications, the PSN layer can provide the protection for PW. Occasionally, a TE (traffic-engineered) LSP signaled by RSVP-TE can be used as a PSN tunnel for a PW. In this scenario, TE can provide FRR to protect the end-to-end LSP in the PSN layer.

FRR-based protection schemes cannot protect against failure of PE nodes and access circuits. However, PW redundancy can protect against these failures. Multi-homed CE (customer edge) devices can be connect between two PE nodes through two access circuits to provide protection. In case of Hierarchical VPLS (HVPLS), the MTU-s can create spoke circuits at the PEs. Any one can be used to protect another.

Topology

The diagram depicts two multi-homed CE devices, CE1 and CE2, connected to two PE devices each, PE1 and PE3, and PE2 and PE4, respectively. In this scenario, multiple single-segment Ethernet pseudowires need to be signaled: PW1 between PE1 and PE2; PW2 between PE1 and PE4; PW3 between PE2 and PE3; and PW4 between PE3 and PE4.

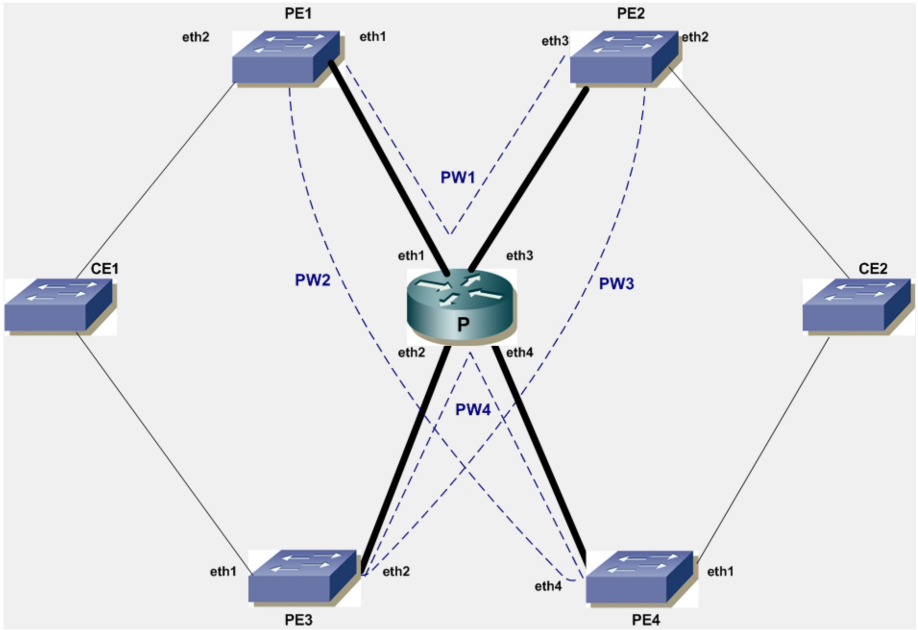


Figure 13-1: Dual-Homed CE Devices for Ethernet Pseudowires

PE1

`#configure terminal`	Enter configure mode.
`(config-if)#interface lo`	Identify the loopback interface to configure (`lo`).
`(config-if)#ip address 66.66.66.66/32`	Set the IP address of the loopback interface to `66.66.66.66/32`.
`(config-if)#exit`	Exit interface mode
`(config)#interface eth1`	Enter interface mode.
`(config-if)#label-switching`	Enable label switching on the interface.
`(config-if)#ip address 11.0.0.66/24`	Set the IP address of the interface to `11.0.0.66/24`.
`(config-if)#exit`	Exit interface mode.
`(config)#router ospf`	Enter the `Router OSPF` mode.
`(config-router)#network 11.0.0.0/24 area 0` `(config-router)#network 66.66.66.66/32 area 0`	Define the Network on which OSPF runs and associate the area ID (`area 0`) with the interface.
`(config-router)#exit`	Exit `Router` mode and return to `Configure` mode.
`(config)#router ldp`	Enter the `Router` mode for LDP.
`(config-router)#transport-address ipv4 66.66.66.66`	Configure loopback address as LDP transport address.
`(config-router)#pw-status-tlv`	Enable the PW Status TLV (`pw-status-tlv`).
`(config-router)#targeted-peer-ipv4 68.68.68.68`	Configure LDP targeted peer to PE2.
`(config-router)#targeted-peer-ipv4 69.69.69.69`	Configure LDP targeted peer to PE4.
`(config-router)#exit`	Exit `Router` mode and return to `Configure` mode.

`(config)#interface eth1`	Enter interface mode.
`(config-if)#enable-ldp ipv4`	Enable IPv4 LDP on the interface.
`(config-if)#exit`	Exit interface mode.
`(config)#mpls l2-circuit vc1 10 68.68.68.68`	Configure a Virtual Circuit for PE1. In this example, `vc1` is the VC name, `10` is the VC ID, and `68.68.68.68` is the endpoint IP address.
`(config-pseduowire)#exit`	Exit pseudowire mode.
`(config)#mpls l2-circuit vc2 20 69.69.69.69`	Configure another Virtual Circuit for PE1. In this example, `vc2` is the VC name, `20` is the VC ID, and `69.69.69.69` is the endpoint IP address.
`(config-pseduowire)#exit`	Exit pseudowire mode.
`(config-if)#interface eth2`	Enter interface mode.
`(config-if)#switchport`	Switch to Layer 2 mode.
`(config-if)#mpls-l2-circuit vc1 ethernet`	Bind VC1 as an Ethernet circuit.
`(config-if)#mpls-l2-circuit vc2 ethernet`	Bind VC2 as an Ethernet circuit.
`(config-if)#exit`	Exit interface mode.

PE2

`#configure terminal`	Enter configure mode.
`(config-if)#interface lo`	Identify the loopback interface to configure `(lo)`.
`(config-if)#ip address 68.68.68.68/24`	Set the IP address of the loopback interface to `68.68.68.68/24`.
`(config-if)#exit`	Exit interface mode.
`(config)#interface eth3`	Enter interface mode.
`(config-if)#label switching`	Enable label switching on the interface.
`(config-if)#ip address 33.0.0.68/24`	Set the IP address of the interface to `33.0.0.68/24`.
`(config-if)#exit`	Exit interface mode.
`(config)#router ospf`	Enter the `Router` mode for OSPF.
`(config-router)#network 68.68.68.68/32 area 0` `(config-router)#network 33.0.0.0/24 area 0`	Define the Network on which OSPF runs and associate the area ID (`area 0`) with the interface.
`(config-router)#exit`	Exit `Router` mode and return to `Configure` mode.
`(config)#router ldp`	Enter the `Router` mode for LDP.
`(config-router)#transport-address ipv4 68.68.68.68`	Configure loopback address as LDP transport address.
`(config-router)#pw-status-tlv`	Enable the PW Status TLV (`pw-status-tlv`).
`(config-router)#targeted-peer-ipv4 66.66.66.66`	Configure LDP targeted peer to PE1.
`(config-router)#targeted-peer-ipv4 67.67.67.67`	Configure LDP targeted peer to PE3.
`(config-router)#exit`	Exit `Router` mode and return to `Configure` mode.

(config)#interface eth3	Enter interface mode.
(config-if)#enable-ldp ipv4	Enable IPv4 LDP on the interface.
(config-if)#exit	Exit interface mode.
(config)#mpls l2-circuit vc1 10 66.66.66.66	Configure a Virtual Circuit for PE2. In this example, vc1 is the VC name, 10 is the VC ID, and 66.66.66.66 is the endpoint IP address.
(config-pseduowire)#exit	Exit pseudowire mode.
(config)#mpls l2-circuit vc2 20 67.67.67.67	Configure another Virtual Circuit for PE2. In this example, vc2 is the VC name, 20 is the VC ID, and 67.67.67.67 is the endpoint IP address.
(config-pseduowire)#exit	Exit pseudowire mode.
(config-if)#interface eth2	Enter interface mode.
(config-if)#switchport	Switch to Layer 2 mode.
(config-if)#mpls-l2-circuit vc1 ethernet	Bind VC1 as an Ethernet circuit.
(config-if)#mpls-l2-circuit vc2 ethernet	Bind VC2 as an Ethernet circuit.
(config-if)#exit	Exit interface mode.

PE3

#configure terminal	Enter configure mode.
(config-if)#interface lo	Identify the loopback interface to configure (lo).
(config-if)#ip address 67.67.67.67/32	Set the IP address of the loopback interface to 67.67.67.67/32.
(config-if)#exit	Exit interface mode.
(config)#interface eth2	Enter interface mode.
(config-if)#label-switching	Enable label switching on the interface.
(config-if)#ip address 22.0.0.67/24	Set the IP address of the interface to 22.0.0.67/24.
(config-if)#exit	Exit interface mode.
(config)#router ospf	Enter the Router mode for OSPF.
(config-router)#network 67.67.67.67/32 area 0 (config-router)#network 22.0.0.0/24 area 0	Define the Network on which OSPF runs and associate the area ID (area 0) with the interface.
(config-router)#exit	Exit Router mode and return to Configure mode.
(config)#router ldp	Enter the Router mode for LDP.
(config-router)#transport-address ipv4 67.67.67.67	Configure loopback address as LDP transport address.
(config-router)#pw-status-tlv	Enable the PW Status TLV (pw-status-tlv).
(config-router)#targeted-peer-ipv4 68.68.68.68	Configure LDP targeted peer for PE2.
(config-router)#targeted-peer-ipv4 69.69.69.69	Configure LDP targeted peer for PE4.
(config-router)#exit	Exit Router mode and return to Configure mode.

(config)#interface eth2	Enter interface mode.
(config-if)#enable-ldp ipv4	Enable IPv4 LDP on the interface.
(config-if)#exit	Exit interface mode.
(config)#mpls l2-circuit vc3 30 68.68.68.68	Configure a Virtual Circuit for PE3. In this example, vc3 is the VC name, 30 is the VC ID, and 68.68.68.68 is the endpoint IP address.
(config-pseduowire)#exit	Exit pseudowire mode.
(config)#mpls l2-circuit vc4 40 69.69.69.69	Configure another Virtual Circuit for PE3. In this example, vc4 is the VC name, 40 is the VC ID, and 69.69.69.69 is the endpoint IP address.
(config-pseduowire)#exit	Exit pseudowire mode.
(config-if)#interface eth1	Enter interface mode.
(config-if)#switchport	Switch to Layer 2 mode.
(config-if)#mpls-l2-circuit vc1 ethernet	Bind VC3 as an Ethernet circuit.
(config-if)#mpls-l2-circuit vc2 ethernet	Bind VC4 as an Ethernet circuit.
(config-if)#vc-mode standby	Configure VC mode as standby.
(config-if)#exit	Exit interface mode.

PE4

#configure terminal	Enter configure mode.
(config-if)#interface lo	Identify the loopback interface to configure (lo).
(config-if)#ip address 69.69.69.69/32	Set the IP address of the loopback interface to 69.69.69.69/32.
(config-if)#exit	Exit interface mode.
(config)#interface eth4	Enter interface mode.
(config-if)#label-switching	Enable label switching on the interface.
(config-if)#ip address 44.0.0.69/24	Set the IP address of the interface to 44.0.0.69/24.
(config-if)#exit	Exit interface mode.
(config)#router ospf	Enter the Router mode for OSPF.
(config-router)#network 69.69.69.69/32 area 0 (config-router)#network 44.0.0.0/24 area 0	Define the Network on which OSPF runs and associate the area ID (area 0) with the interface.
(config-router)#exit	Exit Router mode and return to Configure mode.
(config)#router ldp	Enter the Router mode for LDP.
(config-router)#transport-address ipv4 69.69.69.69	Configure LDP loopback address as transport address.
(config-router)#pw-status-tlv	Enable the Pseudowire Status TLV (pw-status-tlv).
(config-router)#targeted-peer-ipv4 68.68.68.68	Configure LDP targeted peer to PE1.
(config-router)#targeted-peer-ipv4 69.69.69.69	Configure LDP targeted peer to PE3.

(config-router)#exit	Exit the Router mode and return to Configure mode.
(config)#interface eth4	Enter interface mode.
(config-if)#enable-ldp ipv4	Enable IPv4 LDP on the interface.
(config-if)#exit	Exit interface mode.
(config)#mpls l2-circuit vc2 20 66.66.66.66	Configure a Virtual Circuit for PE1. In this example, vc2 is the VC name, 20 is the VC ID, and 66.66.66.66 is the endpoint IP address.
(config-pseduowire)#exit	Exit pseudowire mode.
(config)#mpls l2-circuit vc4 40 67.67.67.67	Configure another Virtual Circuit for PE3. In this example, vc4 is the VC name, 40 is the VC ID, and 66.66.66.66 is the endpoint IP address.
(config-pseduowire)#exit	Exit pseudowire mode.
(config-if)#interface eth1	Enter interface mode.
(config-if)#switchport	Switch to Layer 2 mode.
(config-if)#mpls-l2-circuit vc2 ethernet	Bind VC2 as an Ethernet circuit.
(config-if)#mpls-l2-circuit vc3 ethernet	Bind VC4 as an Ethernet circuit.
(config-if)#vc-mode standby	Configure VC mode as standby.
(config-if)#exit	Exit interface mode.

P

#configure terminal	Enter configure mode.
(config-if)#interface lo	Identify the loopback interface to configure (lo).
(config-if)#ip address 71.71.71.71	Set the IP address of the loopback interface to 71.71.71.71.
(config-if)#exit	Exit interface mode.
(config)#router ldp	Enter the Router mode for LDP.
(config-router)#transport-address ipv4 71.71.71.71	Configure loopback address as LDP transport address.
(config-router)#pw-status-tlv	Enable the PW Status TLV (pw-status-tlv).
(config-router)#exit	Exit Router mode and return to Configure more.
(config)#interface eth1	Enter interface mode.
(config-if)#ip address 11.0.0.71/24	Set the IP address of eth0 to 11.0.0.71/24.
(config-if)#exit	Exit interface mode.
(config)#interface eth2	Enter interface mode.
(config-if)#label-switching	Enable label switching on interface eth1.
(config-if) ip address 22.0.0.71/24	Set the IP address of the interface to 22.0.0.71/24.
(config-if)#enable-ldp ipv4	Enable IPv4 LDP on the interface.
(config-if)#exit	Exit interface mode.
(config)#interface eth3	Enter interface mode.
(config-if)#label-switching	Enable label switching on the interface.

(config-if)#ip address 33.0.0.71/24	Set the IP address for the interface to 33.0.0.71/24.
(config-if)#enable-ldp ipv4	Enable IPv4 LDP on the interface.
(config-if)#exit	Exit interface mode.
(config)#interface eth4	Enter interface mode.
(config-if)#label-switching	Enable label switching on the interface.
(config-if)#ip address 44.0.0.71/24	Set the IP address for the interface to 44.0.0.71/24.
(config-if) enable-ldp ipv4	Enable IPv4 LDP on the interface.
(config-if)#exit	Exit interface mode.
(config)#router ospf	Enter the Router mode for OSPF.
(config-router)#network 11.0.0.0/24 area 0 (config-router)#network 22.0.0.0/24 area 0 (config-router)#network 33.0.0.0/24 area 0 (config-router)#network 44.0.0.0/24 area 0 (config-router)#network 71.71.71.71/32 area 0	Configure the Network associations for router P and associate them all with area 0.
(config-router)#exit	Exit Router mode and return to Configure mode.

Validation

To see summary information about the Virtual Circuits, use the following command:

```
#show mpls vc-table
```

The samples below show summary information about the just-configured four virtual circuits.

```
QA66#show mpls vc-table
VC-ID Vlan-ID  Access-Intf  Network-Intf Out Label Tunnel-Label Nexthop      Status
10    N/A      eth2         eth1         52488     52482        68.68.68.68  Active
20    N/A      eth2         eth1         52480     52484        69.69.69.69  Standby

QA67#show mpls vc-table
VC-ID Vlan-ID  Access-Intf  Network-Intf Out Label Tunnel-Label Nexthop      Status
30    N/A      eth1         eth2         52488     52485        68.68.68.68  Standby
40    N/A      eth1         eth2         52487     52481        69.69.69.69  Standby
```

To view detailed configuration information about the L2 Virtual Circuits, including LDP PW status, use the following command:

```
#show lpd mpls-l2-circuit detail
```

An example of the output of this command follows:

```
QA66#show ldp mpls-l2-circuit detail
vcid: 10, type: ethernet, local groupid: 4, remote groupid: 4 (vc is up)
destination: 68.68.68.68, Peer LDP Ident: 68.68.68.68
Local label: 52480, remote label: 52488
Access IF: eth2, Network IF: eth1
Local MTU: 1500, Remote MTU: 1500
Local Control Word: disabled, Remote Control Word: disabled, Current use: disabled
Local PW Status Capability : enabled
Remote PW Status Capability : enabled
Current PW Status TLV : enabled
```

```
Local PW Status :
  Forwarding
  Active
Remote PW Status :
  Forwarding
  Active

vcid: 20, type: ethernet, local groupid: 4, remote groupid: 3 (vc is up)
destination: 69.69.69.69, Peer LDP Ident: 69.69.69.69
Local label: 52481, remote label: 52480
Access IF: eth2, Network IF: eth1
Local MTU: 1500, Remote MTU: 1500
Local Control Word: disabled, Remote Control Word: disabled, Current use: disabled
Local PW Status Capability : enabled
Remote PW Status Capability : enabled
Current PW Status TLV : enabled
Local PW Status :
  Not Forwarding
  Active
Remote PW Status :
  Not Forwarding
  Standby
```

Virtual Circuit PW Configuration

To view configuration information about the L2 Virtual Circuits, use the following command:

```
#show mpls l2-circuit
```

An sample of the output of this command follows:

```
MPLS Layer-2 Virtual Circuit: vc1, id: 10
 Endpoint: 68.68.68.68
 Control Word: 0
 MPLS Layer-2 Virtual Circuit Group: none
 Bound to interface: eth2
 Virtual Circuit Type: Ethernet
 Virtual Circuit is configured as Primary
 Virtual Circuit is configured as Active
 Virtual Circuit runtime mode is Active

MPLS Layer-2 Virtual Circuit: vc2, id: 20
 Endpoint: 69.69.69.69
 Control Word: 0
 MPLS Layer-2 Virtual Circuit Group: none
 Bound to interface: eth2
 Virtual Circuit Type: Ethernet
 Virtual Circuit is configured as Primary
 Virtual Circuit is configured as Active
 Virtual Circuit runtime mode is Active
```


MTU-s with Redundant Spoke Circuits

In this scenario, MTU-s has redundant spoke circuits PW1 and PW2 connected to PE1 and PE2, respectively. User should configure MTU-s so that one PW is Primary and the other as Secondary. With P1 designated as Primary and PW2 designated as Secondary, MTU-s announces that PW1 is in the Active mode and PW2 is in the Standby mode. If PW1 fails, MTU-s performs a switchover by announcing PW2 as Active and PW1 as Standby.

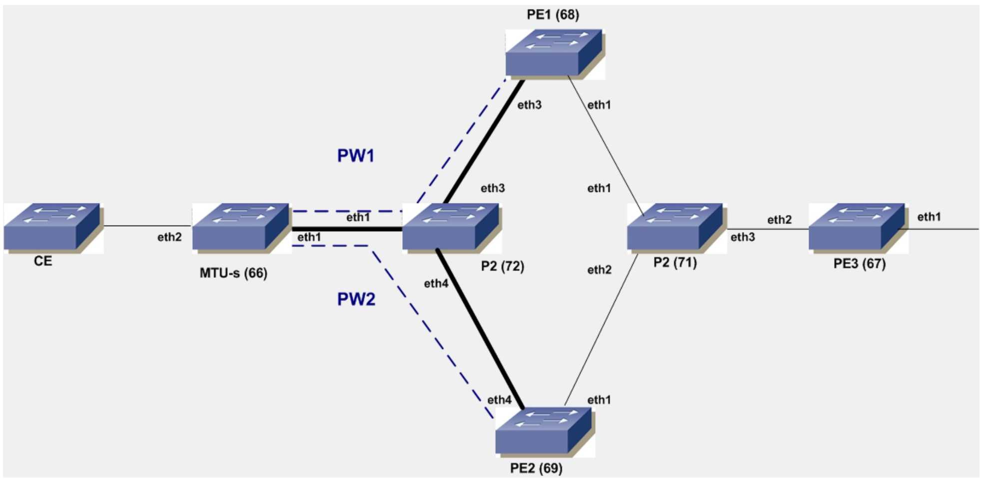


Figure 13-2: MTUs with Redundant Spoke Circuits

MTU-s

`#configure terminal`	Enter configure mode.
`(config-if)#lo`	Identify the loopback interface to configure (`lo`).
`(config-if)#ip address 66.66.66.66/32`	Set the IP address of the loopback interface to `66.96.66.66/32`.
`(config-if)#exit`	Exit interface mode.
`(config)#interface eth1`	Enter interface mode.
`(config-if)#label-switching`	Enable label switching on the interface.
`(config-if)#ip address 11.0.0.66/24`	Set the IP address of the interface to `11.1.1.66./24.`
`(config-if)#exit`	Exit interface mode.
`(config)#router ospf`	Enter the `Router` mode for OSPF.
`(config-router)#network 66.66.66.66/32 area 0` `(config-router)#network 11.0.0.66/24 area 0`	Define the Network on which OSPF runs and associate the area ID (`area 0)` with the interface.
`(config-router)#exit`	Exit `Router` mode and return to `Configure` mode.
`(config)#router ldp`	Enter the `Router` mode for LDP.
`(config-router)#transport-address ipv4 66.66.66.66`	Configure loopback address as LDP transport address.
`(config-router)#pw-status-tlv`	Enable the PW Status TLV `(pw-status-tlv)`.
`(config-router)#targeted-peer-ipv4 68.68.68.68`	Configure LDP targeted peer to PE1.

(config-router)#targeted-peer-ipv4 69.69.69.69	Configure LDP targeted peer to PE2.
(config-router)#exit	Exit Router mode and return to Configure mode.
(config)#interface eth1	Enter interface mode.
(config-if)#enable-ldp ipv4	Enable IPv4 LDP on the interface.
(config-if)#exit	Exit interface mode.
(config)#mpls l2-circuit vc1 10 68.68.68.68	Configure a Virtual Circuit to PE1. In this example, vc1 is the VC name, 10 is the VC ID, and 68.68.68.68 is the endpoint IP address.
(config-pseduowire)#exit	Exit pseudowire mode.
(config)#mpls l2-circuit vc2 20 69.69.69.69	Configure another Virtual Circuit to PE1. In this example, vc2 is the VC name, 20 is the VC ID, and 69.69.69.69 is the endpoint IP address.
(config-pseduowire)#exit	Exit pseudowire mode.
(config-if)#interface eth2	Enter interface mode.
(config-if)#switchport	Switch to Layer 2 mode.
(config-if)#mpls-l2-circuit vc1 ethernet	Bind VC1 as an Ethernet circuit.
(config-if)#mpls-l2-circuit vc2 ethernet secondary	Bind VC2 as secondary.
(config-if)#exit	Exit interface mode.

P1

#configure terminal	Enter configure mode.
(config-if)#interface lo	Identify the loopback interface to configure (lo).
(config-if)#ip address 71.71.71.71	Set the IP address of the loopback interface to 71.71.71.71.
(config-if)#exit	Exit interface mode.
(config)#router ldp	Enter the Router mode for LDP.
(config-router)#transport-address ipv4 71.71.71.71	Configure loopback address as LDP transport address.
(config-router)#pw-status-tlv	Enable the PW Status TLV (pw-status-tlv).
(config-router)#exit	Exit Router mode and return to Configure mode.
(config)#interface eth1	Enter interface mode.
(config-if)#label-switching	Enable label switching on the interface.
(config-if)#ip address 11.0.0.71/24	Set the IP address of eth1 to 11.0.0.71/24.
(config-if)#enable-ldp ipv4	Enable IPv4 LDP on the interface.
(config-if)#exit	Exit interface mode.
(config)#interface eth3	Enter interface mode.
(config-if)#label-switching	Enable label switching on the interface.
(config-if)#ip address 33.0.0.71/24	Set the IP address for eth3 to 33.0.0.71/24.
(config-if)#enable-ldp ipv4	Enable IPv4 LDP on the interface.
(config-if)#exit	Exit interface mode.

(config)#interface eth4	Enter interface mode.
(config-if)#label-switching	Enable label switching on the interface.
(config-if)#ip address 44.0.0.71/24	Set the IP address for the interface to 44.0.0.71/24.
(config-if)#enable-ldp ipv4	Enable IPv4 LDP on the interface.
(config-if)#exit	Exit interface mode.
(config)#router ospf	Enter the Router mode for OSPF.
(config-router)#network 71.71.71.71/32 area 0 (config-router)#network 11.0.0.71/24 area 0 (config-router)#network 33.0.0.71/24 area 0 (config-router)#network 44.0.0.71/24 area 0	Configure the Network associations for router P1 and associate them all to area0.
(config-router)#exit	Exit Router mode and return to Configure mode.

Configure PE1

#configure terminal	Enter configure mode.
(config-if)#interface lo	Identify the loopback interface to configure (lo).
(config-if)#ip address 68.68.68.68/32	Set the IP address of the loopback interface to 68.68.68.68/32.
(config-if)#exit	Exit interface mode.
(config)#interface eth3	Enter interface mode.
(config-if)#label-switching	Enable label switching on the interface.
(config-if)#ip address 33.0.0.68/24	Set the IP address of the interface to 33.0.0.68/24.
(config-if)#exit	Exit interface mode.
(config)#interface eth1	Enter interface mode.
(config-if)#label-switching	Enable label switching on the interface.
(config-if)#ip address 22.0.0.68/24	Set the IP address of the interface to 22.0.0.68/24.
(config-if)#exit	Exit interface mode.
(config)#router ospf	Enter the Router mode for OSPF.
(config-router)#network 68.68.68.68/32 area 0 (config-router)#network 33.0.0.0/24 area 0 (config-router)#network 22.0.0.0/24 area 0	Define the Network on which OSPF runs and associate the area ID (area 0) with the interfaces.
(config-router)#exit	Exit Router mode and return to Configure mode.
(config)#router ldp	Enter the Router mode for LDP.
(config-router)#transport-address ipv4 68.68.68.68	Configure loopback address as LDP transport address.
(config-router)#pw-status-tlv	Enable the PW Status TLV (pw-status-tlv).
(config-router)#targeted-peer-ipv4 66.66.66.66	Configure LDP targeted peer to MTU-s.
(config-router)#targeted-peer-ipv4 67.67.67.67	Configure LDP targeted peer to PE3.
(config-router)#exit	Exit Router mode and return to Configure mode.

(config)#interface eth3	Enter interface mode.
(config-if)#enable-ldp ipv4	Enable IPv4 LDP on the interface.
(config-if)#exit	Exit interface mode.
(config)#interface eth1	Enter interface mode.
(config-if)#enable-ldp ipv4	Enable IPv4 LDP on the interface.
(config-if)#exit	Exit interface mode.
(config)#mpls l2-circuit vc1 10 66.66.66.66	Configure a Virtual Circuit to MTU-s. In this example, vc1 is the VC name, 10 is the VC ID, and 66.66.66.66 is the endpoint IP address.
(config-pseduowire)#exit	Exit pseudowire mode.
(config)#mpls vpls vp1 15	Enter VPLS mode and configure VPLS vp1 with VPLS ID 15.
(config-vpls)#signaling ldp	Enter VPLS signaling LDP mode.
(config-vpls-sig)#vpls-peer 67.67.67.67	Configure a VPLS mesh peer to PE3.
(config-vpls-sig)#exit	Exit signaling LDP mode.
(config-vpls)#vpls-vc vc1	Configure vc1 as a VPLS spoke peer.
(config-vpls)#exit	Exit interface mode.

Configure PE2

#configure terminal	Enter configure mode.
(config-if)#interface lo	Identify the loopback interface to configure (lo).
(config-if)#ip address 69.69.69.69/32	Set the IP address of the loopback interface to 69.69.69.69/32.
(config-if)#exit	Exit interface mode.
(config)#interface eth4	Enter interface mode.
(config-if)#label-switching	Enable label switching on the interface.
(config-if)#ip address 44.0.0.69/24	Set the IP address of the interface to 44.0.0.69/24.
(config-if)#exit	Exit interface mode.
(config)#interface eth1	Enter interface mode.
(config-if)#label-switching	Enable label switching on the interface.
(config-if)#ip address 23.0.0.69/24	Set the IP address of the interface to 23.0.0.69/24.
(config-if)#exit	Exit interface mode.
(config)#router ospf	Enter the Router mode for OSPF.
(config-router)#network 69.69.69.69/32 area 0 (config-router)#network 44.0.0.0/24 area 0 (config-router)#network 23.0.0.0/24 area 0	Define the Network on which OSPF runs and associate the area ID (area 0) with the interfaces.
(config-router)#exit	Exit Router mode and return to Configure mode.
(config)#router ldp	Enter the Router mode for LDP.
(config)#transport-address ipv4 69.69.69.69	Configure LDP transport address as loopback address.
(config-router)#pw-status-tlv	Enable the PW Status TLV (pw-status-tlv).

(config-router)#targeted-peer-ipv4 66.66.66.66	Configure LDP targeted peer to MTU-s.
(config-router)#targeted-peer-ipv4 67.67.67.67	Configure LDP targeted peer to PE3.
(config-router)#exit	Exit the Router mode and return to Configure mode.
(config)#interface eth4	Enter interface mode.
(config-if)#enable-ldp ipv4	Enable IPv4 LDP on the interface.
(config-if)#exit	Exit interface mode.
(config)#interface eth1	Enter interface mode.
(config-if)#enable-ldp ipv4	Enable IPv4 LDP on the interface.
(config-if)#exit	Exit interface mode.
(config)#mpls l2-circuit vc2 20 66.66.66.66	Configure a Virtual Circuit to MTU-s. In this example, vc2 is the VC name, 20 is the VC ID, and 66.66.66.66 is the endpoint IP address.
(config-pseduowire)#exit	Exit pseudowire mode.
(config)#mpls vpls vp1 15	Configure a VPLS vp1 with VPLS ID 15.
(config-vpls)#signaling ldp	Enter VPLS signaling LDP mode.
(config-vpls-sig)#vpls-peer 67.67.67.67	Configure a VPLS mesh peer to PE3.
(config-vpls-sig)#exit	Exit signaling LDP mode.
(config-vpls)#vpls-vc vc2	Configure vc2 as a VPLS spoke peer.
(config-vpls)#exit	Exit VPLS mode and return to Configure mode.

Configure P2

#configure terminal	Enter configure mode.
(config-if)#interface lo	Identify the loopback interface to configure (lo).
(config-if)#ip address 72.72.72.72	Set the IP address of the loopback interface to 72.72.72.72.
(config-if)#exit	Exit interface mode.
(config)#router ldp	Enter the Router mode for LDP.
(config-router)#transport-address ipv4 72.72.72.72	Configure loopback address as LDP transport address.
(config-router)#pw-status-tlv	Enable the PW Status TLV (pw-status-tlv).
(config-if)#exit	Exit interface mode.
(config)#interface eth1	Enter interface mode.
(config-if)#label-switching	Enable label switching on the interface.
(config-if) ip address 22.0.0.72/24	Set the IP address of the interface to 22.0.0.72/24.
(config-if)#enable-ldp ipv4	Enable IPv4 LDP on the interface.
(config-if)#exit	Exit interface mode.
(config)#interface eth2	Enter interface mode.

(config-if)#label-switching	Enable label switching on the interface.
(config-if)#ip address 23.0.0.72/24	Set the IP address for the interface to 23.0.0.72/24.
(config-if)#enable-ldp ipv4	Enable IPv4 LDP on the interface.
(config-if)#exit	Exit interface mode.
(config)#interface eth3	Enter interface mode.
(config-if)#label-switching	Enable label switching on the interface.
(config-if)#ip address 24.0.0.72/24	Set the IP address of the interface to 24.0.0.72/24.
(config-if) enable-ldp ipv4	Enable IPv4 LDP on the interface.
(config-if)#exit	Exit interface mode.
(config)#router ospf	Enter the Router mode for OSPF.
(config-router)#network 72.72.72.72/32 area 0 (config-router)#network 22.0.0.0/24 area 0 (config-router)#network 23.0.0.0/24 area 0 (config-router)#network 24.0.0.0/24 area 0	Configure the Network associations for router P2 and associate them all with area 0.
(config-router)#exit	Exit Router mode and return to Configure mode.

Configure PE3

#configure terminal	Enter configure mode.
(config-if)#interface lo	Identify the loopback interface to configure (lo).
(config-if)#ip address 67.67.67.67/32	Set the IP address of the loopback interface to 67.67.67.67/32.
(config-if)#exit	Exit interface mode.
(config)#interface eth2	Enter interface mode.
(config-if)#label-switching	Enable label switching on the interface.
(config-if)#ip address 24.0.0.67/24	Set the IP address of the interface to 24.0.0.67/24.
(config-if)#exit	Exit interface mode.
(config)#router ospf	Enter the Router mode for OSPF.
(config-router)#network 67.67.67.67/32 area 0 (config-router)#network 24.0.0.0/24 area 0	Define the Network on which OSPF runs and associate the area ID (area 0) with the interface.
(config-router)#exit	Exit Router mode and return to Configure mode.
(config)#router ldp	Enter the Router mode for LDP.
(config-router)#transport-address ipv4 67.67.67.67	Configure loopback address as LDP transport address.
(config-router)#pw-status-tlv	Enable the Pseudowire Status TLV (pw-status-tlv).
(config-router)#targeted-peer-ipv4 68.68.68.68	Configure LDP targeted peer to PE1.
(config-router)#targeted-peer-ipv4 69.69.69.69	Configure LDP targeted peer to PE2.
(config-router)#exit	Exit Router mode and return to Configure mode.
(config)#interface eth2	Enter interface mode.

(config-if)#enable-ldp ipv4	Enable IPv4 LDP on the interface.
(config-if)#exit	Exit interface mode.
(config)#mpls vpls vp1 15	Configure VPLS vp1 with VPLS ID 15.
(config-vpls)#signaling ldp	Enter VPLS signaling LDP mode.
(config-vpls-sig)#vpls-peer 68.68.68.68	Configure VPLS mesh peer to PE1.
(config-vpls-sig)#vpls-peer 69.69.69.69	Configure VPLS mesh peer to PE2.
(config-vpls-sig)#exit	Exit signaling LDP mode.
(config-vpls)#exit	Exit VPLS mode and return to Configure mode.
(config)#interface eth1	Enter interface mode.
(config-if)#switchport	Switch to Layer 2 mode.
(config-if)#mpls-vpls vp1	Bind VPLS vp1 to interface.
(config-if)#exit	Exit interface mode.

Validation

```
QA66#show mpls vc-table
VC-ID  Vlan-ID  Access-Intf Network-Intf Out Label Tunnel-Label Nexthop     Status
10     N/A      eth2        eth1          52488     52482        68.68.68.68 Active
20     N/A      eth2        eth1          52480     52484        69.69.69.69 Standby
```

Note: The first VC is designated as primary and the second as secondary.

```
QA66#show mpls l2-circuit
MPLS Layer-2 Virtual Circuit: vc1, id: 10
 Endpoint: 68.68.68.68
 Control Word: 0
 MPLS Layer-2 Virtual Circuit Group: none
 Bound to interface: eth2
 Virtual Circuit Type: Ethernet
 Virtual Circuit is configured as Primary
 Virtual Circuit is configured as Non-Revertive
 Virtual Circuit runtime mode is active

MPLS Layer-2 Virtual Circuit: vc2, id: 20
 Endpoint: 69.69.69.69
 Control Word: 0
 MPLS Layer-2 Virtual Circuit Group: none
 Bound to interface: eth2
 Virtual Circuit Type: Ethernet
 Virtual Circuit is configured as Secondary
 Virtual Circuit is configured as Non-Revertive
 Virtual Circuit runtime mode is standby
```

The following command displays the Layer 2 Virtual Circuits for MTU-s with the Local and Remote VC Labels:

```
QA66#show ldp mpls-l2-circuit
Transport Client     VC     VC            Local       Remote      Destination
VC ID     Binding    State  Type          VC Label    VC Label    Address
10        eth2       UP     Ethernet      52480       52488       68.68.68.68
20        eth2       UP     Ethernet      52481       52480       69.69.69.69
```

The example below is sample output from this command for the configuration just completed:

```
QA67#show mpls vpls mesh
VPLS-ID     Peer Addr         In-Intf     In-Label    Out-Intf    Out-Label   Lkps/St  PW-INDEX
SIG-Protocol Status  Ecmp-Group
15          68.68.68.68       eth2        52480       eth2        52480       2/Up1            BGP
Active    N/A
15          69.69.69.69       eth2        52488       eth2        52488       2/Up2            BGP
Active    N/A
```

Multi-Homed CE with PW Redundancy for VLAN PW

In the following topology diagram, VLAN pseudowires PW1, PW2, PW3 and PW4 are configured for VLAN-100 between PE1-PE3, PE1-PE4, PE2-PE3 and PE2-PE4 respectively. The VC-mode is configured as standby on the access interfaces of PE2 and PE4 so that PW1 is active and used for forwarding. All the other PWs will be in standby mode.

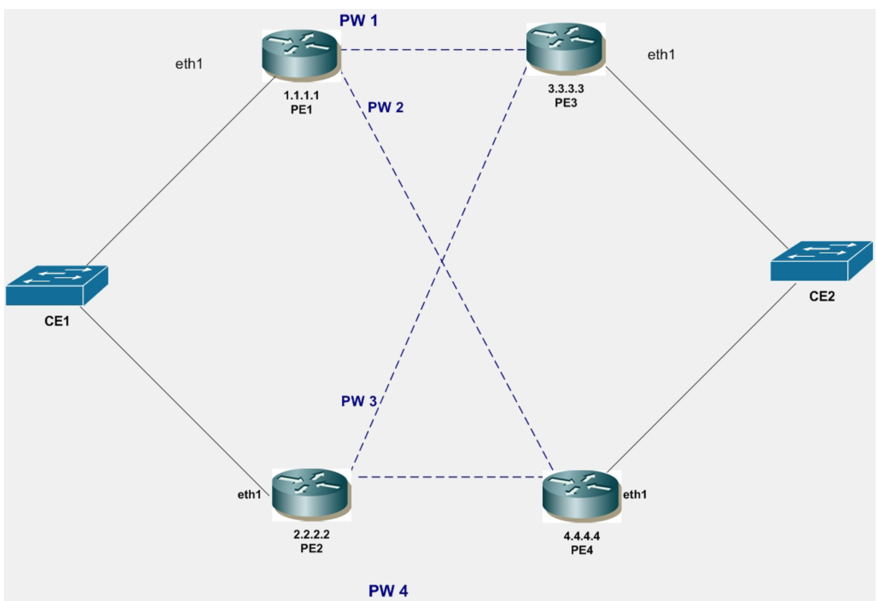


Figure 13-3: Multi-Homed CE with PW Redundancy for VLAN PW

PE1

`#configure terminal`	Enter `Configure` mode for the router.
`(config)#router ldp`	Enter `Router LDP` mode.
`(config-router)#pw-status-tlv`	Configure PW status TLV for PW status signaling.
`(config-router)#targeted-peer ipv4 3.3.3.3`	Configure targeted LDP session to PE3 loopback address.
`(config-router)#targeted-peer ipv4 4.4.4.4`	Configure targeted LDP session to PE4 loopback address.
`(config-router)#exit`	Exit the `Router LDP` mode and return to `Configure` mode.
`(config)#mpls l2-circuit pw1 10 3.3.3.3`	Configure pseudowire PW1 between PE1 and PE3.
`(config-pseduowire)#exit`	Exit pseudowire mode.
`(config)#mpls l2-circuit pw2 20 4.4.4.4`	Configure pseudowire PW2 between PE1 and PE4.

`(config-pseduowire)#exit`	Exit pseudowire mode.
`(config)#bridge 1 protocol ieee vlan-bridge`	Specify the VLAN for bridge 1.
`(config)#vlan database`	Enter the `VLAN Database` mode.
`(config-vlan)#vlan 100 bridge 1`	Configure VLAN 100.
`(config-vlan)#exit`	Exit the `VLAN Database` mode and return to `Configure` mode.
`(config)#interface eth1`	Enter interface mode.
`(config-if)#switchport`	Switch to Layer-2 mode.
`(config-if)#switchport mode access`	Set the switching characteristics of this interface to access mode.
`(config-if)#mpls-l2-circuit pw1 vlan 100`	Bind the pseudowire PW1 to access interface.
`(config-if)#mpls-l2-circuit pw2 vlan 100`	Bind the pseudowire PW2 to access interface.
`(config-if)#exit`	Exit interface mode.
`(config)#exit`	Exit the `Configure` mode.

PE2

`#configure terminal`	Enter configure mode.
`(config)#router ldp`	Enter the `Router LDP` mode.
`(config-router)#pw-status-tlv`	Configure PW status TLV for PW status signaling.
`(config-router)#targeted-peer ipv4 3.3.3.3`	Configure targeted LDP session to PE3 loopback address.
`(config-router)#targeted-peer ipv4 4.4.4.4`	Configure targeted LDP session to PE4 loopback address.
`(config-router)#exit`	Exit the `Router LDP` mode and return to `Configure` mode.
`(config)#mpls l2-circuit pw3 30 3.3.3.3`	Configure pseudowire PW3 between PE2 and PE3.
`(config-pseduowire)#exit`	Exit pseudowire mode.
`(config)#mpls l2-circuit pw4 40 4.4.4.4`	Configure pseudowire PW4 between PE2 and PE4.
`(config-pseduowire)#exit`	Exit pseudowire mode.
`(config)#bridge 1 protocol ieee vlan-bridge`	Specify the VLAN for bridge 1.
`(config)#vlan database`	Enter the `VLAN Database` mode.
`(config-vlan)#vlan 100 bridge 1`	Configure VLAN 100.
`(config-vlan)#exit`	Exit the `VLAN Database` mode and return to `Configure` mode.
`(config)#interface eth1`	Enter interface mode.
`(config-if)#switchport`	Switch to Layer-2 mode.
`(config-if)#switchport mode access`	Set the switching characteristics of this Interface to Access mode.
`(config-if)#mpls-l2-circuit pw3 vlan 100`	Bind the pseudowire PW3 to access interface.
`(config-if)#mpls-l2-circuit pw4 vlan 100`	Bind the pseudowire PW4 to access interface.
`(config-if)#vc-mode standby vlan 100`	Configure VC-mode as standby for VLAN 100. Note: The command for Ethernet PWs is `vc-mode standby`.

(config-if)#exit	Exit interface mode.
(config)#exit	Exit the Configure mode.

PE3

#configure terminal	Enter configure mode.
(config)#router ldp	Enter the Router LDP mode.
(config-router)#pw-status-tlv	Configure PW status TLV for PW status signaling.
(config-router)#targeted-peer ipv4 1.1.1.1	Configure targeted LDP session to PE1 loopback address.
(config-router)#targeted-peer ipv4 2.2.2.2	Configure targeted LDP session to PE2 loopback address.
(config-router)#exit	Exit the Router LDP mode and return to Configure mode.
(config)#mpls l2-circuit pw1 10 1.1.1.1	Configure pseudowire PW1 between PE3 and PE1.
(config-pseduowire)#exit	Exit pseudowire mode.
(config)#mpls l2-circuit pw3 30 2.2.2.2	Configure pseudowire pw2 between PE3 and PE2.
(config-pseduowire)#exit	Exit pseudowire mode.
(config)#bridge 1 protocol ieee vlan-bridge	Specify the VLAN for bridge 1.
(config)#vlan database	Enter the VLAN Database mode.
(config-vlan)#vlan 100 bridge 1	Configure VLAN 100.
(config-vlan)#exit	Exit the VLAN Database mode and return to Configure mode.
(config)#interface eth1	Enter interface mode.
(config-if)#switchport	Switch to Layer-2 mode.
(config-if)#switchport mode access	Set the switching characteristics of this interface to access mode.
(config-if)#mpls-l2-circuit pw1 vlan 100	Bind the pseudowire PW1 to access interface.
(config-if)#mpls-l2-circuit pw3 vlan 100	Bind the pseudowire PW3 to access interface.
(config-if)#exit	Exit interface mode.
(config)#exit	Exit the Configure mode.

PE4

#configure terminal	Enter configure mode.
(config)#router ldp	Enter the Router LDP mode.
(config-router)#pw-status-tlv	Configure PW status TLV for PW status signaling.
(config-router)#targeted-peer ipv4 1.1.1.1	Configure targeted LDP session to PE1 loopback address.

(config-router)#targeted-peer ipv4 2.2.2.2	Configure targeted LDP session to PE2 loopback address.
(config-router)#exit	Exit the Router LDP mode and return to Configure mode.
(config)#mpls l2-circuit pw2 20 1.1.1.1	Configure pseudowire PW2 between PE4 and PE3.
(config-pseduowire)#exit	Exit pseudowire mode.
(config)#mpls l2-circuit pw4 40 2.2.2.2	Configure pseudowire PW4 between PE4 and PE2.
(config-pseduowire)#exit	Exit pseudowire mode.
(config)#bridge 1 protocol ieee vlan-bridge	Specify the VLAN for bridge 1.
(config)#vlan database	Enter the VLAN Database mode.
(config-vlan)#vlan 100 bridge 1	Configure VLAN 100.
(config-vlan)#exit	Exit the VLAN Database mode and return to Configure mode.
(config)#interface eth1	Enter interface mode.
(config-if)#switchport	Switch to Layer-2 mode.
(config-if)#switchport mode access	Set the switching characteristics of this interface to access mode.
(config-if)#mpls-l2-circuit pw2 vlan 100	Bind the pseudowire PW2 to access interface.
(config-if)#mpls-l2-circuit pw4 vlan 100	Bind the pseudowire PW4 to access interface.
(config-if)#vc-mode standby vlan 100	Configure VC-mode as standby for VLAN 100. Note: The command for Ethernet PWs is vc-mode standby.
(config-if)#exit	Exit interface mode.
(config)#exit	Exit the Configure mode.

Remove VC-mode Standby Configuration

PE2

#configure terminal	Enter configure mode.
(config)#interface eth1	Enter interface mode.
(config-if)#no vc-mode standby vlan 100	Remove VC-mode standby for VLAN 100.
(config-if)#exit	Exit interface mode.

Validation

Verify the VPLS Session On DUT

```
PE1#show mpls vc-table
VC-ID  Vlan-ID  Access-Intf   Network-Intf  Out Label  Tunnel-Label  Nexthop  Status
10      100       eth1          eth2          53121      3            3.3.3.3  Active
20      100       eth1          eth3          53121      3            4.4.4.4  Standby
PE1#show ldp mpls-l2-circuit detail
```

```
vcid: 10, type: ethernet, local groupid: 5, remote groupid: 5 (vc is up)
destination: 3.3.3.3, Peer LDP Ident: 3.3.3.3
Local label: 52481, remote label: 53121
Access IF: eth1, Network IF: eth2
Local MTU: 1500, Remote MTU: 1500
Local Control Word: disabled, Remote Control Word: disabled, Current use: disabled
Local PW Status Capability : enabled
Remote PW Status Capability : enabled
Current PW Status TLV : enabled
Local PW Status :
  Forwarding
  Active
Remote PW Status :
  Forwarding
  Active

vcid: 20, type: ethernet, local groupid: 5, remote groupid: 5 (vc is up)
destination: 4.4.4.4 , Peer LDP Ident: 4.4.4.4
Local label: 52480, remote label: 53121
Access IF: eth1, Network IF: eth3
Local MTU: 1500, Remote MTU: 1500
Local Control Word: disabled, Remote Control Word: disabled, Current use: disabled
Local PW Status Capability : enabled
Remote PW Status Capability : enabled
Current PW Status TLV : enabled
Local PW Status :
  Not Forwarding
Remote PW Status :
  Not Forwarding
  Standby
```

MTU-s with PW Redundancy

Follow these basic configuration steps for MTU-s with PW redundancy.

1. Configure VLAN pseudowires PW1 and PW2 between MTU-s and PE1 and MTU-s and PE2.
2. Configure PW1 as primary, PW2 as secondary and VC mode as revertive on MTU-s.
3. Configure VPLS and peer between PE1and PE3, PE2 and PE3.
4. Configure VPLS spoke VC use PW1 on PE1 and VPLS spoke VC use PW2 on PE2.

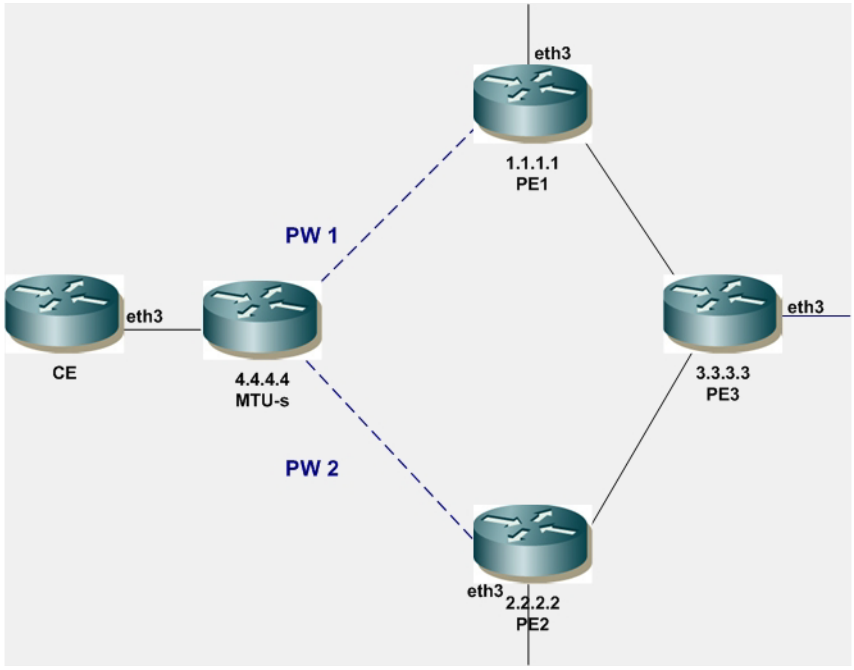


Figure 13-4: MTU-s with PW Redundancy

MTU-s

`#configure terminal`	Enter configure mode.
`(config)#router ldp`	Enter the `Router LDP` mode.
`(config-router)#pw-status-tlv`	Configure PW status TLV for PW status signaling.
`(config-router)#targeted-peer ipv4 1.1.1.1`	Configure targeted LDP session to PE1 loopback address.
`(config-router)#targeted-peer ipv4 2.2.2.2`	Configure targeted LDP session to PE2 loopback address.
`(config-router)#exit`	Exit the `Router LDP` mode and return to `Configure` mode.
`(config)#bridge 1 protocol ieee vlan-bridge`	Specify the VLAN for bridge 1.
`(config)#vlan database`	Enter the `VLAN database` mode.
`(config-vlan)#vlan 100 bridge 1`	Configure VLAN 100.
`(config-vlan)#exit`	Exit the `VLAN database` mode and return to `Configure` mode.
`(config)#mpls l2-circuit pw1 10 4.4.4.4`	Configure pseudowire PW1 between MTU-s and PE1
`(config-pseduowire)#exit`	Exit pseudowire mode.
`(config)#mpls l2-circuit pw2 20 4.4.4.4`	Configure pseudowire PW2 between MTU-s and PE2
`(config-pseduowire)#exit`	Exit pseudowire mode.
`(config)#interface eth3`	Enter interface mode.
`(config-if)#switchport`	Switch to Layer-2 mode.
`(config-if)#switchport mode access`	Set the switching characteristics of this interface to access mode.
`(config-if)#mpls-l2-circuit pw1 vlan 100`	Bind the PW1 as primary pseudowire to access interface

`(config-if)#mpls-l2-circuit pw2 vlan 100 secondary`	Bind the PW2 as secondary pseudowire to access interface
`(config-if)#vc-mode revertive vlan 100`	Configure VC-mode as revertive.
`(config-if)#exit`	Enter interface mode.
`(config)#exit`	Enter configure mode.
`#vc-switchover pw1 pw2`	Configure VC-switchover to change the forwarding status of active PW1 to standby and standby PW2 to active.

PE1

`#configure terminal`	Enter configure mode.
`(config)#router ldp`	Enter the `Router LDP` mode.
`(config-router)#pw-status-tlv`	Configure PW status TLV for pseudowire status signaling.
`(config-router)#targeted-peer ipv4 3.3.3.3`	Configure targeted LDP session to PE3 loopback address.
`(config-router)#targeted-peer ipv4 4.4.4.4`	Configure targeted LDP session to MTU-s loopback address.
`(config-router)#exit`	Exit the `Router LDP` mode and return to `Configure` mode.
`(config)#bridge 1 protocol ieee vlan-bridge`	Specify the VLAN for bridge 1.
`(config)#vlan database`	Enter the `VLAN Database` mode.
`(config-vlan)#vlan 100 bridge 1`	Configure VLAN 100.
`(config-vlan)#exit`	Exit the `VLAN Database` mode and return to `Configure` mode.
`(config)#mpls l2-circuit pw1 10 4.4.4.4`	Configure pseudowire PW1 between PE1 and MTU-s.
`(config-pseduowire)#exit`	Exit pseudowire mode.
`(config)#mpls vpls v1 111`	Configure VPLS v1 with ID 111 on PE1.
`(config-vpls)#signaling ldp`	Enter VPLS signaling LDP mode.
`(config-vpls-sig)#vpls-peer 3.3.3.3`	Configure PE3 as VPLS peer
`(config-vpls-sig)#exit`	Exit signaling LDP mode.
`(config-vpls)#vpls-vc pw1 vlan`	Configure PW1 as VLAN VC-Spoke.
`(config-vpls)#exit`	Exit the `VPLS` mode and return to `Configure` mode.
`(config)#interface eth3`	Enter configure mode.
`(config-if)#switchport`	Switch to Layer-2 mode.
`(config-if)#switchport mode access`	Set the switching characteristics of this interface to access mode.
`(config-if)#mpls-vpls v1`	Bind the VPLS to access interface.
`(config-if)#exit`	Enter interface mode.
`(config)#exit`	Enter configure mode.

PE2

#configure terminal	Enter configure mode.
(config)#router ldp	Enter the Router LDP mode.
(config-router)#pw-status-tlv	Configure PW status TLV for pseudowire status signaling.
(config-router)#targeted-peer ipv4 3.3.3.3	Configure targeted LDP session to PE3 loopback address.
(config-router)#targeted-peer ipv4 4.4.4.4	Configure targeted LDP session to MTU-s loopback address.
(config-router)#exit	Exit the Router LDP mode and return to Configure mode.
(config)#bridge 1 protocol ieee vlan-bridge	Specify the VLAN for bridge 1.
(config)#vlan database	Enter the VLAN Database mode.
(config-vlan)#vlan 100 bridge 1	Configure VLAN 100.
(config-vlan)#exit	Exit the VLAN Database mode and return to Configure mode.
(config)#mpls l2-circuit pw2 20 4.4.4.4	Configure pseudowire PW2 between PE2 and MTU-s.
(config)#mpls vpls v1 111	Configure VPLS v1 with ID 111 on PE2.
(config-vpls)#signaling ldp	Enter VPLS signaling LDP mode.
(config-vpls-sig)#vpls-peer 3.3.3.3	Configure PW3 as VPLS peer.
(config-vpls-sig)#exit	Exit signaling LDP mode.
(config-vpls)#vpls-vc pw2 vlan	Configure PW2 as VLAN VC-spoke.
(config-vpls)#exit	Exit the VPLS mode and return to Configure mode.
(config)#interface eth3	Enter interface mode.
(config-if)#switchport	Switch to Layer-2 mode.
(config-if)#switchport mode access	Set the switching characteristics of this interface to access mode.
(config-if)#mpls-vpls v1	Bind the VPLS to access interface
(config-if)#exit	Exit interface mode.

PE3

#configure terminal	Enter configure mode.
(config)#router ldp	Enter the Router LDP mode.
(config-router)#pw-status-tlv	Configure PW status TLV for PW status signaling.
(config-router)#targeted-peer ipv4 1.1.1.1	Configure targeted LDP session to PE1 loopback address.
(config-router)#targeted-peer ipv4 2.2.2.2	Configure targeted LDP session to PE2 loopback address.
(config-router)#exit	Exit the Router LDP mode and return to Configure mode.

`(config)#mpls vpls v1 111`	Configure VPLS v1 with ID 111 on PE1.
`(config-vpls)#signaling ldp`	Enter VPLS signaling LDP mode.
`(config-vpls-sig)#vpls-peer 1.1.1.1`	Configure PE1 as VPLS peer.
`(config-vpls-sig)#vpls-peer 2.2.2.2`	Configure PE2 as VPLS peer.
`(config-vpls-sig)#exit`	Exit signaling LDP mode.
`(config-vpls)#exit`	Exit the `VPLS` mode and return to `Configure` mode.
`(config)#interface eth3`	Enter interface mode.
`(config-if)#switchport`	Switch to Layer-2 mode.
`(config-if)#switchport mode access`	Set the switching characteristics of this interface to access mode.
`(config-if)#mpls-vpls v1`	Bind the VPLS to access interface.
`(config-if)#exit`	Enter interface mode.

Remove VC-mode Revertive Configuration

MTU-s

`#configure terminal`	Enter configure mode.
`(config)#interface eth3`	Enter interface mode.
`(config-if)#no vc-mode revertive vlan 100`	Remove VC-mode revertive for VLAN 100.
`(config-if)#exit`	Enter interface mode.
`(config)#exit`	Enter configure mode.

Validation

Enter the commands listed in the section below.

Verify the VC-table Session on DUT

```
MTU-s#show mpls vc-table
VC-ID  Vlan-ID  Access-Intf  Network-Intf  Out Label  Tunnel-Label  Nexthop  Status
10      100      eth3          eth1          53121       3            1.1.1.1  Active
20      100      eth3          eth2          53120       3            2.2.2.2  Standby
```

Verify VPLS Session on PE1

```
PE1#show mpls vpls detail
Virtual Private LAN Service Instance: vpls3100, ID: 3100
SIG-Protocol: BGP
Route-Distinguisher :65010:3100
Route-Target :65010:3100
VE-ID :31
Attachment-Circuit :UP
Learning: Enabled
Group ID: 0, Configured MTU: 9216
Description: none
```

```
service-tpid: dot1.q
Operating mode: Raw
Configured interfaces:
Interface: xe26
Service-template : vpls3100_3100_13100
Match criteria : 3100
Action type : Translate
Action value : 4075
Outgoing tpid : dot1.q

 Mesh Peers:  3.3.3.3 (Up)
 Spoke Peers: pw1 (Up)
```

CHAPTER 14 Multi-Segment Pseudowire Configuration

This chapter contains configurations for Multi-Segment Pseudowires (MS-PW).

For details about the commands used, see the *Label Distribution Protocol Command Reference*.

Overview

An L2VPN (Layer 2 Virtual Private Network) multi-segment pseudowire (MS-PW), also called a switched PW, is a statically- or dynamically-configured set of two or more PW segments that function as a single PW. An MS-PW spans across multiple cores or autonomous systems of the same or different carrier networks.

Multi-segment pseudowires enable a service provider to extend the reach of pseudo-wires across multiple domains. The domains can be autonomous systems under one provider administrative control, IGP areas in one autonomous system, different autonomous systems under the administrative control of two or more service providers, or administratively established pseudowire domains.

The end routers are called terminating PE routers (T-PEs), and the switching routers are called S-PE routers. The S-PE router terminates the tunnels of the preceding and succeeding PW segments in an MS-PW.

The S-PE router switches the control and data planes of the preceding and succeeding PW segments of the MS-PW. An MS-PW is declared to be up when all the single-segment PWs are up.

This document contains the procedures required to accomplish the following tasks:

- Configure signaled VCs (virtual circuits)
- Configure static VCs
- Add FIB entries for static VCs
- Bind Layer 2 VC to physical interfaces (switchport)
- Configure targeted LDP sessions and enable the pseudowire status TLV (pw-status-tlv)
- Enable or Disable LDP and label-switching on interfaces
- Stitch two VCs at an S-PE
- Configure S-PE string descriptions
- Display details of MS-PW associations on an S-PE
- Display the stitching associations configured on an S-PE
- Display the Status, Interface and Label associations for an MS-PW
- Display the configuration of the S-PE for the LDP module.

Topology

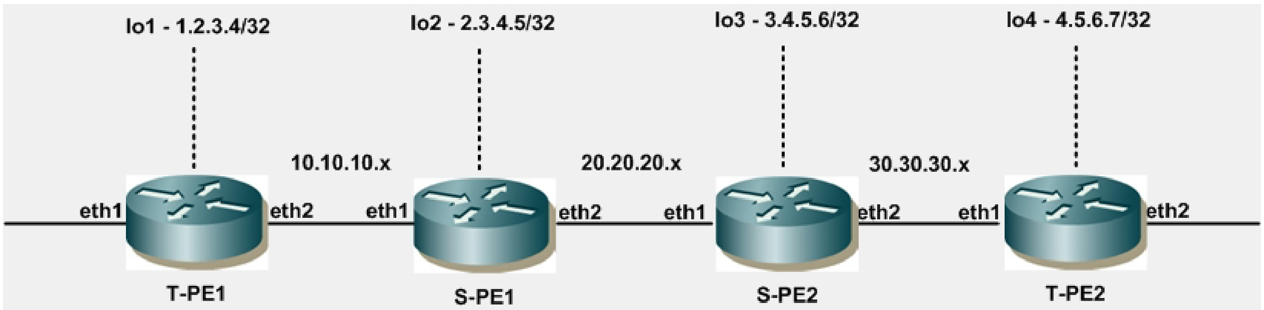


Figure 14-1: MS-PW Configuration

Dynamic MS-PW

T-PE2

`#configure terminal`	Enter Configure mode.
`(config)#interface eth1`	Enter interface mode.
`(config-if)#ip add 30.30.30.55/24`	Assign an IP address.
`(config-if)#exit`	Exit interface mode.
`(config)#router ospf 100`	Enter Router OSPF mode.
`(config-router)#network 4.5.6.7/32 a 0`	Configure OSPF network.
`(config-router)#network 30.30.30.0/24 a 0`	Configure OSPF network.
`(config-router)#exit`	Exit Router OSPF mode and return to Configure mode.
`(config)#router ldp`	Enter Router LDP mode.
`(config-router)#pw-status-tlv`	Enable pw-status-tlv.
`(config-router)#targeted-peer ipv4 3.4.5.6`	Configure targeted-peer LDP session to S-PE2.
`(config-router)#exit`	Exit Router LDP mode and return to Configure mode.
`(config)#interface eth1`	Enter interface mode.
`(config-if)#label-switching`	Enable label-switching on the interface connected to S-PE.
`(config-if)#enable-ldp ipv4`	Enable LDP on the interface connected to S-PE.
`(config-if)#exit`	Exit interface mode.
`(config)#mpls l2-circuit c3 300 3.4.5.6 passive`	Configure dynamic-passive pseudowire.
`(config-pseduowire)#exit`	Exit pseudowire mode.
`(config)#interface eth2`	Enter interface mode.
`(config-if)#switchport`	Change eth2 to Layer 2 interface.
`(config-if)#mpls-l2-circuit c3 ethernet`	Bind the PW to the Layer 2 interface connected to CE router.
`(config-if)#exit`	Exit interface mode.

S-PE2

`#configure terminal`	Enter Configure mode.
`(config)#interface eth1`	Enter interface mode.
`(config-if)#ip add 20.20.20.54/24`	Assign an IP address.
`(config-if)#exit`	Exit interface mode.
`(config)#interface eth2`	Enter interface mode.
`(config-if)#ip add 30.30.30.54/24`	Assign an IP address.
`(config-if)#exit`	Exit interface mode.
`(config)#router ospf 100`	Enter Router OSPF mode.
`(config-router)#network 3.4.5.6/32 a 0`	Configure OSPF network.
`(config-router)#network 20.20.20.0/24 a 0`	Configure OSPF network.
`(config-router)#network 30.30.30.0/24 a 0`	Configure OSPF network.
`(config-router)#exit`	Exit Router OSPF mode and return to Configure mode.
`(config)#router ldp`	Enter Router LDP mode.
`(config-router)#pw-status-tlv`	Enable pw-status-tlv.
`(config-router)#targeted-peer ipv4 4.5.6.7`	Configure targeted-peer LPD session to T-PE2.
`(config-router)#targeted-peer ipv4 2.3.4.5`	Configure targeted-peer LDP session to S-PE1.
`(config-router)#exit`	Exit Router LDP mode and return to Configure mode.
`(config)#mpls l2-circuit c3 300 4.5.6.7`	Configure dynamic PW for circuit c3.
`(config-pseduowire)#exit`	Exit pseudowire mode.
`(config)#mpls l2-circuit c2 200 2.3.4.5`	Configure dynamic PW for circuit c2.
`(config-pseduowire)#exit`	Exit pseudowire mode.
`(config)#mpls ms-pw-stitch sp2 c2 c3`	Stitch the two PWs.
`(config)#mpls ms-pw sp2 from-mpls-pc2-to-mpls-pc4`	Configure S-PE description.

S-PE1

`#configure terminal`	Enter Configure mode.
`(config)#interface eth1`	Enter interface mode.
`(config-if)#ip add 10.10.10.53/24`	Assign an IP address.
`(config-if)#exit`	Exit interface mode.
`(config)#interface eth2`	Enter interface mode.
`(config-if)#ip add 20.20.20.52/24`	Assign an IP address.
`(config-if)#exit`	Exit interface mode.
`(config)#router ospf 100`	Enter Router OSPF mode.
`(config-router)#network 2.3.4.5/32 a 0`	Configure OSPF network.
`(config-router)#network 10.10.10.0/24 a 0`	Configure OSPF network.
`(config-router)#network 20.20.20.0/24 a 0`	Configure OSPF network.

`(config-router)#exit`	Exit Router OSPF mode and return to Configure mode.
`(config)#router ldp`	Enter Router LDP mode.
`(config-router)#pw-status-tlv`	Enable pw-status-tlv.
`(config-router)#targeted-peer ipv4 3.4.5.6`	Configure targeted-peer LDP session to S-PE2.
`(config-router)#targeted-peer ipv4 1.2.3.4`	Configure targeted-peer LDP session to T-PE1.
`(config-router)#exit`	Exit Router LDP mode and return to Configure mode.
`(config)#mpls l2-circuit c2 200 3.4.5.6`	Configure dynamic PW for circuit c2.
`(config-pseduowire)#exit`	Exit pseudowire mode.
`(config)#mpls l2-circuit c1 100 1.2.3.4`	Configure dynamic PW for circuit c1.
`(config-pseduowire)#exit`	Exit pseudowire mode.
`(config)#mpls ms-pw-stitch sp2 c1 c2`	Stitch the two pseudowires.
`(config)#mpls ms-pw sp1 from-mpls-pc1-to-mpls-pc3`	Configure S-PE description.

Static MS-PW

S-PE1

`(config)#mpls l2-circuit c1 100 1.2.3.4 manual`	Configure static pseudowire.
`(config)#mpls ms-pw-stitch sp1 c1 c2 mtu 1500 ethernet`	Stitch the two pseudowires, one of which is signaled and the other is manual.
`(config)#mpls l2-circuit-fib-entry 100 101 201 1.2.3.4 eth3 c2`	Add FIB entry for the static PW. c2 is the PW to which it has to be stitched at S-PE1.

T-PE1

`#configure terminal`	Enter Configure mode.
`(config)#interface eth1`	Enter interface mode.
`(config-if)#ip add 10.10.10.51/24`	Assign IP address.
`(config-if)#exit`	Exit interface mode.
`(config)#router ospf 100`	Enter Router OSPF mode.
`(config-router)#network 1.2.3.4/32 a 0`	Configure OSPF network.
`(config-router)#network 10.10.10.0/24 a 0`	Configure OSPF network.
`(config-router)#exit`	Exit Router OSPF mode and return to Configure mode.
`(config)#router ldp`	Enter Router LDP mode
`(config-router)#pw-status-tlv`	Enable pw-status-tlv.
`(config-router)#targeted-peer ipv4 2.3.4.5`	Configure targeted-peer LDP session to S-PE1.
`(config-router)#exit`	Exit Router LDP mode and return to Configure mode.
`(config)#interface eth1`	Enter interface mode.

(config-if)#label-switching	Enable label-switching on the interface.
(config-if)#enable-ldp ipv4	Enable LDP on the interface.
(config-if)#exit	Exit interface mode.
(config)#mpls l2-circuit c1 100 2.3.4.5	Configure dynamic PW.
(config-pseduowire)#exit	Exit pseudowire mode.
(config)#interface eth2	Enter interface mode.
(config-if)#switchport	Configure eth2 as a Layer 2 interface.
(config-if)#mpls-l2-circuit c1 ethernet	Bind the PW to the Layer 2 interface connected to CE router.
(config-if)#exit	Exit interface mode.

T-PE1

(config)#mpls l2-circuit c1 100 2.3.4.5 manual	Configure static pseudowire.
(config)#mpls l2-circuit-fib-entry 100 201 101 2.3.4.5 eth1 eth2	Adding FIB entry for the static PW created, after binding it to the access interface (eth2).

Validation

Display LDP Configuration on S-PE

```
#show ldp ms-pw sp2
S-PE description: from-mpls-pc3-to-mpls-pc4
===================================================================
id:                         200                 id:                         300
Endpoint:                   2.3.4.5             Endpoint:                   4.5.6.7
Role:                       Passive             Role:                       Passive
Group ID:                   4                   Groups ID:                  4
Rmt Flt/Clr sndr(S-PE):     0.0.0.0             Rmt Flt/Clr sndr(S-PE):     0.0.0.0
===================================================================
```

Display All Stitching Associations Configured on S-PE

```
#show mpls ms-pw
===================================================================
MS-PW  Segment-1  VC1-ID  Segment-2  VC2-ID
sp2    c2         200     c3         300
```

Display Details of MS-PW Association on S-PE

```
#show mpls ms-pw sp2
===================================================================
VC1:              c2              VC2:            c3
id:               200             id:             300
Endpoint:         2.3.4.5         Endpoint:       4.5.6.7
Control Word:     0               Control Word:   0
VC Type:          Ethernet        VC Type:        Ethernet
Owner:            Signaled        Owner:          Signaled
Role:             Active          Role:           Active
```

```
====================================================================
```

Display Status, Interface and Label Associations for an MS-PW

```
#show mpls ms-pw sp2 vc-table
====================================================================
In VC   Vlan-ID   In-lbl   Nw-Intf         Out-Lbl        Status      Tunnel-lbl
c2         N/A    53125    eth4            53120          Active      3
c3         N/A    53124    eth3            53124          Active      3
====================================================================
```

`#show mpls ms-pw sp1 vc-table` (in case of stitched dynamic and static PW at S-PE)

```
====================================================================
In VC    Vlan-ID     In-Lbl      Nw-Intf      Out-Lbl   Status  Tunnel- Lbl
c1          N/A       101        eth4        53120      Active  3
c2          N/A      53120       eth3        201        Active  3
====================================================================
```

Display Details of MS-PW Association on S-PE if One VC is Manual

`#show mpls ms-pw sp1` (in case of one signaled VC and one manual VC, stitched)

```
====================================================================
VC1:                    c1              VC2:                    c2
id:                     100             id:                     200
Endpoint:               1.2.3.4         Endpoint:               3.4.5.6
Control Word:           0               Control Word:           0
VC Type:                Ethernet        VC Type:                Ethernet
Owner:                  Manual          Owner:                  Signaled
Role:                   Active          Role:                   Active
====================================================================
```

Display VC-Table and PW-Status Individual Segments of a MS-PW

```
#show ldp mpls-l2-circuit
====================================================================
Transport Client     VC     VC             Local        Remote       Destination
VC ID     Binding    State  Type           VC Label     VC Label     Address
200       eth4       UP     Ethernet       53125        53124        2.3.4.5
300       eth3       UP     Ethernet       53124        53120        4.5.6.7
====================================================================
```

```
#show mpls vc-table
====================================================================
VC-ID  Vlan-ID  Access-Intf  Network-Intf  Out Label  Tunnel-Label  Nexthop    Status
200      N/A      eth4         eth3          53124         3        2.3.4.5    Active
300      N/A      eth3         eth4          53120         3        4.5.6.7    Active
====================================================================
```

CHAPTER 15 SAToP Configuration

Structure agnostic TDM over PSN (SATop) emulates an end-to-end TDM circuit over MPLS. This feature creates a pseudowire between two end points over MPLS as defined in RFC 4447.

SAToP Pseudowire Creation

This procedure show how to establish the pseudowire between provider edge routers. The configuration assumes that you are running the `ospfd`, `ldpd`, `mstpd`, `nsm`, and `imi` daemons.

Topology

Figure 15-1: Three router topology for PW creation

Rtr1

`#configure terminal`	Enter configure mode
`(config)#hostname Rtr1`	Configure the name of the host as Rtr1
`Rtr1(config)#interface eth7`	Enter interface mode
`Rtr1(config-if)#ip address 1.1.1.1/24`	Assign IP address 1.1.1.1 to the interface
`Rtr1(config-if)#exit`	Exit interface mode
`Rtr1(config)#int lo`	Enter interface mode
`Rtr1(config-if)#ip address 2.2.2.2/32`	Assign an IP address to the loopback interface
`Rtr1(config-if)#exit`	Exit interface mode
`Rtr1(config)#router ospf`	Enter OSPF router mode
`Rtr1(config-router)#network 2.2.2.2/32 area 0`	Define the interface on which OSPF runs and associate the area ID (0) with the interface
`Rtr1(config-router)#network 1.1.1.1/24 area 0`	Define the interface on which OSPF runs and associate the area ID (0) with the interface
`Rtr1(config-router)#exit`	Exit OSPF router mode
`Rtr1(config)#router ldp`	Enter LDP router mode
`Rtr1(config-router)#targeted-peer ipv4 4.4.4.4`	Configure the target peer IP address
`Rtr1(config-router-targeted-peer)#exit`	Exit LDP targeted peer mode
`Rtr1(config-router)#exit`	Exit LDP router mode

Rtr1(config)#int eth7	Enter interface mode
Rtr1(config-if)#enable-ldp ipv4	Enable the LDP protocol on eth1
Rtr1(config-if)#label-switching	Enable label switching on interface eth1
Rtr1(config-if)#exit	Exit the LDP configuration mode
Rtr1(config)#int tdm 5	Enter interface mode
Rtr1(config-if)#tdm payload bytes 200	Configure the TDM payload bytes to 200
Rtr1(config-if))#mpls-l2-circuit vc1 tdm-T1	Bind the T1 interface to the pseudowire
Rtr1(config-if)#exit	Exit interface configuration mode
Rtr1(config)#mpls l2-circuit vc1 10 4.4.4.4	Configure a Virtual Circuit for PE1. In this example, vc1 is the VC name, 10 is the VC ID, and 4.4.4.4 is the Endpoint IP address.
(config-pseduowire)#exit	Exit pseudowire mode.

Rtr2

#configure terminal	Enter configure mode
(config)#hostname Rtr2	Configure the name of the host as Rtr2
Rtr2(config)#int eth2	Enter interface mode
Rtr2(config-if)#ip address 1.1.1.2/24	Assign IP address 1.1.1.2 to the interface
Rtr2(config-if)#exit	Exit interface mode
Rtr2(config)#int eth3	Enter interface mode
Rtr2(config-if)#ip address 5.5.5.1/24	Assign IP address 5.5.5.1 to the interface
Rtr2(config-if)#exit	Exit interface mode.
Rtr2(config)#int lo	Enter interface mode
Rtr2(config-if)#ip address 3.3.3.3/32	Assign IP address 3.3.3.3 to the loopback interface
Rtr2(config-if)#exit	Exit interface mode
Rtr2(config)#router ospf	Enter OSPF router mode
Rtr1(config-router)#network 3.3.3.3/32 area 0	Define the interface on which OSPF runs and associate the area ID (0) with the interface
Rtr2(config-router)#network 1.1.1.2/24 area 0	Define the interface on which OSPF runs and associate the area ID (0) with the interface
Rtr2(config-router)#network 5.5.5.1/24 area 0	Define the interface on which OSPF runs and associate the area ID (0) with the interface
Rtr2(config-router)#exit	Exit OSPF router mode
Rtr2(config)#int eth2	Enter interface mode
Rtr2(config-if)#enable ldp ipv4	Enable the LDP protocol on eth1
Rtr2(config-if)#label switching	Enable label switching on interface eth1
Rtr2(config-if)#exit	Exit interface mode
Rtr2(config)#int eth3	Enter interface mode
Rtr2(config-if)#enable ldp ipv4	Enable the LDP protocol on eth2

Rtr2(config-if)#label switching	Enable label switching on interface eth2
Rtr2(config-if)#exit	Exit interface mode

Rtr3

#configure terminal	Enter configure mode
(config)#hostname Rtr3	Configure the name of the host as Rtr3
Rtr3(config)#interface eth2	Enter interface mode
Rtr3(config-if)#ip address 5.5.5.2/24	Assign IP address 5.5.5.2 to the interface
Rtr3(config-if)#exit	Exit interface mode
Rtr3(config)#int lo	Enter interface mode
Rtr3(config-if)#ip address 4.4.4.4/32	Assign an IP address to the loopback interface
Rtr3(config-if)#exit	Exit interface mode
Rtr3(config)#router ospf	Enter OSPF router mode
Rtr3(config-router)#network 4.4.4.4./32 area 0	Define the interface on which OSPF runs and associate the area ID (0) with the interface
Rtr3(config-router)#network 5.5.5.2/24 area 0	Define the interface on which OSPF runs and associate the area ID (0) with the interface
Rtr3(config-router)#exit	Exit OSPF router mode
Rtr3(config)#router ldp	Enter LDP router mode
Rtr3(config-router)#targeted-peer ipv4 2.2.2.2	Configure the target peer IP address
Rtr3(config-router-targeted-peer)#exit	Exit LDP router mode
Rtr3(config-router)#exit	Exit the router mode
Rtr3(config)#int eth2	Enter interface mode
Rtr3(config-if)#enable-ldp ipv4	Enable the LDP protocol on eth1
Rtr3(config-if)#label-switching	Enable label switching on interface eth1
Rtr3(config-if)#exit	Exit interface mode
Rtr3(config)#int tdm 5	Enter interface mode
Rtr1(config-if)#tdm payload bytes 200	Configure the TDM payload bytes to be 200 bytes
Rtr3(config-if))#mpls-l2-circuit vc1 tdm-T1	Bind the T1 interface to the pseudowire
Rtr3(config-if)#exit	Exit interface mode
Rtr3(config)#mpls l2-circuit vc1 10 2.2.2.2	Configure a Virtual Circuit for PE1. In this example, vc1 is the VC name, 10 is the VC ID, and 2.2.2.2 is the endpoint IP address.
(config-pseduowire)#exit	Exit pseudowire mode.

Validation

Verify on Rtr1 or Rtr3 that the LDP session is operating and that the PW is set-up successfully.

```
rtr1#show ldp session
Peer IP Address          IF Name    My Role          State                KeepAlive
4.4.4.4                  eth7        Passive          OPERATIONAL          30
3.3.3.3                  eth7        Passive          OPERATIONAL          30
rtr1#show ldp mpls-l2-circuit
Transport Client    VC          VC             Local         Remote        Destination
VC ID     Binding   State       Type           VC Label      VC Label      Address
10        tdm5      UP          tdm-E1         16            16            4.4.4.4
```

Handling Defects and Alarms

Once a pseudowire has been set up, the CE-bound IWF begins to receive SAToP packets and to store their payload in the jitter buffer but continues to transmit the “all ones” pattern to its TDM attachment circuit. This intermediate state persists until a preconfigured amount of TDM data (usually half of the jitter buffer) has been received in consecutive SAToP packets or until a preconfigured intermediate state timer (started when the PW setup is completed) expires.

If the CE-bound SAToP IWF detects the loss of a preconfigured number of consecutive packets or if the intermediate state timer expires before the required amount of TDM data has been received, it enters its packet loss state. While in this state, the local PSN-bound SAToP IWF should mark every packet it transmits with the R bit set. The CE-bound SAToP IWF leaves this state and transitions to the normal one once a preconfigured number of consecutive valid SAToP packets have been received. (Successfully reordered packets contribute to the count of consecutive packets.)

In addition to the packet loss state of the CE-bound SAToP IWF, it may detect the following defects:

- Stray packets
- Malformed packets
- Excessive packet loss rate
- Buffer overrun
- Remote packet loss.

Stray packets may be detected by the PSN and PW demultiplexing layers. When RTP is used, the SSRC field in the RTP header may be used for this purpose as well. Stray packets must be discarded by the CE-bound IWF, and their detection must not affect mechanisms for detection of packet loss.

Malformed packets are detected by mismatch between the expected packet size (taking the value of the L bit into account) and the actual packet size inferred from the PSN and PW demultiplexing layers. When RTP is used, lack of correspondence between the PT value and that allocated for this direction of the PW MAY also be used for this purpose. Malformed in-order packets MUST be discarded by the CE-bound IWF and replacement data generated as with lost packets.

Excessive packet loss rate is detected by computing the average packet loss rate over a configurable amount of times and comparing it with a preconfigured threshold. Buffer overrun is detected in the normal operation state when the jitter buffer of the CE-bound IWF cannot accommodate newly arrived SAToP packets.

Remote packet loss is indicated by reception of packets with their Rbit set.

Topology

See Figure 15-1.

Rtr1

`#configure terminal`	Enter configure mode
`(config)#hostname Rtr1`	Configure the name of the host as Rtr1
`Rtr1(config)#interface eth7`	Enter interface mode
`Rtr1(config-if)#ip address 1.1.1.1/24`	Assign IP address 1.1.1.1 to the interface
`Rtr1(config-if)#exit`	Exit interface mode
`Rtr1(config)#int lo`	Enter interface mode
`Rtr1(config-if)#ip address 2.2.2.2/32`	Assign an IP address to the loopback interface
`Rtr1(config-if)#exit`	Exit interface mode
`Rtr1(config)#router ospf`	Enter OSPF router mode
`Rtr1(config-router)#network 2.2.2.2/32 area 0`	Define the interface on which OSPF runs and associate the area ID (0) with the interface
`Rtr1(config-router)#network 1.1.1.1/24 area 0`	Define the interface on which OSPF runs and associate the area ID (0) with the interface
`Rtr1(config-router)#exit`	Exit OSPF router mode
`Rtr1(config)#router ldp`	Enter LDP router mode
`Rtr1(config-router)#targeted-peer ipv4 4.4.4.4`	Configure the target peer IP address
`Rtr1(config-router-targeted-peer)#exit`	Exit LDP router mode
`Rtr1(config-router)#exit`	Exit OSPF router mode
`Rtr1(config)#int eth7`	Enter interface mode
`Rtr1(config-if)#enable-ldp ipv4`	Enable the LDP protocol on eth1
`Rtr1(config-if)#label-switching`	Enable label switching on interface eth1
`Rtr1(config-if)#exit`	Exit interface mode
`Rtr1(config)#int tdm 5`	Enter interface mode
`Rtr1(config-if)#tdm payload bytes 200`	Configure the TDM payload bytes to 200
`Rtr1(config-if)#jitter-buffer-size 300`	Configure the jitter-buffer size to 300
`Rtr1 (config-if)#timer error-set malformed-packets 3000`	Configure the value to detect malformed packets
`Rtr1(config-if)#timer error-clear malformed-packets 8000`	Configure the value to clear malformed packets
`Rtr1 (config-if)#timer error-set buffer-overrun 3000`	Configure the value to detect buffer overrun
`Rtr1(config-if)#timer error-clear buffer-overrun 3000`	Configure the value to clear buffer overrun
`Rtr1(config-if)#timer error-set packet-loss 3000`	Configure the value to detect packet-loss
`Rtr1(config-if)#timer error-clear packet-loss 3000`	Configure the value to clear packet-loss

`Rtr1(config-if)#timer error-set excessive-packet-loss-rate 3000`	Configure the value to detect excessive-packet-loss-rate
`Rtr1(config-if)#timer error-clear excessive-packet-loss-rate 3000`	Configure the value to clear excessive-packet-loss-rate
`Rtr1(config-if)#timer error-set stray-packets 3000`	Configure the value to detect stray-packets
`Rtr1 (config-if)#timer error-clear stray-packets 3000`	Configure the value to clear stray-packets
`Rtr1 (config-if)#timer error-set remote-packet-loss 3000`	Configure the value to detect remote-packet-loss 3000
`Rtr1 (config-if)#timer error-clear remote-packet-loss 3000`	Configure the value to clear remote-packet-loss 3000
`Rtr1(config-if))#mpls-l2-circuit vc1 tdm-T1`	Bind the T1 interface to the pseudowire
`Rtr1(config-if)#exit`	Exit interface configuration mode
`Rtr1(config)#mpls l2-circuit vc1 10 4.4.4.4`	Configure a Virtual Circuit for PE1. In this example, vc1 is the VC name, 10 is the VC ID, and 4.4.4.4 is the Endpoint IP address.
`(config-pseduowire)#exit`	Exit pseudowire mode.

Rtr2

`#configure terminal`	Enter configure mode
`(config)#hostname Rtr2`	Configure the name of the host as Rtr2
`Rtr2(config)#int eth2`	Enter interface mode.
`Rtr2(config-if)#ip address 1.1.1.2/24`	Assign IP address 1.1.1.2 to the interface
`Rtr2(config-if)#exit`	Exit interface mode.
`Rtr2(config)#int eth3`	Enter interface mode.
`Rtr2(config-if)#ip address 5.5.5.1/24`	Assign IP address 5.5.5.1 to the interface
`Rtr2(config-if)#exit`	Exit interface mode.
`Rtr2(config)#int lo`	Enter interface mode
`Rtr2(config-if)#ip address 3.3.3.3/32`	Assign IP address 3.3.3.3 to the loopback interface
`Rtr2(config-if)#exit`	Exit interface mode.
`Rtr2(config)#router ospf`	Enter OSPF router mode
`Rtr2(config-router)#network 3.3.3.3/32 area 0`	Define the interface on which OSPF runs and associate the area ID (0) with the interface.
`Rtr2(config-router)#network 1.1.1.2/24 area 0`	Define the interface on which OSPF runs and associate the area ID (0) with the interface.
`Rtr2(config-router)#network 5.5.5.1/24 area 0`	Define the interface on which OSPF runs and associate the area ID (0) with the interface.
`Rtr2(config-router)#exit`	Exit OSPF router mode
`Rtr2(config)#int eth2`	Enter interface mode

Rtr2(config-if)#enable ldp ipv4	Enable the LDP protocol on eth1
Rtr2(config-if)#label switching	Enable label switching on interface eth1.
Rtr2(config-if)#exit	Exit interface mode
Rtr2(config)#int eth3	Enter interface mode
Rtr2(config-if)#enable ldp ipv4	Enable the LDP protocol on eth2
Rtr2(config-if)#label switching	Enable label switching on interface eth2.
Rtr2(config-if)#exit	Exit interface mode.

Rtr3

#configure terminal	Enter configure mode
(config)#hostname Rtr3	Configure the name of the host as Rtr3
Rtr3(config)#interface eth2	Enter interface mode.
Rtr3(config-if)#ip address 5.5.5.2/24	Assign IP address 5.5.5.2 to the interface
Rtr3(config-if)#exit	Exit interface mode
Rtr3(config)#int lo	Enter interface mode
Rtr3(config-if)#ip address 4.4.4.4/32	Assign an IP address to the loopback interface
Rtr3(config-if)#exit	Exit interface mode
Rtr3(config)#router ospf	Enter OSPF router mode
Rtr3(config-router)#network 4.4.4.4/32 area 0	Define the interface on which OSPF runs and associate the area ID (0) with the interface
Rtr3(config-router)#network 5.5.5.2/24 area 0	Define the interface on which OSPF runs and associate the area ID (0) with the interface
Rtr3(config-router)#exit	Exit OSPF router mode
Rtr3(config)#router ldp	Enter LDP router mode
Rtr3(config-router)#targeted-peer ipv4 2.2.2.2	Configure the target peer IP address
Rtr3(config-router-targeted-peer)#exit	Exit LDP router mode
Rtr3(config-router)#exit	Exit the router mode
Rtr3(config)#int eth2	Enter interface mode
Rtr3(config-if)#enable-ldp ipv4	Enable the LDP protocol on eth1
Rtr3(config-if)#label-switching	Enable label switching on interface eth1
Rtr3(config-if)#exit	Exit interface mode
Rtr3(config)#int tdm 5	Enter interface mode
Rtr3(config-if)#jitter-buffer-size 300	Configure the jitter buffer of the size to 300

`Rtr3(config-if)#timer error-set malformed-packets 3000`	Configure the value to detect malformed packets
`Rtr3(config-if)#timer error-clear malformed-packets 8000`	Configure the value to clear malformed packets
`Rtr3(config-if)#timer error-set buffer-overrun 3000`	Configure the value to detect buffer overrun
`Rtr3(config-if)#timer error-clear buffer-overrun 8000`	Configure the value to clear buffer overrun
`Rtr3(config-if)#timer error-set packet-loss 3000`	Configure the value to detect packet-loss
`Rtr3(config-if)#timer error-clear packet-loss 8000`	Configure the value to clear packet-loss
`Rtr3(config-if)#timer error-set excessive-packet-loss-rate 3000`	Configure the value to detect excessive-packet-loss-rate
`Rtr3(config-if)#timer error-clear excessive-packet-loss-rate 8000`	Configure the value to clear excessive-packet-loss-rate
`Rtr3(config-if)#timer error-set stray-packets 3000`	Configure the value to detect stray-packets
`Rtr3(config-if)#timer error-clear stray-packets 8000`	Configure the value to clear stray-packets
`Rtr3(config-if)#timer error-set remote-packet-loss 3000`	Configure the value to detect remote-packet-loss to 3000
`Rtr3(config-if)#timer error-clear remote-packet-loss 8000`	Configure the value to clear remote-packet-loss to 3000
`Rtr3(config-if))#mpls-l2-circuit vc1 tdm-T1`	Bind the T1 interface to the pseudowire
`Rtr3(config-if)#exit`	Exit interface mode
`Rtr1(config)#mpls l2-circuit vc1 10 2.2.2.2`	Configure a Virtual Circuit for PE1. In this example, vc1 is the VC name, 10 is the VC ID, and 2.2.2.2 is the Endpoint IP address.
`(config-pseduowire)#exit`	Exit pseudowire mode.

Validation

1. Verify the details on Rtr3.

```
Rtr3#show tdm error-detection-timers interface tdm5

packet_loss_set_period                     = 3000ms
stray_packets_set_period                   = 3000ms
malformed_packets_set_period               = 3000ms
excessive_packet_loss_rate_set_period      = 3000ms
buffer_overrun_set_period                  = 3000ms
remote_packet_loss_set_period              = 3000ms
packet_loss_clear_period                   = 8000ms
stray_packets_clear_period                 = 8000ms
malformed_packets_clear_period             = 8000ms
excessive_packet_loss_rate_clear_period    = 8000ms
buffer_overrun_clear_period                = 8000ms
remote_packet_loss_clear_period            = 8000ms
```

2. See the values of TDM interface parameters such as TDM payload bytes and pseudowire control word information.


```
Rtr3#show tdm interface tdm5

tdm-name  status  type  bitrate   payload_bytes  buffer-size  PW_Id control_word
--------------------------------------------------------------------------------
tdm5      UP      E1    2048 kb/s 200            500
```

3. Show the statistics counter of following from the CE-bound IWF:

```
rtr3#show tdm satop-statistics ce-bound interface tdm5
==========================================================
   Interface tdm5
==========================================================
forwarded packets              = 0
fbp_drop_packets               = 0
out_of_window_packets          = 0
buffer_overun_dropped_packets = 0
window_switchover              = 0
buffer_overun_events           = 0
stray_packets                  = 0
malformed_packets              = 0
cw_ais_drop_packets            = 0
multiple_packets               = 0
mpls_drop_packets              = 0
denied_packets                 = 0
out_of_sequence_packets        = 0
out_of_band_cas_packets        = 0
rdi_dropped_packets            = 0
rai_packets                    = 0
```

CHAPTER 16 MPLS-TP Processing

Overview

This feature performs 'Time To Live' (TTL) processing for Multi-Protocol Label Switching (MPLS) packets. The TTL processing is decided by the model chosen by you. This feature will provide TTL processing of MPLS packets on ingress, egress, and intermediate routers. TTL processing is compliant with RFC 3443. The details of TTL processing vary with the tunnel model that is configured for TTL processing.

The incoming and outgoing TTL of the packet is determined by the configured tunnel model. This feature implements different rules for processing of the TTL on I-LER, LSR, E-LER:

Short Pipe model is a slight variation of the Pipe Model and is used to differentiate between different egress forwarding and QoS treatments.Short Pipe Model is utilized when the customer and service provider are in different DiffServ domains. Hence the models provided to the users are uniform, Short Pipe, and Pipe.

In OcNOS, Uniform and Pipe model are present. Uniform model is taken by default. The Pipe Model for TTL is can be being used in multiple networks and is provided as a configurable option. This chapter shows Uniform, Short pipe, and Pipe models as per RFC 3443.

Configuring Tunnels Using IETF Identifiers

Topology

The procedures in this section use the topology in Figure 16-1.

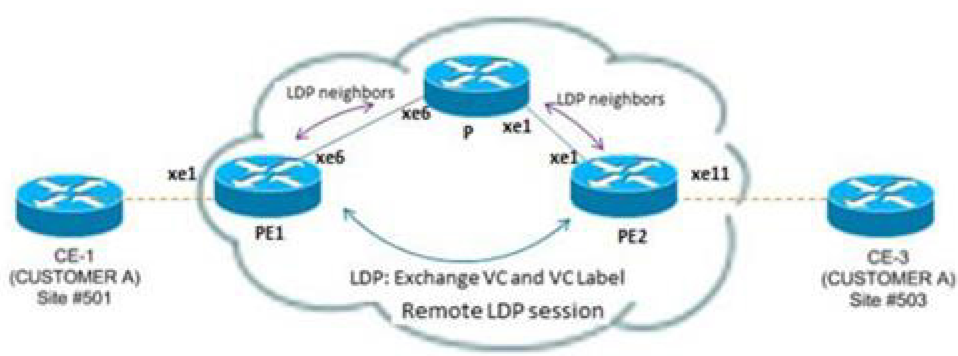


Figure 16-1: TTL Processing Topology

Unidirectional Tunnel

PE1 (NSM)

#configure terminal	Enter configure mode.
(config)#mpls-tp global-id 100 node-id 1.1.1.1	Configure the global identifier and node identifier.
(config)#interface eth1	Enter interface mode for eth1.
(config-if)#mpls-tp provider-interface 10.1.1.1	Configure the interface as provider and set the local identifier to 10.1.1.1.
(config)#mpls-tp tunnel 1 source 100 1.1.1.1 destination 300 3.3.3.3	Configure the tunnel identifier, the source global identifier and node identifier, and the destination global identifier and node identifier.
(config-tnl)#tunnel-name tnl1	Set the tunnel name.
(config-tnl)#tunnel-mode unidirectional	Make the tunnel unidirectional.
(config-unidir-tnl)#nhlfe-entry 1001 eth1	Configure the NHLFE entry as push.

P1 (NSM)

#configure terminal	Enter configure mode.
(config)#mpls-tp global-id 200 node-id 2.2.2.2	Configure the global identifier and node identifier.
(config)#interface eth1	Enter interface mode.
(config-if)#mpls-tp provider-interface 10.1.1.2	Configure the interface as provider and set the local identifier to 10.1.1.2.
(config)#interface eth2	Enter interface mode for eth2.
(config-if)#mpls-tp provider-interface 30.1.1.1	Configure the interface eth2 as provider interface and the interface local ID as 30.1.1.1.
(config)#mpls-tp tunnel 1 source 100 1.1.1.1 destination 300 3.3.3.3	Configure the tunnel identifier, the source global identifier and node identifier, and the destination global identifier and node identifier.
(config-tnl)#tunnel-name tnl1	Set the tunnel name.
(config-tnl)#tunnel-mode unidirectional	Make the tunnel unidirectional.
(config-unidir-tnl)#ilm-entry 1001 eth1 swap 1002 eth2	Configure the ILM entry as swap.

PE2 (NSM)

#configure terminal	Enter configure mode.
(config)#mpls-tp global-id 300 node-id 3.3.3.3	Configure the global identifier and node identifier.
(config)#interface eth2	Enter interface mode.
(config-if)#mpls-tp provider-interface 30.1.1.2	Configure the interface as provider and set the local identifier to 30.1.1.2.
(config)#mpls-tp tunnel 1 source 100 1.1.1.1 destination 300 3.3.3.3	Configure the tunnel identifier, the source global identifier and node identifier, and the destination global identifier and node identifier.

(config-tnl)#tunnel-name tnl1	Set the tunnel name.
(config-tnl)#tunnel-mode unidirectional	Make the tunnel unidirectional.
(config-unidir-tnl)#ilm-entry 1002 eth2 pop	Configure the ILM entry as pop.

Validation

PE1

```
PE1#sh mpls-tp tunnel

<==============================================================================>
 Tunnel-id              : 1                Tunnel-Name          : tnl1
 Source Global-Id       : 100              Source Node-Id       : 1.1.1.1
 Destination Global-Id : 300               Destination Node-Id : 3.3.3.3
 Role   : Source                           Tunnel Index         : 1
 Mode   : UNIDIRECTIONAL                   Tunnel State         : UP


     Forward-Path : NHLFE   <OPCODE : Push>
       Outgoing-Label : 1001                Outgoing-Interface : eth1
       NHLFE Index    : 1
       BW-class       : N/A
       Status : UP
```

P1

```
P1#show mpls-tp tunnel

<==============================================================================>
 Tunnel-id              : 1                Tunnel-Name          : tnl1
 Source Global-Id       : 100              Source Node-Id       : 1.1.1.1
 Destination Global-Id : 300               Destination Node-Id : 3.3.3.3
 Role   : Transit                          Tunnel Index         : 1
 Mode   : UNIDIRECTIONAL                    Tunnel State         : UP

     Forward-Path : ILM   <OPCODE : Swap>
       Incoming-Label : 1001                Incoming-Interface  : eth1
       ILM-Index      : 1                          Cross-Connect-Index : 1
       Outgoing-Label : 1002                Outgoing-Interface  : eth2
       NHLFE Index    : 1
       BW-class       : N/A
       Status : UP
```

PE2

```
PE2#show mpls-tp tunnel

 Tunnel-id              : 1                Tunnel-Name          : tnl1
 Source Global-Id       : 100              Source Node-Id       : 1.1.1.1
 Destination Global-Id : 300               Destination Node-Id : 3.3.3.3
 Role   : Destination                      Tunnel Index         : 1
 Mode   : UNIDIRECTIONAL                   Tunnel State         : UP

    Reverse-Path : ILM   <OPCODE : Pop>
       Incoming-Label : 1002                Incoming-Interface  : eth2
       ILM-Index      : 1                   Cross-Connect-Index : 1
       Status : UP
```

Co-Routed Bi-Directional Tunnel

PE1 (NSM)

`#configure terminal`	Enter configure mode.
`(config)#mpls-tp global-id 100 node-id 1.1.1.1`	Configure the global identifier and node identifier.
`(config)#interface eth1`	Enter interface mode for eth1.
`(config-if)#mpls-tp provider-interface 10.1.1.1`	Configure the interface as provider and set the local identifier to 10.1.1.1.
`(config)#mpls-tp tunnel 1 source 100 1.1.1.1 destination 300 3.3.3.3`	Configure the tunnel identifier, the source global identifier and node identifier, and the destination global identifier and node identifier.
`(config-tnl)#tunnel-name tnl1`	Set the tunnel name.
`(config-tnl)#tunnel-mode bidirectional`	Make the tunnel bidirectional.
`(config-bidir-tnl)#forward-path nhlfe-entry 1001 eth1`	Configure the NHLFE entry to push the label at ingress for the forward path.
`(config-bidir-tnl)#reverse-path ilm-entry 2002 eth1 pop`	Configure the ILM entry to pop the label at egress for the reverse path.

P1 (NSM)

`#configure terminal`	Enter configure mode.
`(config)#mpls-tp global-id 200 node-id 2.2.2.2`	Configure the global identifier and node identifier.
`(config)#interface eth1`	Enter interface mode for eth1.
`(config-if)#mpls-tp provider-interface 10.1.1.2`	Configure the interface as provider and set the local identifier to 10.1.1.2
`(config)#interface eth2`	Enter interface mode for eth2.
`(config-if)#mpls-tp provider-interface 30.1.1.1`	Configure the interface as provider and set the local identifier to 20.1.1.1.
`(config)#mpls-tp tunnel 1 source 100 1.1.1.1 destination 300 3.3.3.3`	Configure the tunnel identifier, the source global identifier and node identifier, and the destination global identifier and node identifier.
`(config-tnl)#tunnel-name tnl1`	Set the tunnel name.
`(config-tnl)#tunnel-mode bidirectional`	Make the tunnel bidirectional.
`(config-bidir-tnl)#forward-path ilm-entry 1001 eth1 swap 1002 eth2`	Configure the ILM entry to swap the label at transit for the forward path.
`(config-bidir-tnl)#reverse-path ilm-entry 2001 eth2 swap 2002 eth1`	Configure the ILM entry to swap the label at transit for the reverse path.

PE2 (NSM)

`#configure terminal`	Enter configure mode.
`(config)#mpls-tp global-id 300 node-id 3.3.3.3`	Configure the global identifier and node identifier.
`(config)#interface eth2`	Enter interface mode for eth2

`(config-if)#mpls-tp provider-interface 30.1.1.2`	Configure the interface as provider and set the local identifier to 20.1.1.2.
`(config)#mpls-tp tunnel 1 source 100 1.1.1.1 destination 300 3.3.3.3`	Configure the tunnel identifier, the source global identifier and node identifier, and the destination global identifier and node identifier.
`(config-tnl)#tunnel-name tnl1`	Set the tunnel name.
`(config-tnl)#tunnel-mode bidirectional`	Make the tunnel bidirectional.
`(config-bidir-tnl)#forward-path ilm-entry 1002 eth2 pop`	Configure the NHLFE entry to push the label at ingress for the forward path.
`(config-bidir-tnl)#reverse-path nhlfe-entry 2001 eth2`	Configure the ILM entry to pop the label at egress for the reverse path.

Validation

PE1

```
PE1#show mpls-tp tunnel

<==============================================================================>
 Tunnel-id             : 1              Tunnel-Name         : tnl1
 Source Global-Id      : 100            Source Node-Id      : 1.1.1.1
 Destination Global-Id : 300            Destination Node-Id : 3.3.3.3
 Role  : Source                         Tunnel Index        : 1
 Mode  : COROUTED(bidirectional)     Tunnel State        : UP


     Forward-Path : NHLFE   <OPCODE : Push>
       Outgoing-Label : 1001              Outgoing-Interface : eth1
       NHLFE Index    : 1
       BW-class       : N/A
       Status : UP
     Reverse-Path : ILM   <OPCODE : Pop>
       Incoming-Label : 2002              Incoming-Interface  : eth1
       ILM-Index      : 1                         Cross-Connect-Index : 2
       Status : UP
<==============================================================================>
```

P1

```
P1#show mpls-tp tunnel

<==============================================================================>
 Tunnel-id             : 1              Tunnel-Name         : tnl1
 Source Global-Id      : 100           Source Node-Id      : 1.1.1.1
 Destination Global-Id : 300          Destination Node-Id : 3.3.3.3
 Role  : Transit                        Tunnel Index        : 1
 Mode  : COROUTED(bidirectional)     Tunnel State        : UP

     Forward-Path : ILM   <OPCODE : Swap>
       Incoming-Label : 1001              Incoming-Interface  : eth1
       ILM-Index      : 1                         Cross-Connect-Index : 1
       Outgoing-Label : 1002              Outgoing-Interface  : eth2
       NHLFE Index    : 1
       BW-class       : N/A
       Status : UP
     Reverse-Path : ILM   <OPCODE : Swap>
```

```
        Incoming-Label : 2001             Incoming-Interface  : eth2
        ILM-Index      : 2                       Cross-Connect-Index : 2
        Outgoing-Label : 2002            Outgoing-Interface  : eth1
        NHLFE Index    : 2
        BW-class       : N/A
        Status : UP
    : N/A
        Status : UP
<==============================================================================>
```

PE2

```
PE2#show mpls-tp tunnel

<==============================================================================>
  Tunnel-id            : 1              Tunnel-Name         : tnl1
 Source Global-Id      : 100            Source Node-Id      : 1.1.1.1
 Destination Global-Id : 300            Destination Node-Id : 3.3.3.3
 Role  : Destination                    Tunnel Index        : 1
 Mode  : COROUTED(bidirectional)        Tunnel State        : UP


      Forward-Path : ILM   <OPCODE : Pop>
        Incoming-Label : 1002            Incoming-Interface  : eth2
        ILM-Index      : 1                          Cross-Connect-Index : 1
        Status : UP
      Reverse-Path : NHLFE   <OPCODE : Push>
        Outgoing-Label : 2001              Outgoing-Interface : eth2
        NHLFE Index    : 1
        BW-class       : N/A
        Status : UP
    : N/A
        Status : UP
<==============================================================================>
```

Associated Bi-Directional Tunnel

In this configuration, the associated tunnel reverse path travels in different nodes.

PE1 (NSM)

`#configure terminal`	Enter configure mode.
`(config)#mpls-tp global-id 100 node-id 1.1.1.1`	Configure the global identifier and node identifier.
`(config)#interface eth1`	Enter interface mode for eth1.
`(config-if)#mpls-tp provider-interface 10.1.1.1`	Configure the interface as provider and set the local identifier to 10.1.1.1.
`(config-if)#exit`	Exit interface mode.
`(config)#interface eth3`	Enter interface mode.
`(config-if)#mpls-tp provider interface 20.1.1.1`	Configure the interface as provider and set the local identifier to 20.1.1.1.
`(config-if)#exit`	Exit interface mode.

`(config)#mpls-tp tunnel 1 source 100 1.1.1.1 destination 300 3.3.3.3`	Configure the tunnel identifier, the source global identifier and node identifier, and the destination global identifier and node identifier.
`(config-tnl)#tunnel-name tnl1`	Set the tunnel name.
`(config-tnl)#tunnel-mode unidirectional`	Make the tunnel unidirectional.
`(config-unidir-tnl)#nhlfe-entry 1001 eth1`	Configure the NHLFE entry to push label at ingress for the forward path.
`(config)#mpls-tp tunnel 2 source 300 3.3.3.3 destination 100 1.1.1.1`	Configure the tunnel identifier, the source global identifier and node identifier, and the destination global identifier and node identifier.
`(config-tnl)#tunnel-name tnl2`	Set the tunnel name.
`(config-tnl)#tunnel-mode unidirectional`	Make the tunnel unidirectional.
`(config-unidir-tnl)#ilm-entry 2002 eth3 pop`	Configure the ILM entry to pop the label at ingress for the reverse path.
`(config)#mpls-tp associate fwd-tunnel tnl1 rev-tunnel tnl2`	Associate the forward and reverse tunnels.

P1 (NSM)

`#configure terminal`	Enter configure mode.
`(config)#mpls-tp global-id 200 node-id 2.2.2.2`	Configure the global identifier and node identifier.
`(config)#interface eth1`	Enter interface mode for eth1.
`(config-if)#mpls-tp provider-interface 10.1.1.2`	Configure the interface as provider and set the local identifier to 10.1.1.2
`(config)#interface eth2`	Enter interface mode for eth2.
`(config-if)#mpls-tp provider-interface 20.1.1.1`	Configure the interface as provider and set the local identifier to 20.1.1.1
`(config)#mpls-tp tunnel 1 source 100 1.1.1.1 destination 300 3.3.3.3`	Configure the tunnel identifier, the source global identifier and node identifier, and the destination global identifier and node identifier.
`(config-tnl)#tunnel-name tnl1`	Set the tunnel name.
`(config-tnl)#tunnel-mode unidirectional`	Make the tunnel unidirectional.
`(config-unidir-tnl)#ilm-entry 1001 eth1 swap 1002 eth2`	Configure the ILM entry to swap the label at transit for the forward path.

P2 (NSM)

`#configure terminal`	Enter configure mode.
`(config)#mpls-tp global-id 400 node-id 4.4.4.4`	Configure the global identifier and node identifier.
`(config)#interface eth1`	Enter interface mode for eth1.
`(config-if)#mpls-tp provider-interface 60.1.1.1`	Configure the interface as provider and set the local identifier to 60.1.1.1
`(config-if)#exit`	Exit interface mode.
`(config)#interface eth3`	Enter interface mode.

`(config-tnl)#mpls-tp provider-interface 20.1.1.2`	Configure the interface as provider and set the local identifier to 20.1.1.2
`(config-if)#exit`	Exit interface mode.
`(config-tnl)#mpls-tp tunnel 2 source 300 3.3.3.3 destination 100 1.1.1.1`	Configure the tunnel identifier, the source global identifier and node identifier, and the destination global identifier and node identifier.
`(config-tnl)#tunnel-name tnl2`	Set the tunnel name.
`(config-tnl)#tunnel-mode undirectional`	Make the tunnel unidirectional.
`(config-unidir-tnl)#ilm-entry 2001 eth1 swap 2002 eth3`	Configure the ILM entry to swap the label at transit for the forward path.

PE2 (NSM)

`#configure terminal`	Enter configure mode.
`(config)#mpls-tp global-id 300 node-id 3.3.3.3`	Configure the global identifier and node identifier.
`(config)#interface eth1`	Enter interface mode.
`(config-if)#mpls-tp provider-interface 20.1.1.2`	Configure the interface as provider and set the local identifier to 20.1.1.2
`(config-if)#exit`	Exit interface mode.
`(config)#interface eth2`	Enter interface mode for eth2.
`(config-if)#mpls-tp provider-interface 30.1.1.1`	Configure the interface as provider and set the local identifier to 30.1.1.1
`(config-if)#exit`	Exit interface mode.
`(config)#mpls-tp tunnel 1 source 100 1.1.1.1 destination 300 3.3.3.3`	Configure the tunnel identifier, the source global identifier and node identifier, and the destination global identifier and node identifier.
`(config-tnl)#tunnel-name tnl1`	Set the tunnel name.
`(config-tnl)#tunnel-mode unidirectional`	Make the tunnel unidirectional.
`(config-unidir-tnl)#ilm-entry 1002 eth2 pop`	Configure the ILM entry to pop the label for the forward path at egress.
`(config)#mpls-tp tunnel 2 source 300 3.3.3.3 destination 100 1.1.1.1`	Configure the tunnel identifier, the source global identifier and node identifier, and the destination global identifier and node identifier.
`(config-tnl)#tunnel-name tnl2`	Set the tunnel name.
`(config-tnl)#tunnel-mode unidirectional`	Make the tunnel unidirectional.
`(config-unidir-tnl)#nhlfe-entry 2001 eth1`	Configure NHFLE entry to push the label for the reverse path at egress.
`(config)#mpls-tp associate fwd-tunnel tnl2 rev-tunnel tnl1`	Associate the forward and reverse tunnels.

Validation

PE1

```
PE1#show mpls-tp tunnel
<===============================================================================>
 Tunnel-id              : 1                     Tunnel-Name          : tnl1
 Source Global-Id       : 100                   Source Node-Id       : 1.1.1.1
 Destination Global-Id : 300                    Destination Node-Id : 3.3.3.3
```

```
 Role  : Source                         Tunnel Index        : 1
 Mode  : ASSOCIATED(unidirectional)     Tunnel State        : UP
 Associated-Tunnel   : tnl2
     Forward-Path : NHLFE   <OPCODE : Push>
       Outgoing-Label : 1001             Outgoing-Interface : eth1
       NHLFE Index    : 1
       BW-class       : N/A
       Status : UP

<============================================================================>
 Tunnel-id             : 2              Tunnel-Name         : tnl2
 Source Global-Id      : 300            Source Node-Id      : 3.3.3.3
 Destination Global-Id : 100            Destination Node-Id : 1.1.1.1
 Role  : Destination                    Tunnel Index        : 2
 Mode  : ASSOCIATED(unidirectional)     Tunnel State        : UP
 Associated-Tunnel   : tnl1

     Reverse-Path : ILM   <OPCODE : Pop>
       Incoming-Label : 2002             Incoming-Interface  : eth3
       ILM-Index      : 1                Cross-Connect-Index : 2
       Status : UP
```

P1

```
P1#show mpls-tp tunnel

<===========================================================================>
 Tunnel-id             : 1              Tunnel-Name         : tnl1
 Source Global-Id      : 100            Source Node-Id      : 1.1.1.1
 Destination Global-Id : 300            Destination Node-Id : 3.3.3.3
 Role  : Transit                        Tunnel Index        : 1
 Mode  : UNIDIRECTIONAL                  Tunnel State        : UP
     Forward-Path : ILM   <OPCODE : Swap>
       Incoming-Label : 1001             Incoming-Interface  : eth1
       ILM-Index      : 1                       Cross-Connect-Index : 1
       Outgoing-Label : 1002             Outgoing-Interface  : eth2
       NHLFE Index    : 1
       BW-class       : N/A
       Status : UP
```

P2

```
P2#show mpls-tp tunnel

<===========================================================================>
 Tunnel-id             : 2              Tunnel-Name         : tnl2
 Source Global-Id      : 300            Source Node-Id      : 3.3.3.3
 Destination Global-Id : 100            Destination Node-Id : 1.1.1.1
 Role  : Transit                        Tunnel Index        : 2
 Mode  : UNIDIRECTIONAL                 Tunnel State        : UP

     Forward-Path : ILM   <OPCODE : Swap>
       Incoming-Label : 2001             Incoming-Interface  : eth1
       ILM-Index      : 2                Cross-Connect-Index : 1
       Outgoing-Label : 2002             Outgoing-Interface  : eth3
       NHLFE Index    : 2
       BW-class       : N/A
       Status : UP
```

PE2

```
PE2#show mpls-tp tunnel

<==========================================================================>
 Tunnel-id              : 2               Tunnel-Name          : tnl2
 Source Global-Id       : 300             Source Node-Id       : 3.3.3.3
 Destination Global-Id : 100              Destination Node-Id : 1.1.1.1
 Role  : Source                           Tunnel Index         : 2
 Mode  : ASSOCIATED(unidirectional)       Tunnel State         : UP
 Associated-Tunnel    : tnl1

     Forward-Path : NHLFE   <OPCODE : Push>
       Outgoing-Label : 2001               Outgoing-Interface : eth1
       NHLFE Index    : 1
       BW-class       : N/A
       Status : UP

<============================================================================>
 Tunnel-id              : 1               Tunnel-Name          : tnl1
 Source Global-Id       : 100             Source Node-Id       : 1.1.1.1
 Destination Global-Id : 300              Destination Node-Id : 3.3.3.3
 Role  : Destination                      Tunnel Index         : 1
 Mode  : ASSOCIATED(unidirectional)       Tunnel State         : UP
 Associated-Tunnel    : tnl2

     Reverse-Path : ILM   <OPCODE : Pop>
       Incoming-Label : 1002               Incoming-Interface  : eth2
       ILM-Index      : 1                  Cross-Connect-Index : 1
       Status : UP
```

Configuring Tunnels Using ITU-T Identifiers

Topology

The procedures in this section use the topology in Figure 16-2.

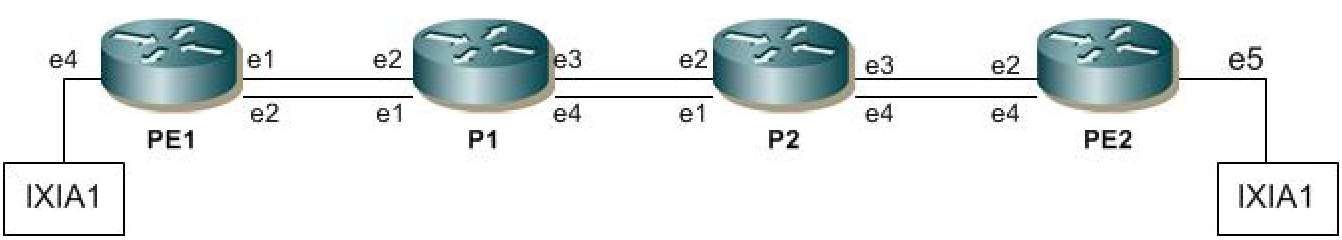


Figure 16-2: MPLS-TP Tunnel Topology (ITUT-T)

Unidirectional Tunnel

Forward Tunnel

PE1 (NSM)

`#configure terminal`	Enter configure mode
`(config)#mpls-tp itut cc IN icc AIRTEL node-id 1.1.1.1`	Configure the country code, carrier code, and node identifier.
`(config)#interface eth1`	Enter interface mode for eth1.
`(config-if)#mpls-tp provider-interface 10.1.1.1`	Configure the interface as provider and set the local identifier to 10.1.1.1
`(config)#mpls-tp tunnel 2 source IN AIRTEL 1.1.1.1 destination IN AIRTEL 4.4.4.4`	Configure the tunnel identifier as well as the country code, carrier code, and node identifier for the source and destination.
`(config-tnl)#tunnel-name tnl_as_fwd`	Set the tunnel name.
`(config-tnl)#tunnel-mode unidirectional`	Make the tunnel unidirectional.
`(config-unidir-tnl)#nhlfe-entry 1001 eth1`	Configure the NHFE entry to push the label at ingress for the forward path.

P1 (NSM)

`#configure terminal`	Enter configure mode
`(config)#mpls-tp itut cc IN icc AIRTEL node-id 2.2.2.2`	Configure the country code, carrier code, and node identifier.
`(config)#interface eth2`	Enter interface mode for eth2
`(config-if)#mpls-tp provider-interface 20.1.1.1`	Configure the interface as provider and set the local identifier to 20.1.1.1
`(config)#interface eth3`	Enter interface mode for eth3
`(config-if)#mpls-tp provider-interface 30.1.1.1`	Configure the interface as provider and set the local identifier to 30.1.1.1
`(config)#mpls-tp tunnel 2 source IN AIRTEL 1.1.1.1 destination IN AIRTEL 4.4.4.4`	Configure the tunnel identifier as well as the country code, carrier code, and node identifier for the source and destination.
`(config-tnl)#tunnel-name tnl_as_fwd`	Set the tunnel name.
`(config-tnl)#tunnel-mode unidirectional`	Make the tunnel unidirectional.
`(config-unidir-tnl)#ilm-entry 1001 eth2 swap 1002 eth3`	Configure the ILM entry to swap the label at transit for the forward path

P2 (NSM)

`#configure terminal`	Enter configure mode
`(config)#mpls-tp itut cc IN icc AIRTEL node-id 3.3.3.3`	Configure the country code, carrier code, and node identifier.
`(config)#interface eth2`	Enter interface mode for eth2

(config-if)#mpls-tp provider-interface 20.1.1.1	Configure the interface as provider and set the local identifier to 20.1.1.1
(config)#interface eth3	Enter interface mode for eth3
(config-if)#mpls-tp provider-interface 30.1.1.1	Configure the interface as provider and set the local identifier to 30.1.1.1
(config)#mpls-tp tunnel 2 source IN AIRTEL 1.1.1.1 destination IN AIRTEL 4.4.4.4	Configure the tunnel identifier as well as the country code, carrier code, and node identifier for the source and destination.
(config-tnl)#tunnel-name tnl_as_fwd	Set the tunnel name.
(config-tnl)#tunnel-mode unidirectional	Make the tunnel unidirectional.
(config-unidir-tnl)#ilm-entry 1002 eth2 swap 1003 eth3	Configure the ILM entry to swap the label at transit for the forward path

PE2 (NSM)

#configure terminal	Enter configure mode
(config)#mpls-tp itut cc IN icc AIRTEL node-id 4.4.4.4	Configure the country code, carrier code, and node identifier.
(config)#interface eth2	Enter interface mode for eth2
(config-if)#mpls-tp provider-interface 10.1.1.1	Configure the interface as provider and set the local identifier to 10.1.1.1
(config)#mpls-tp tunnel 2 source IN AIRTEL 1.1.1.1 destination IN AIRTEL 4.4.4.4	Configure the tunnel identifier as well as the country code, carrier code, and node identifier for the source and destination.
(config-tnl)#tunnel-name tnl_as_fwd	Set the tunnel name.
(config-tnl)#tunnel-mode unidirectional	Make the tunnel unidirectional.
(config-unidir-tnl)#ilm-entry 1003 eth2 pop	Configure the ILM entry to pop the label for the forward path at egress

Validation

PE1

```
#sh mpls-tp tunnel tnl_as_fwd
 Tunnel-id             : 2             Tunnel-Name         : tnl_as_fwd
 Source ICC-Oper-ID    : INAIRTEL      Source Node-Id      : 1.1.1.1
 Destination ICC-Oper-ID: INAIRTEL      Destination Node-Id : 4.4.4.4
 Role   : Source                       Tunnel Index        : 2
 Mode   : UNIDIRECTIONALTunnel State     : UP
 Associated-Tunnel    : tnl_as_rev

     Forward-Path : NHLFE   <OPCODE : Push>
       Outgoing-Label : 1001              Outgoing-Interface : eth1
       NHLFE Index    : 3
       BW-class       : N/A
       Status : UP
     ---------------------------------------------------------
      MEG Index       : 2             ME Index        : 11
     ---------------------------------------------------------
        Lock          : Disabled
        Loopback      : Disabled
```

P1

```
#sh mpls-tp tunnel tnl_as_fwd
 Tunnel-id              : 2               Tunnel-Name         : tnl_as_fwd
 Source ICC-Oper-ID     : INAIRTEL        Source Node-Id      : 1.1.1.1
 Destination ICC-Oper-ID: INAIRTEL         Destination Node-Id : 4.4.4.4
 Role  : Transit                          Tunnel Index        : 2
 Mode  : UNIDIRECTIONALTunnel State         : UP
 Associated-Tunnel    : tnl_as_rev

     Forward-Path : ILM   <OPCODE : Swap>
       Incoming-Label : 1001               Incoming-Interface  : eth2
       ILM-Index      : 3                  Cross-Connect-Index : 3
       Outgoing-Label : 1002               Outgoing-Interface  : eth3
       NHLFE Index    : 3
       BW-class       : N/A
       Status : UP
     ---------------------------------------------------------
      MEG Index       : 2              ME Index        : 22
     ---------------------------------------------------------
        Lock          : Disabled
        Loopback      : Disabled
```

P2

```
#sh mpls-tp tunnel tnl_as_fwd
 Tunnel-id              : 2               Tunnel-Name         : tnl_as_fwd
 Source ICC-Oper-ID     : INAIRTEL        Source Node-Id      : 1.1.1.1
 Destination ICC-Oper-ID: INAIRTEL         Destination Node-Id : 4.4.4.4
 Role  : Transit                          Tunnel Index        : 2
 Mode  : UNIDIRECTIONALTunnel State         : UP
 Associated-Tunnel    : tnl_as_rev

     Forward-Path : ILM   <OPCODE : Swap>
       Incoming-Label : 1002               Incoming-Interface  : eth2
       ILM-Index      : 6                  Cross-Connect-Index : 3
       Outgoing-Label : 1003               Outgoing-Interface  : eth3
       NHLFE Index    : 3
       BW-class       : N/A
       Status : UP
     ---------------------------------------------------------
      MEG Index       : 2              ME Index        : 33
     ---------------------------------------------------------
        Lock          : Disabled
        Loopback      : Disabled
```

PE2

```
#sh mpls-tp tunnel tnl_as_fwd
 Tunnel-id              : 2               Tunnel-Name         : tnl_as_fwd
 Source ICC-Oper-ID     : INAIRTEL        Source Node-Id      : 1.1.1.1
 Destination ICC-Oper-ID: INAIRTEL         Destination Node-Id : 4.4.4.4
 Role  : Destination                      Tunnel Index        : 2
 Mode  : UNIDIRECTIONAL  Tunnel State         : UP
 Associated-Tunnel    : tnl_as_rev

     Reverse-Path : ILM   <OPCODE : Pop>
       Incoming-Label : 1003               Incoming-Interface  : eth2
       ILM-Index      : 2                  Cross-Connect-Index : 3
```

```
    Status : UP
------------------------------------------------------------
  MEG Index       : 3               ME Index       : 444
------------------------------------------------------------
    Lock          : Disabled
    Loopback      : Disabled
```

Reverse Tunnel

PE2 (NSM)

#configure terminal	Enter configure mode
(config)#mpls-tp itut cc IN icc AIRTEL node-id 4.4.4.4	Configure the country code, carrier code, and node identifier.
(config)#interface eth4	Enter interface mode for eth4
(config-if)#mpls-tp provider-interface 40.1.1.1	Configure the interface as provider and set the local identifier to 40.1.1.1
(config)#mpls-tp tunnel 3 source IN AIRTEL 4.4.4.4 destination IN AIRTEL 1.1.1.1	Configure the tunnel identifier as well as the country code, carrier code, and node identifier for the source and destination.
(config-tnl)#tunnel-name tnl_as_rev	Set the tunnel name.
(config-tnl)#tunnel-mode unidirectional	Make the tunnel unidirectional.
(config-unidir-tnl)#nhlfe-entry 2002 eth4	Configure the NHFE entry to push the label for the reverse path.

P1 (NSM)

#configure terminal	Enter configure mode
(config)#mpls-tp itut cc IN icc AIRTEL node-id 2.2.2.2	Configure the country code, carrier code, and node identifier.
(config)#interface eth1	Enter interface mode for eth1
(config-if)#mpls-tp provider-interface 10.1.1.1	Configure the interface as provider and set the local identifier to 10.1.1.1
(config)#interface eth4	Enter interface mode for eth4
(config-if)#mpls-tp provider-interface 40.1.1.1	Configure the interface as provider and set the local identifier to 40.1.1.1
(config)#mpls-tp tunnel 3 source IN AIRTEL 4.4.4.4 destination IN AIRTEL 1.1.1.1	Configure the tunnel identifier as well as the country code, carrier code, and node identifier for the source and destination.
(config-tnl)#tunnel-name tnl_as_rev	Set the tunnel name.
(config-tnl)#tunnel-mode unidirectional	Make the tunnel unidirectional.
(config-unidir-tnl)#ilm-entry 2003 eth4 swap 2004 eth1	Configure the ILM entry to swap the label at transit for the forward path.

P2 (NSM)

`#configure terminal`	Enter configure mode
`(config)#mpls-tp itut cc IN icc AIRTEL node-id 3.3.3.3`	Configure the country code, carrier code, and node identifier.
`(config)#interface eth1`	Enter interface mode for eth1
`(config-if)#mpls-tp provider-interface 10.1.1.1`	Configure the interface as provider and set the local identifier to 10.1.1.1
`(config)#interface eth4`	Enter interface mode for eth3.
`(config-if)#mpls-tp provider-interface 40.1.1.1`	Configure the interface as provider and set the local identifier to 40.1.1.1
`(config)#mpls-tp tunnel 3 source IN AIRTEL 4.4.4.4 destination IN AIRTEL 1.1.1.1`	Configure the tunnel identifier as well as the country code, carrier code, and node identifier for the source and destination.
`(config-tnl)#tunnel-name tnl_as_rev`	Set the tunnel name.
`(config-tnl)#tunnel-mode unidirectional`	Make the tunnel unidirectional.
`(config-unidir-tnl)#ilm-entry 2002 eth4 swap 2003 eth1`	Configure the ILM entry to swap the label at transit for the forward path.

PE1 (NSM)

`#configure terminal`	Enter configure mode
`(config)#mpls-tp itut cc IN icc AIRTEL node-id 1.1.1.1`	Configure the country code, carrier code, and node identifier.
`(config)#interface eth2`	Enter interface mode for eth2
`(config-if)#mpls-tp provider-interface 20.1.1.1`	Configure the interface as provider and set the local identifier to 20.1.1.1
`(config)#mpls-tp tunnel 3 source IN AIRTEL 4.4.4.4 destination IN AIRTEL 1.1.1.1`	Configure the tunnel identifier as well as the country code, carrier code, and node identifier for the source and destination.
`(config-tnl)#tunnel-name tnl_as_rev`	Set the tunnel name.
`(config-tnl)#tunnel-mode unidirectional`	Make the tunnel unidirectional.
`(config-unidir-tnl)#ilm-entry 2004 eth2 pop`	Configure the ILM entry to pop the label at egress for the reverse path.

Validation

PE1

```
#sh mpls-tp tunnel tnl_as_rev
 Tunnel-id              : 3          Tunnel-Name          : tnl_as_rev
 Source ICC-Oper-ID     : INAIRTEL   Source Node-Id       : 4.4.4.4
 Destination ICC-Oper-ID: INAIRTEL    Destination Node-Id : 1.1.1.1
 Role   : Destination                Tunnel Index         : 3
 Mode   : UNIDIRECTIONALTunnel State   : UP
 Associated-Tunnel    : tnl_as_fwd

     Reverse-Path : ILM   <OPCODE : Pop>
       Incoming-Label : 2004            Incoming-Interface  : eth2
       ILM-Index      : 2               Cross-Connect-Index : 4
```

```
        Status : UP
       ---------------------------------------------------------
    MEG Index       : 2              ME Index        : 11
      ---------------------------------------------------------
         Lock          : Disabled
         Loopback      : Disabled
```

P1

```
#sh mpls-tp tunnel tnl_as_rev
 Tunnel-id             : 3              Tunnel-Name         : tnl_as_rev
 Source ICC-Oper-ID    : INAIRTEL       Source Node-Id      : 4.4.4.4
 Destination ICC-Oper-ID: INAIRTEL       Destination Node-Id : 1.1.1.1
 Role  : Transit                        Tunnel Index        : 3
 Mode  : UNIDIRECTIONALTunnel State       : UP
 Associated-Tunnel   : tnl_as_fwd

     Forward-Path : ILM   <OPCODE : Swap>
       Incoming-Label : 2003              Incoming-Interface  : eth4
       ILM-Index      : 4                 Cross-Connect-Index : 4
       Outgoing-Label : 2004              Outgoing-Interface  : eth1
       NHLFE Index    : 4
       BW-class       : N/A
       Status : UP
     ---------------------------------------------------------
      MEG Index       : 3             ME Index        : 222
     ---------------------------------------------------------
        Lock          : Disabled
        Loopback      : Disabled
```

P2

```
#sh mpls-tp tunnel tnl_as_rev
 Tunnel-id             : 3              Tunnel-Name         : tnl_as_rev
 Source ICC-Oper-ID    : INAIRTEL       Source Node-Id      : 4.4.4.4
 Destination ICC-Oper-ID: INAIRTEL       Destination Node-Id : 1.1.1.1
 Role  : Transit                        Tunnel Index        : 3
 Mode  : UNIDIRECTIONALTunnel State       : UP
 Associated-Tunnel   : tnl_as_fwd

     Forward-Path : ILM   <OPCODE : Swap>
       Incoming-Label : 2002              Incoming-Interface  : eth4
       ILM-Index      : 7                 Cross-Connect-Index : 4
       Outgoing-Label : 2003              Outgoing-Interface  : eth1
       NHLFE Index    : 4
       BW-class       : N/A
       Status : UP
     ---------------------------------------------------------
      MEG Index       : 3             ME Index        : 333
     ---------------------------------------------------------
        Lock          : Disabled
        Loopback      : Disabled
```

PE2

```
#sh mpls-tp tunnel tnl_as_rev
 Tunnel-id             : 3              Tunnel-Name         : tnl_as_rev
 Source ICC-Oper-ID    : INAIRTEL       Source Node-Id      : 4.4.4.4
 Destination ICC-Oper-ID: INAIRTEL       Destination Node-Id : 1.1.1.1
```

```
Role  : Source                          Tunnel Index        : 3
Mode  : UNIDIRECTIONALTunnel State        : UP
Associated-Tunnel   : tnl_as_fwd

    Forward-Path : NHLFE   <OPCODE : Push>
      Outgoing-Label : 2002               Outgoing-Interface : eth4
      NHLFE Index    : 4
      BW-class       : N/A
      Status : UP
    ----------------------------------------------------------
     MEG Index       : 2              ME Index        : 44
    ----------------------------------------------------------
       Lock          : Disabled
       Loopback      : Disabled
```

Co-Routed Bi-Directional Tunnel

PE1 (NSM)

`#configure terminal`	Enter configure mode
`(config)#mpls-tp itut cc IN icc AIRTEL node-id 1.1.1.1`	Configure the country code, carrier code, and node identifier.
`(config)#interface eth1`	Enter interface mode for eth1
`(config-if)#mpls-tp provider-interface 10.1.1.1`	Configure the interface as provider and set the local identifier to 10.1.1.1
`(config)#mpls-tp tunnel 1 source IN AIRTEL 1.1.1.1 destination IN AIRTEL 4.4.4.4`	Configure the tunnel identifier as well as the country code, carrier code, and node identifier for the source and destination.
`(config-tnl)#tunnel-name tnl_co`	Set the tunnel name.
`(config-tnl)#tunnel-mode bidirectional`	Make the tunnel bidirectional.
`(config-bidir-tnl)#forward-path nhlfe-entry 3001 eth1`	Configure the NHFE entry to push the label at ingress for the forward path.
`(config-bidir-tnl)#reverse-path ilm-entry 4002 eth1 pop`	Configure the ILM entry to pop the label for the reverse path.

P1 (NSM)

`#configure terminal`	Enter configure mode
`(config)#mpls-tp itut cc IN icc AIRTEL node-id 2.2.2.2`	Configure the country code, carrier code, and node identifier.
`(config)#interface eth2`	Enter interface mode for eth2
`(config-if)#mpls-tp provider-interface 20.1.1.1`	Configure the interface as provider and set the local identifier to 20.1.1.1
`(config)#interface eth3`	Enter interface mode for eth3
`(config-if)#mpls-tp provider-interface 30.1.1.1`	Configure the interface as provider and set the local identifier to 30.1.1.1
`(config)#mpls-tp tunnel 1 source IN AIRTEL 1.1.1.1 destination IN AIRTEL 4.4.4.4`	Configure the tunnel identifier as well as the country code, carrier code, and node identifier for the source and destination.

(config-tnl)#tunnel-name tnl_co	Set the tunnel name.
(config-tnl)#tunnel-mode bidirectional	Make the tunnel bidirectional.
(config-bidir-tnl)#forward-path ilm-entry 3001 eth2 swap 3002 eth3	Configure the ILM entry to swap the label at transit for the forward path.
(config-bidir-tnl)#reverse-path ilm-entry 4001 eth3 swap 4002 eth2	Configure the ILM entry to swap the label at transit for the reverse path.

P2 (NSM)

#configure terminal	Enter configure mode.
(config)#mpls-tp itut cc IN icc AIRTEL node-id 3.3.3.3	Configure the country code, carrier code, and node identifier.
(config)#interface eth2	Enter interface mode for eth2.
(config-if)#mpls-tp provider-interface 20.1.1.1	Configure the interface as provider and set the local identifier to 20.1.1.1
(config)#interface eth3	Enter interface mode for eth3
(config-if)#mpls-tp provider-interface 30.1.1.1	Configure the interface as provider and set the local identifier to 30.1.1.1
(config)#mpls-tp tunnel 2 source IN AIRTEL 1.1.1.1 destination IN AIRTEL 4.4.4.4	Configure the tunnel identifier as well as the country code, carrier code, and node identifier for the source and destination.
(config-tnl)#tunnel-name tnl_co	Set the tunnel name.
(config-tnl)#tunnel-mode bidirectional	Make the tunnel bidirectional.
(config-bidir-tnl)#forward-path ilm-entry 3002 eth2 swap 3003 eth3	Configure the ILM entry to swap the label at transit for the forward path.
(config-bidir-tnl)#reverse-path ilm-entry 4000 eth3 swap 4001 eth2	Configure the ILM entry to swap the label at transit for the reverse path.

PE2 (NSM)

#configure terminal	Enter configure mode.
(config)#mpls-tp itut cc IN icc AIRTEL node-id 4.4.4.4	Configure the country code, carrier code, and node identifier.
(config)#interface eth2	Enter interface mode for eth2
(config-if)#mpls-tp provider-interface 20.1.1.1	Configure the interface as provider and set the local identifier to 20.1.1.1
(config)#mpls-tp tunnel 1 source IN AIRTEL 1.1.1.1 destination IN AIRTEL 4.4.4.4	Configure the tunnel identifier as well as the country code, carrier code, and node identifier for the source and destination.
(config-tnl)#tunnel-name tnl_co	Set the tunnel name.
(config-tnl)#tunnel-mode bidirectional	Make the tunnel bidirectional.
(config-bidir-tnl)#forward-path ilm-entry 3003 eth2 pop	Configure the ILM entry to pop the label for the forward path at egress.
(config-bidir-tnl)#reverse-path nhlfe-entry 4000 eth2	Configure the NHFE entry to push the label for the reverse path at egress.

Validation

PE1

```
#sh mpls-tp tunnel tnl_co
PE1#sh mpls-tp tunnel tnl_co
 Tunnel-id             : 1                Tunnel-Name         : tnl_co
 Source ICC-Oper-ID    : INAIRTEL         Source Node-Id      : 1.1.1.1
 Destination ICC-Oper-ID: INAIRTEL         Destination Node-Id : 4.4.4.4
 Role  : Source                           Tunnel Index        : 1
 Mode  : COROUTED(bidirectional)          Tunnel State        : UP


     Forward-Path : NHLFE   <OPCODE : Push>
       Outgoing-Label : 3001              Outgoing-Interface : eth1
       NHLFE Index    : 1
       BW-class       : N/A
       Status : UP
     Reverse-Path : ILM   <OPCODE : Pop>
       Incoming-Label : 4002              Incoming-Interface  : eth1
       ILM-Index      : 1                 Cross-Connect-Index : 2
       Status : UP
     ---------------------------------------------------------
      MEG Index       : 1              ME Index        : 1
     ---------------------------------------------------------
        Lock          : Enabled
        Loopback      : Disabled
```

P1

```
#sh mpls-tp tunnel tnl_co
 Tunnel-id             : 1                Tunnel-Name         : tnl_co
 Source ICC-Oper-ID    : INAIRTEL         Source Node-Id      : 1.1.1.1
 Destination ICC-Oper-ID: INAIRTEL         Destination Node-Id : 4.4.4.4
 Role  : Transit                          Tunnel Index        : 1
 Mode  : COROUTED(bidirectional)          Tunnel State        : UP


     Forward-Path : ILM   <OPCODE : Swap>
       Incoming-Label : 3001              Incoming-Interface  : eth2
       ILM-Index      : 1                 Cross-Connect-Index : 1
       Outgoing-Label : 3002              Outgoing-Interface  : eth3
       NHLFE Index    : 1
       BW-class       : N/A
       Status : UP
     Reverse-Path : ILM   <OPCODE : Swap>
       Incoming-Label : 4001              Incoming-Interface  : eth3
       ILM-Index      : 2                 Cross-Connect-Index : 2
       Outgoing-Label : 4002              Outgoing-Interface  : eth2
       NHLFE Index    : 2
       BW-class       : N/A
       Status : UP
     ---------------------------------------------------------
      MEG Index       : 1              ME Index        : 2
     ---------------------------------------------------------
        Lock          : Disabled
        Loopback      : Disabled
```

P2

```
#sh mpls-tp tunnel tnl_co
 Tunnel-id              : 1                 Tunnel-Name          : tnl_co
 Source ICC-Oper-ID     : INAIRTEL          Source Node-Id       : 1.1.1.1
 Destination ICC-Oper-ID: INAIRTEL           Destination Node-Id : 4.4.4.4
 Role  : Transit                            Tunnel Index         : 1
 Mode  : COROUTED(bidirectional)            Tunnel State         : UP


     Forward-Path : ILM   <OPCODE : Swap>
       Incoming-Label : 3002                 Incoming-Interface  : eth2
       ILM-Index      : 3                    Cross-Connect-Index : 1
       Outgoing-Label : 3003                 Outgoing-Interface  : eth3
       NHLFE Index    : 1
       BW-class       : N/A
       Status : UP
     Reverse-Path : ILM   <OPCODE : Swap>
       Incoming-Label : 4000                 Incoming-Interface  : eth3
       ILM-Index      : 4                    Cross-Connect-Index : 2
       Outgoing-Label : 4001                 Outgoing-Interface  : eth2
       NHLFE Index    : 2
       BW-class       : N/A
       Status : UP
     ---------------------------------------------------------
      MEG Index       : 1             ME Index        : 3
     ---------------------------------------------------------
        Lock          : Disabled
        Loopback      : Disabled
```

PE2

```
#sh mpls-tp tunnel tnl_co
 Tunnel-id              : 1                 Tunnel-Name          : tnl_co
 Source ICC-Oper-ID     : INAIRTEL          Source Node-Id       : 1.1.1.1
 Destination ICC-Oper-ID: INAIRTEL           Destination Node-Id : 4.4.4.4
 Role  : Destination                        Tunnel Index         : 1
 Mode  : COROUTED(bidirectional)            Tunnel State         : UP


     Forward-Path : ILM   <OPCODE : Pop>
       Incoming-Label : 3003                 Incoming-Interface  : eth2
       ILM-Index      : 1                    Cross-Connect-Index : 1
       Status : UP
     Reverse-Path : NHLFE   <OPCODE : Push>
       Outgoing-Label : 4000                 Outgoing-Interface : eth2
       NHLFE Index    : 2
       BW-class       : N/A
       Status : UP
     ---------------------------------------------------------
      MEG Index       : 1             ME Index        : 4
     ---------------------------------------------------------
        Lock          : Disabled
        Loopback      : Disabled
```

Associated Bi-Directional Tunnel

Forward Tunnel

PE1 (NSM)

`#configure terminal`	Enter configure mode.
`(config)#mpls-tp itut cc IN icc AIRTEL node-id 1.1.1.1`	Configure the country code, carrier code, and node identifier.
`(config)#interface eth1`	Enter interface mode for eth1
`(config-if)#mpls-tp provider-interface 10.1.1.1`	Configure the interface as provider and set the local identifier to 10.1.1.1
`(config)#mpls-tp tunnel 2 source IN AIRTEL 1.1.1.1 destination IN AIRTEL 4.4.4.4`	Configure the tunnel identifier as well as the country code, carrier code, and node identifier for the source and destination.
`(config-tnl)#tunnel-name tnl_as_fwd`	Set the tunnel name.
`(config-tnl)#tunnel-mode unidirectional`	Make the tunnel unidirectional.
`(config-unidir-tnl)#nhlfe-entry 1001 eth1`	Configure the NHFE entry to push the label at ingress for the forward path.

P1 (NSM)

`#configure terminal`	Enter configure mode.
`(config)#mpls-tp itut cc IN icc AIRTEL node-id 2.2.2.2`	Configure the country code, carrier code, and node identifier.
`(config)#interface eth2`	Enter interface mode for eth2
`(config-if)#mpls-tp provider-interface 20.1.1.1`	Configure the interface as provider and set the local identifier to 20.1.1.1
`(config)#interface eth3`	Enter interface mode for eth3
`(config-if)#mpls-tp provider-interface 30.1.1.1`	Configure the interface as provider and set the local identifier to 30.1.1.1
`(config)#mpls-tp tunnel 2 source IN AIRTEL 1.1.1.1 destination IN AIRTEL 4.4.4.4`	Configure the tunnel identifier as well as the country code, carrier code, and node identifier for the source and destination.
`(config-tnl)#tunnel-name tnl_as_fwd`	Set the tunnel name.
`(config-tnl)#tunnel-mode unidirectional`	Make the tunnel unidirectional.
`(config-unidir-tnl)#ilm-entry 1001 eth2 swap 1002 eth3`	Configure the ILM entry to swap the label at transit for the forward path.

P2 (NSM)

`#configure terminal`	Enter configure mode.
`(config)#mpls-tp itut cc IN icc AIRTEL node-id 3.3.3.3`	Configure the country code, carrier code, and node identifier.
`(config)#interface eth2`	Enter interface mode for eth2

`(config-if)#mpls-tp provider-interface 20.1.1.1`	Configure the interface as provider and set the local identifier to 20.1.1.1
`(config)#interface eth3`	Enter interface mode for eth3
`(config-if)#mpls-tp provider-interface 30.1.1.1`	Configure the interface as provider and set the local identifier to 30.1.1.1
`(config)#mpls-tp tunnel 2 source IN AIRTEL 1.1.1.1 destination IN AIRTEL 4.4.4.4`	Configure the tunnel identifier as well as the country code, carrier code, and node identifier for the source and destination.
`(config-tnl)#tunnel-name tnl_as_fwd`	Set the tunnel name.
`(config-tnl)#tunnel-mode unidirectional`	Make the tunnel unidirectional.
`(config-unidir-tnl)#ilm-entry 1002 eth2 swap 1003 eth3`	Configure the ILM entry to swap the label at transit for the forward path.

PE2 (NSM)

`#configure terminal`	Enter configure mode.
`(config)#mpls-tp itut cc IN icc AIRTEL node-id 4.4.4.4`	Configure the country code, carrier code, and node identifier.
`(config)#interface eth1`	Enter interface mode for eth1
`(config-if)#mpls-tp provider-interface 10.1.1.1`	Configure the interface as provider and set the local identifier to 10.1.1.1
`(config)#mpls-tp tunnel 2 source IN AIRTEL 1.1.1.1 destination IN AIRTEL 4.4.4.4`	Configure the tunnel identifier as well as the country code, carrier code, and node identifier for the source and destination.
`(config-tnl)#tunnel-name tnl_as_fwd`	Set the tunnel name.
`(config-tnl)#tunnel-mode unidirectional`	Make the tunnel unidirectional.
`(config-unidir-tnl)#ilm-entry 1003 eth2 pop`	Configure the ILM entry to pop the label for the forward path at egress.

Reverse Tunnel

PE2 (NSM)

`#configure terminal`	Enter configure mode.
`(config)#mpls-tp itut cc IN icc AIRTEL node-id 4.4.4.4`	Configure the country code, carrier code, and node identifier.
`(config)#interface eth4`	Enter interface mode for eth4
`(config-if)#mpls-tp provider-interface 40.1.1.1`	Configure the interface as provider and set the local identifier to 40.1.1.1
`(config)#mpls-tp tunnel 3 source IN AIRTEL 4.4.4.4 destination IN AIRTEL 1.1.1.1`	Configure the tunnel identifier as well as the country code, carrier code, and node identifier for the source and destination.
`(config-tnl)#tunnel-name tnl_as_rev`	Set the tunnel name.
`(config-tnl)#tunnel-mode unidirectional`	Make the tunnel unidirectional.
`(config-unidir-tnl)#nhlfe-entry 2002 eth4`	Configure the NHFE entry to push the label for the reverse path.

P1 (NSM)

`#configure terminal`	Enter configure mode.
`(config)#mpls-tp itut cc IN icc AIRTEL node-id 2.2.2.2`	Configure the country code, carrier code, and node identifier.
`(config)#interface eth1`	Enter interface mode for eth1
`(config-if)#mpls-tp provider-interface 10.1.1.1`	Configure the interface as provider and set the local identifier to 10.1.1.1
`(config)#interface eth4`	Enter interface mode for eth4
`(config-if)#mpls-tp provider-interface 40.1.1.1`	Configure the interface as provider and set the local identifier to 40.1.1.1
`(config)#mpls-tp tunnel 3 source IN AIRTEL 4.4.4.4 destination IN AIRTEL 1.1.1.1`	Configure the tunnel identifier as well as the country code, carrier code, and node identifier for the source and destination.
`(config-tnl)#tunnel-name tnl_as_rev`	Set the tunnel name.
`(config-tnl)#tunnel-mode unidirectional`	Make the tunnel unidirectional.
`(config-unidir-tnl)#ilm-entry 2003 eth4 swap 2004 eth1`	Configure the ILM entry to SWAP the labels at transit for the forward path

P2 (NSM)

`#configure terminal`	Enter configure mode.
`(config)#mpls-tp itut cc IN icc AIRTEL node-id 3.3.3.3`	Configure the country code, carrier code, and node identifier.
`(config)#interface eth1`	Enter interface mode for eth1
`(config-if)#mpls-tp provider-interface 10.1.1.1`	Configure the interface as provider and set the local identifier to 10.1.1.1
`(config)#interface eth4`	Enter interface mode for eth3
`(config-if)#mpls-tp provider-interface 40.1.1.1`	Configure the interface as provider and set the local identifier to 40.1.1.1
`(config)#mpls-tp tunnel 3 source IN AIRTEL 4.4.4.4 destination IN AIRTEL 1.1.1.1`	Configure the tunnel identifier as well as the country code, carrier code, and node identifier for the source and destination.
`(config-tnl)#tunnel-name tnl_as_rev`	Set the tunnel name.
`(config-tnl)#tunnel-mode unidirectional`	Make the tunnel unidirectional.
`(config-unidir-tnl)#ilm-entry 2002 eth4 swap 2003 eth1`	Configure the ILM entry to swap the label at transit for the forward path

PE1 (NSM)

`#configure terminal`	Enter configure mode.
`(config)#mpls-tp itut cc IN icc AIRTEL node-id 1.1.1.1`	Configure the country code, carrier code, and node identifier.
`(config)#interface eth2`	Enter interface mode for eth2
`(config-if)#mpls-tp provider-interface 20.1.1.1`	Configure the interface as provider and set the local identifier to 20.1.1.1

`(config)#mpls-tp tunnel 3 source IN AIRTEL 4.4.4.4 destination IN AIRTEL 1.1.1.1`	Configure the tunnel identifier as well as the country code, carrier code, and node identifier for the source and destination.
`(config-tnl)#tunnel-name tnl_as_rev`	Set the tunnel name.
`(config-tnl)#tunnel-mode unidirectional`	Make the tunnel unidirectional.
`(config-unidir-tnl)#ilm-entry 2004 eth2 pop`	Configure the ILM entry to pop the label at egress for the reverse path

Associate Forward and Reverse Tunnel

PE1 (OAM)

`#configure terminal`	Enter configure mode.
`(config)#mpls-tp associate fwd-tunnel tnl_as_fwd rev-tunnel tnl_as_rev`	Associate the forward and reverse tunnels.

PE2 (OAM)

`#configure terminal`	Enter configure mode.
`(config)#mpls-tp associate fwd-tunnel tnl_as_rev rev-tunnel tnl_as_fwd`	Associate the forward and reverse tunnels.

Validation: Forward Tunnel

PE1

```
#sh mpls-tp tunnel tnl_as_fwd
 Tunnel-id              : 2                 Tunnel-Name          : tnl_as_fwd
 Source ICC-Oper-ID     : INAIRTEL          Source Node-Id       : 1.1.1.1
 Destination ICC-Oper-ID: INAIRTEL           Destination Node-Id : 4.4.4.4
 Role  : Source                             Tunnel Index         : 2
 Mode  : ASSOCIATED(unidirectional)         Tunnel State         : UP
 Associated-Tunnel   : tnl_as_rev

     Forward-Path : NHLFE   <OPCODE : Push>
       Outgoing-Label : 1001                 Outgoing-Interface : eth1
       NHLFE Index    : 3
       BW-class       : N/A
       Status : UP
     ----------------------------------------------------------
      MEG Index       : 2              ME Index        : 11
     ----------------------------------------------------------
        Lock          : Disabled
        Loopback      : Disabled
```

P1

```
#sh mpls-tp tunnel tnl_as_fwd
 Tunnel-id              : 2                 Tunnel-Name          : tnl_as_fwd
 Source ICC-Oper-ID     : INAIRTEL          Source Node-Id       : 1.1.1.1
 Destination ICC-Oper-ID: INAIRTEL           Destination Node-Id : 4.4.4.4
 Role  : Transit                            Tunnel Index         : 2
 Mode  : ASSOCIATED(unidirectional)         Tunnel State         : UP
 Associated-Tunnel   : tnl_as_rev
```



```
    Forward-Path : ILM   <OPCODE : Swap>
      Incoming-Label : 1001               Incoming-Interface  : eth2
      ILM-Index      : 3                  Cross-Connect-Index : 3
      Outgoing-Label : 1002               Outgoing-Interface  : eth3
      NHLFE Index    : 3
      BW-class       : N/A
      Status : UP
    ---------------------------------------------------------
     MEG Index       : 2              ME Index        : 22
    ---------------------------------------------------------
       Lock          : Disabled
       Loopback      : Disabled
```

P2

```
#sh mpls-tp tunnel tnl_as_fwd
 Tunnel-id              : 2              Tunnel-Name         : tnl_as_fwd
 Source ICC-Oper-ID     : INAIRTEL       Source Node-Id      : 1.1.1.1
 Destination ICC-Oper-ID: INAIRTEL        Destination Node-Id : 4.4.4.4
 Role  : Transit                         Tunnel Index        : 2
 Mode  : ASSOCIATED(unidirectional)      Tunnel State        : UP
 Associated-Tunnel   : tnl_as_rev

    Forward-Path : ILM   <OPCODE : Swap>
      Incoming-Label : 1002               Incoming-Interface  : eth2
      ILM-Index      : 6                  Cross-Connect-Index : 3
      Outgoing-Label : 1003               Outgoing-Interface  : eth3
      NHLFE Index    : 3
      BW-class       : N/A
      Status : UP
    ---------------------------------------------------------
     MEG Index       : 2              ME Index        : 33
    ---------------------------------------------------------
       Lock          : Disabled
       Loopback      : Disabled
```

PE2

```
#sh mpls-tp tunnel tnl_as_fwd
 Tunnel-id              : 2              Tunnel-Name         : tnl_as_fwd
 Source ICC-Oper-ID     : INAIRTEL       Source Node-Id      : 1.1.1.1
 Destination ICC-Oper-ID: INAIRTEL        Destination Node-Id : 4.4.4.4
 Role  : Destination                     Tunnel Index        : 2
 Mode  : ASSOCIATED(unidirectional)      Tunnel State        : UP
 Associated-Tunnel   : tnl_as_rev

    Reverse-Path : ILM   <OPCODE : Pop>
      Incoming-Label : 1003               Incoming-Interface  : eth2
      ILM-Index      : 2                  Cross-Connect-Index : 3
      Status : UP
    ---------------------------------------------------------
     MEG Index       : 3              ME Index        : 444
    ---------------------------------------------------------
       Lock          : Disabled
       Loopback      : Disabled
```

Validation: Reverse Tunnel

PE1

```
#sh mpls-tp tunnel tnl_as_rev
 Tunnel-id             : 3                  Tunnel-Name         : tnl_as_rev
 Source ICC-Oper-ID    : INAIRTEL           Source Node-Id      : 4.4.4.4
 Destination ICC-Oper-ID: INAIRTEL           Destination Node-Id : 1.1.1.1
 Role  : Destination                        Tunnel Index        : 3
 Mode  : ASSOCIATED(unidirectional)         Tunnel State        : UP
 Associated-Tunnel   : tnl_as_fwd

     Reverse-Path : ILM   <OPCODE : Pop>
       Incoming-Label : 2004                 Incoming-Interface  : eth2
       ILM-Index      : 2                    Cross-Connect-Index : 4
       Status : UP
 MEG Index       : 2              ME Index        : 11
     ---------------------------------------------------------
        Lock          : Disabled
        Loopback      : Disabled
```

P1

```
#sh mpls-tp tunnel tnl_as_rev
 Tunnel-id             : 3                  Tunnel-Name         : tnl_as_rev
 Source ICC-Oper-ID    : INAIRTEL           Source Node-Id      : 4.4.4.4
 Destination ICC-Oper-ID: INAIRTEL           Destination Node-Id : 1.1.1.1
 Role  : Transit                            Tunnel Index        : 3
 Mode  : ASSOCIATED(unidirectional)         Tunnel State        : UP
 Associated-Tunnel   : tnl_as_fwd

     Forward-Path : ILM   <OPCODE : Swap>
       Incoming-Label : 2003                 Incoming-Interface  : eth4
       ILM-Index      : 4                    Cross-Connect-Index : 4
       Outgoing-Label : 2004                 Outgoing-Interface  : eth1
       NHLFE Index    : 4
       BW-class       : N/A
       Status : UP
     ---------------------------------------------------------
      MEG Index       : 3              ME Index        : 222
     ---------------------------------------------------------
        Lock          : Disabled
        Loopback      : Disabled
```

P2

```
#sh mpls-tp tunnel tnl_as_rev
 Tunnel-id             : 3                  Tunnel-Name         : tnl_as_rev
 Source ICC-Oper-ID    : INAIRTEL           Source Node-Id      : 4.4.4.4
 Destination ICC-Oper-ID: INAIRTEL           Destination Node-Id : 1.1.1.1
 Role  : Transit                            Tunnel Index        : 3
 Mode  : ASSOCIATED(unidirectional)         Tunnel State        : UP
 Associated-Tunnel   : tnl_as_fwd

     Forward-Path : ILM   <OPCODE : Swap>
       Incoming-Label : 2002                 Incoming-Interface  : eth4
       ILM-Index      : 7                    Cross-Connect-Index : 4
       Outgoing-Label : 2003                 Outgoing-Interface  : eth1
       NHLFE Index    : 4
```



```
      BW-class       : N/A
      Status : UP
    ---------------------------------------------------------
     MEG Index       : 3               ME Index       : 333
    ---------------------------------------------------------
       Lock          : Disabled
       Loopback      : Disabled
```

PE2

```
#sh mpls-tp tunnel tnl_as_rev
 Tunnel-id              : 3               Tunnel-Name         : tnl_as_rev
 Source ICC-Oper-ID     : INAIRTEL        Source Node-Id      : 4.4.4.4
 Destination ICC-Oper-ID: INAIRTEL         Destination Node-Id : 1.1.1.1
 Role  : Source                           Tunnel Index        : 3
 Mode  : ASSOCIATED(unidirectional)       Tunnel State        : UP
 Associated-Tunnel    : tnl_as_fwd

     Forward-Path : NHLFE   <OPCODE : Push>
       Outgoing-Label : 2002               Outgoing-Interface : eth4
       NHLFE Index    : 4
       BW-class       : N/A
       Status : UP
     ---------------------------------------------------------
      MEG Index       : 2               ME Index       : 44
     ---------------------------------------------------------
        Lock          : Disabled
        Loopback      : Disabled
```

CHAPTER 17 MPLS-TP Layer 2 Virtual Circuit

The MPLS-TP Layer 2 Virtual Circuit (VC) is a point-to-point Layer-2 connection that is transported by a Multi-Protocol Label Switching Transport Profile (MPLS-TP) on the service provider's network. The Layer 2 circuit is transported over a single Label Switched Path (LSP) tunnel between two Provider Edge (PE) routers.

Topology

The diagram below illustrates the configuration example in this chapter. Interfaces eth2 on PE1 and eth3 on PE2 are connected to the customer network (Host3 and Host 4). Interfaces eth1 on PE1 and eth2 on PE2 are connected to the MPLS-TP cloud. The following is a summary of the VC configuration process:

- Configure the VC
- Bind the customer interface to the VC
- Map the VC to the tunnel

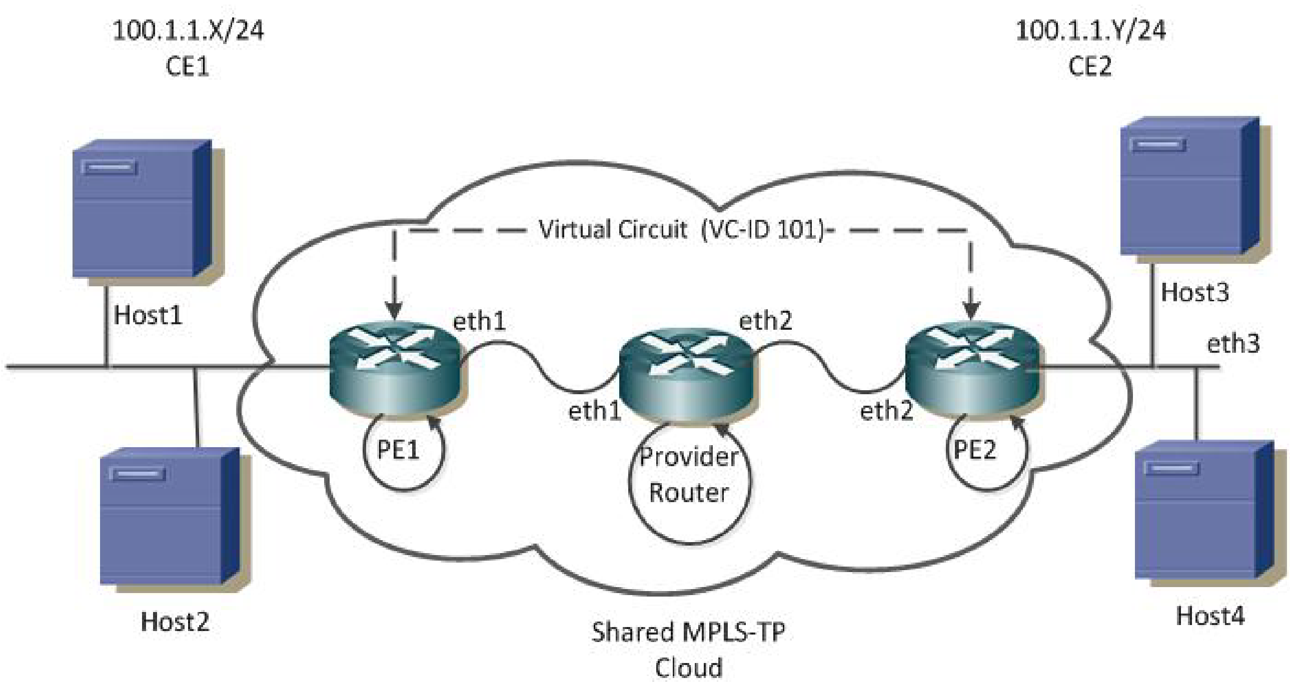


Figure 17-1: Layer 2 Virtual Circuit

The configurations are based on the network shown in Figure 17-1.

- For tunnel connectivity, refer to Figure 16-1.
- For details about configuring a co-routed tunnel, refer to Co-Routed Bi-Directional Tunnel.

Configure Virtual Circuit

Each VC ID uniquely identifies the Layer 2 circuit among all the Layer-2 circuits.

Note: Both PE routers (endpoints) must be configured with the same VC-ID.

PE1 (NSM)

`#configure terminal`	Enter configure mode.
`(config)#mpls l2-circuit VC-1 101 300 3.3.3.3 200 grp-1 manual`	Configure the virtual circuit (VC) for PE2. In this example, VC-1 is the VC name, 101 is the VC ID, 300 is the peer global ID, 3.3.3.3 is the VC endpoint node ID, 200 is VC endpoint, AC-ID grp-1 is the group name.

PE2 (NSM)

`#configure terminal`	Enter configure mode.
`(config)#mpls l2-circuit VC-1 101 100 1.1.1.1 200 grp-1 manual`	Configure the virtual circuit (VC) for PE1. In this example, VC-1 is the VC name, 101 is the VC ID, 100 is the peer global ID, 1.1.1.1 is the VC endpoint node ID, 200 is VC endpoint, VC is VC-ID, grp-1 is the group name.

Bind Customer Interface to VC

Attach the Customer Interface to the VC.

Note: Layer 2 VCs can only be bound to Layer 2 interfaces. VC encapsulation should be Ethernet (default), VLAN, HDLC or PPP.

Layer-2 Untagged Traffic

Use Access mode for Layer 2 untagged traffic.

PE1 (NSM)

`#configure terminal`	Enter configure mode.
`(config)#bridge 1 protocol ieee vlan- bridge`	Configure the VLAN for bridge 1.
`(config)#interface eth2`	Enter interface mode.
`(config-if)#switchport`	Switch to Layer 2 mode.
`(config-if)#bridge-group 1`	Associate the eth2 interface with bridge group 1.
`(config-if)#switchport mode access`	Set the switching characteristics of this interface to access mode.
`(config-if)#mpls-tp service-interface type layer-2 200`	Configure the service interface.in this example, local AC-ID is 200.
`(config-if)#mpls-l2-circuit VC-1 ethernet`	Bind the access interface to the Ethernet VC.

PE2 (NSM)

`#configure terminal`	Enter configure mode.
`(config)#bridge 1 protocol ieee vlan- bridge`	Specify the VLAN for bridge 1.
`(config)#interface eth3`	Enter interface mode.

`(config-if)#switchport`	Switch to Layer 2 mode.
`(config-if)#bridge-group 1`	Associate the eth3 interface with bridge group 1.
`(config-if)#switchport mode access`	Set the switching characteristics of this interface to Access mode.
`(config-if)#mpls-tp service-interface type layer-2 200`	Configure the service interface.In this example, local AC-ID is 200.
`(config-if)#mpls-l2-circuit VC-1 ethernet`	Bind the interface to the VC.

Layer-2 Tagged Traffic

Use

Trunk mode for Layer 2 tagged traffic. The following configuration allows only VLAN 2 and 3 traffic.

PE1

`#configure terminal`	Enter configure mode.
`(config)#bridge 1 protocol ieee vlan- bridge`	Specify the VLAN for bridge 1.
`(config)#mpls l2-circuit VC-2 201 300 3.3.3.3 200 grp-1`	Configure the VC for PE2. In this example, VC-2 is the VC name, 201 is the VC ID, 300 is the peer global ID, 3.3.3.3 is the VC endpoint node ID, 200 is VC endpoint VC-ID and grp-1 is the group name.
`(config-pseudowire)#control-word`	Enable Control-word.
`(config-pseudowire)#manual-pseudowire`	Configure pseudowire manual (no signaling).
`(config-pseduowire)#exit`	Exit pseudowire mode.
`(config)#vlan database`	Enter the VLAN configuration mode.
`(config-vlan)#vlan 2 bridge 1`	Enable the state of VLAN 2 on bridge 1.
`(config-vlan)#exit`	Exit the VLAN configuration mode.
`(config)#interface eth2`	Enter interface mode.
`(config-if)#switchport`	Switch to Layer 2 mode.
`(config-if)#bridge-group 1`	Associate the eth2 interface with bridge group 1.
`(config-if)#switchport mode trunk`	Configure the switching characteristics of this interface to Trunk mode.
`(config-if)#switchport trunk allowed vlan add 2`	Enable VLAN ID 2 on this port.
`(config-if)#mpls-tp service-interface type layer-2 200`	Configure the service interface.in this example local AC-id is 200.
`(config-if)#mpls-l2-circuit VC-2 vlan 2`	Allow VLAN 2 traffic on this VC.

PE2

`#configure terminal`	Enter configure mode.
`(config)#bridge 1 protocol ieee vlan- bridge`	Specify the VLAN for bridge 1.

`(config)#mpls l2-circuit VC-2 201 100 1.1.1.1 200 grp-1`	Configure the VC for PE2. In this example, VC-2 is the VC name, 201 is the VC ID and 1.1.1.1 is the VC endpoint node-id.
`(config-pseudowire)#control-word`	Enable Control-word.
`(config-pseudowire)#manual-pseudowire`	Configure pseudowire manual (no signaling).
`(config-pseduowire)#exit`	Exit pseudowire mode.
`(config)#interface eth3`	Enter interface mode.
`(config-if)#switchport`	Switch to Layer 2 mode.
`(config-if)#bridge-group 1`	Associate the eth1 interface with bridge group 1.
`(config-if)#switchport mode trunk`	Configure the switching characteristics of this interface to Trunk mode.
`(config-if)#switchport trunk allowed vlan add 2`	Enable VLAN ID 2 on this port.
`(config-if)#mpls-tp service-interface type layer-2 200`	Configure the service interface.in this example local AC-id is 200.
`(config-if)#mpls-l2-circuit VC-2 vlan 2`	Allow VLAN 2 traffic on this VC.

Map VC to Tunnel

PE1 (NSM)

`#configure terminal`	Enter configure mode.
`(config)#mpls l2-circuit-fib-entry 101 1111 2222 tp-tunnel tnl1 eth2`	Configured an FIB entry. In this example, 111 is the incoming label, 2222 is the outgoing label, 3.3.3.3 is the endpoint, eth2 is the AC interface name, and tnl1 is the tunnel name.

PE2 (NSM)

`#configure terminal`	Enter configure mode.
`(config)#mpls l2-circuit-fib-entry 101 2222 1111 tp-tunnel tnl2 eth3`	Configure an FIB entry. In this example, 2222 is the incoming label, 1111 is the outgoing label, 3.3.3.3 is the endpoint, eth3 is the AC interface name, and tnl2 is the tunnel name.

Validation

For a correct configuration, the following commands should provide these results:

- Status is `Active` in the `show mpls vc-table` command on ingress/egress for the configured virtual circuit
- Ping from CE1 to CE2 is successful

Validation is displayed in the following example. The command used to display Layer 2 virtual circuit information:

- show mpls mapped-routes (in the NSM daemon)

```
#show mpls vc-table
```



```
VC-ID  Vlan-ID Inner-Vlan-ID Access-Intf Network-Intf  Out Label tunnel-Label Nexthop
Status
100    2        N/A           eth1  eth2       1111  2001       N/A      Active
```

CHAPTER 18 MPLS DiffServ Configuration

This chapter contains an overview of MPLS DiffServ functionality and terminology, MPLS DiffServ configuration example for a relevant scenario, configuration guidelines, and sample procedures for enabling and configuring MPLS DiffServ.

MPLS Diff-Serv Overview

The initial efforts to provide quality of service (QoS) in IP networks were based on a per application-Flow model (IntServ), in which individual applications requested QoS. With large number of flows traversing IP networks, this approach proved to be un-scalable and overly complex, and a more “coarse-grained” model was developed in the form of DiffServ. DiffServ approaches the problem of QoS by dividing traffic into a small number of classes and allocating network resources on a per-class basis. DiffServ provides differential forwarding treatment to traffic, thus enforcing QoS for different traffic flows. It is a scalable solution that does not require per flow signalling and state maintenance in the core. However, it cannot guarantee QoS if the path followed by the traffic does not have adequate resources to meet the QoS requirements.

DiffServ Tunnelling modes:

RFC 3270 has recommended three QoS models for DiffServ tunnelled traffic in MPLS networks:

OcNOS supports two models:

- Pipe model (default mode): With the Pipe Model, MPLS tunnels (aka LSPs) are used to hide the intermediate MPLS nodes between LSP Ingress and Egress from the Diff-Serv perspective. In this model, tunneled packets must convey two meaningful pieces of Diff-Serv information:
    - The Diff-Serv information which is meaningful to intermediate nodes along the LSP span including the LSP Egress (which we refer to as the “LSP Diff-Serv Information”).This LSP Diff-Serv Information is not meaningful beyond the LSP Egress: Whether Traffic Conditioning at intermediate nodes on the LSP span affects the LSP Diff-Serv information or not, this updated Diff-Serv information is not considered meaningful beyond the LSP Egress and is ignored.
    - The Diff-Serv information which is meaningful beyond the LSP Egress (which we refer to as the “Tunneled Diff-Serv Information”).This information is to be conveyed by the LSP Ingress to the LSP Egress.This Diff-Serv information is not meaningful to the intermediate nodes on the LSP span.
- Uniform model: With the Uniform Model, MPLS tunnels (aka LSPs) are viewed as artifacts of the end-to-end path from the Diff-Serv standpoint. MPLS Tunnels may be used for forwarding purposes but have no significant impact on Diff-Serv. In this model, any packet contains exactly one piece of Diff-Serv information which is meaningful and is always encoded in the outer most label entry (or in the IP DSCP where the IP packet is transmitted unlabeled for instance at the egress of the LSP). Any Diff-Serv information encoded somewhere else (e.g., in deeper label entries) is of no significance to intermediate nodes or to the tunnel egress and is ignored. If Traffic Conditioning at intermediate nodes on the LSP span affects the “outer” Diff-Serv information, the updated Diff-Serv information is the one considered meaningful at the egress of the LSP.
    - The Uniform Model for Diff-Serv over MPLS is such that, from the Diff-Serv perspective, operations are exactly identical to the operations if MPLS was not used. In other words, MPLS is entirely transparent to the Diff-Serv operations.
    - Use of the Uniform Model allows LSPs to span Diff-Serv domain boundaries without any other measure in place than an inter-domain Traffic Conditioning Agreement at the physical boundary between the Diff-Serv

domains and operating exclusively on the "outer" header, since the meaningful Diff-Serv information is always visible and modifiable in the outmost label entry.

Terminology

Following is a brief description of terms and concepts used to describe MPLS Diffserv.

EXP Value

The MPLS experimental bits (EXP) field is a 3-bit field in the MPLS header that you can use to define the QoS treatment (per-hop behavior) that a node should give to a packet. In an IP network, the DiffServ Code Point (DSCP) (a 6-bit field) defines a class and drop precedence. The EXP bits can be used to carry some of the information encoded in the IP DSCP and can also be used to encode the dropping precedence.

By default, OcNOS copies the three most significant bits of the DSCP or the IP precedence of the IP packet to the EXP field in the MPLS header. This action happens when the MPLS header is initially imposed on the IP packet. However, you can also set the EXP field by defining a mapping between the DSCP or IP precedence and the EXP bits. This mapping is configured using the set mpls class command in pmap-class mode or qos map class exp in global mode. For more information, see the "Remarking" section.

DSCP Value

Differentiated Services Code Point (DSCP) is a 6-bit value used to classify the priority of Layer-3 packets upon entry into a network. DSCP values range from 0 to 63, 63 being the highest priority, 0 being best-effort traffic.

Classification

Traffic classification allows the network to recognize traffic as it falls into classes that you have configured. Network traffic must be classified to apply specific QoS to it. Classification can be inclusive (for example, all of the traffic passing through an interface) or classification can be very specific (for example, you can use a class map with match commands that recognize specific aspects of the traffic). You can classify and apply QoS (for example, marking) and then, on another interface or network device, classify again based on the marked value and apply other QoS.

Policing

Policing determines whether a packet is in or out of profile by comparing the internal DSCP to the configured policer. Policer limits the bandwidth consumed by a traffic flow with the results given to the marker.

Policing and policers have the following attributes:

- Policers can occur only on a physical port basis.
- Policing can occur on ingress interfaces.
- Only one policer can be applied to a packet per direction.

Marking

Marking determines how to handle a packet when it is out of profile. It assesses the policer and the configuration data to determine the action required for the packet, and then handles the packet using one of the following methods:

- Let the packet through without modification

- Drop the packet

Marking can occur on ingress and egress interfaces.

Class Map

A class map names and isolates specific traffic from other traffic. The class map defines the criteria used to match against a specific traffic flow to classify it further. The criteria can include:

- Matching the access group defined by the ACL
- Matching a specific list of DSCP values

If there is more than one type of traffic to be classified, another class map can be created under a different name. After a packet is matched against the class-map criteria, it is further classified using a policy map.

Policy Map

A policy map specifies on which traffic class to act. This can be implemented as follows:

- Set a specific CoS or DSCP value in the traffic class.
- Specify the traffic bandwidth limitations for each matched traffic class (policer) and the action to take (marking) when the traffic is out of profile.

Policy maps have the following attributes:

- A policy map can contain multiple class statements, each with different match criteria and policers.
- A separate policy-map class can exist for each type of traffic received through an interface.
- There can be only one policy map per interface per direction. The same policy map can be applied to multiple interfaces and directions.
- Before a policy map can be effective, it must be attached to an interface.

MPLS Class

MPLS class or class specifies the class of the frames, for example frames with DSCP 0-7 belongs to class 0, DSCP 8-15 belongs to Class 1, and so on.

In OcNOS, there are 8 classes varying form 0-7. By default, EXP to class is mapped one-to-one.

For more, see Table 18-1

For MPLS Diff-Serv to work, QoS must be enabled at the global level. By default QoS is disabled.

Table 18-1: EXP to class mapping

CoS	DSCP	EXP	Class	Queue
0	0-7	0	0	0
1	8-15	1	1	1
2	16-23	2	2	2
3	24-31	3	3	3
4	32-39	4	4	4
5	40-47	5	5	5

Table 18-1: EXP to class mapping (Continued)

CoS	DSCP	EXP	Class	Queue
6	48-55	6	6	6
7	56-63	7	7	7

CHAPTER 19 Policing Configuration

This chapter contains a complete sample of configuration of Policing for Pipe and Uniform models.This example shows configurations using LDP.

Configuration

Configuring Remarking for MPLS EXP bits require following configurations:

- Enabling label-switching on the interface on NSM.
- Configuring LSP (Using LDP, Static or RSVP-TE, in this example we are using LDP for setting UP LSP).
- Running an IGP (Internal Gateway Protocol), for example, OSPF, to distribute reachability information within the MPLS cloud.
- Enable QoS, Configuring Policing on interface Level.

Topology

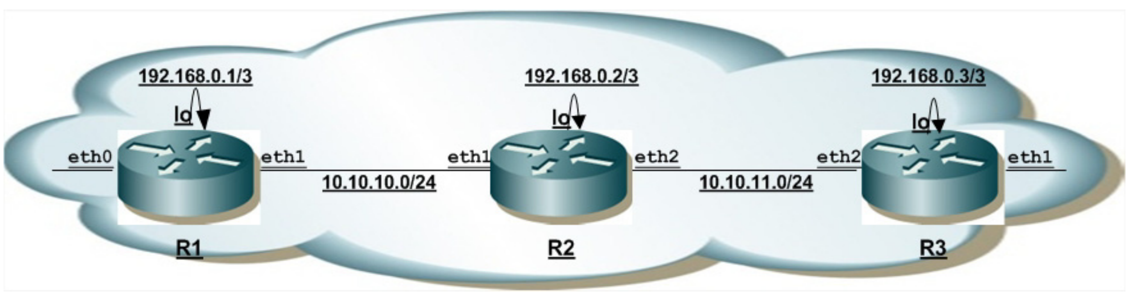


Figure 19-1: Basic Policing Topology

R1

The following steps describes how to configure Policing.

Note: Basic configuration for Policing is same as that of the configurations given in Remarking chapter

`(config)#class-map cmap1`	Enter Class-map mode
`(config-cmap-qos)#match dscp 2`	Configure match criteria as DSCP with Value 2
`(config-cmap-qos)#exit`	Exit Class-map mode
`(config)#policy-map pmap1`	Enter policy-map mode
`(config-pmap-qos)#class cmap1`	Assign Class cmap1 to Policy-map pmap1
`(config-pmap-c-qos)#police cir 1 mbps conform set-mpls-class 6 violate drop`	Police DSCP 2 packets @ Committed information rate 1 mbps, and map DSCP 2 to class 6.
`(config-pmap-c-qos)#exit`	Exit out of policy-class-map mode
`(config-pmap-qos)#exit`	Exit out of Policy-map mode
`(config)#interface eth2`	Enter eth0 interface

(config-if)#service-policy type qos input pmap1	Assign service-policy to interface on in-direction
(config-if)#exit	Exit interface mode.

Validation

```
R1#show class-map

  Type qos class-maps
  ===================
      class-map type qos match-any class-default

      class-map cmap1
         match dscp 2


  Type queuing class-maps
  =======================
      class-map match-any q0

      class-map match-any q1

      class-map match-any q2

      class-map match-any q3

      class-map match-any q4

      class-map match-any q5

      class-map match-any q6

      class-map match-any q7


  Type Vlan-Queuing class-maps
  ============================


#show running-config qos
qos enable
!
qos statistics
!
class-map cmap1
 match dscp 2
!
policy-map pmap1
 class cmap1
  police cir 1 mbps conform set-mpls-class 6 violate drop
  exit
!
interface eth2
 service-policy type qos input pmap1 exit
#
```



```
#show policy-map

Type qos policy-maps
====================

policy-map pmap1
 class cmap1
  police cir 1 mbps conform set-mpls-class 6 violate drop
  exit


Type queuing policy-maps
========================

policy-map type queuing default default-out-policy
 class type queuing default q0
  priority level 1
  exit
 class type queuing default q1
  priority level 1
  exit
 class type queuing default q2
  priority level 1
  exit
 class type queuing default q3
  priority level 1
  exit
 class type queuing default q4
  priority level 1
  exit
 class type queuing default q5
  priority level 1
  exit
 class type queuing default q6
  priority level 1
  exit
 class type queuing default q7
  priority level 1
  exit


#show policy-map interface eth1

Interface eth1
Global statistics status : enabled

Service-policy (queuing) output: default-out-policy
-----------------------------------
Class-map (queuing): q0
 priority level 1
      output       : 5 packets, 340 bytes
      dropped      : 0 packets, 0 bytes

Class-map (queuing): q1
 priority level 1
      output       : 25 packets, 2208 bytes
      dropped      : 0 packets, 0 bytes
```

```
    Class-map (queuing): q2
     priority level 1
          output       : 0 packets, 0 bytes
          dropped      : 0 packets, 0 bytes

    Class-map (queuing): q3
     priority level 1
          output       : 0 packets, 0 bytes
          dropped      : 0 packets, 0 bytes

    Class-map (queuing): q4
     priority level 1
          output       : 0 packets, 0 bytes
          dropped      : 0 packets, 0 bytes

    Class-map (queuing): q5
     priority level 1
          output       : 0 packets, 0 bytes
          dropped      : 0 packets, 0 bytes

    Class-map (queuing): q6
     priority level 1
          output       : 46337 packets, 3150916 bytes
          dropped      : 0 packets, 0 bytes

    Class-map (queuing): q7
     priority level 1
          output       : 346 packets, 25193 bytes
          dropped      : 0 packets, 0 bytes

    Class-map (queuing): mc-q0
          output       : 0 packets, 0 bytes
          dropped      : 0 packets, 0 bytes

    Class-map (queuing): mc-q1
          output       : 0 packets, 0 bytes
          dropped      : 0 packets, 0 bytes

    Class-map (queuing): mc-q2
          output       : 0 packets, 0 bytes
          dropped      : 0 packets, 0 bytes

    Class-map (queuing): mc-q3
          output       : 0 packets, 0 bytes
          dropped      : 0 packets, 0 bytes

    Class-map (queuing): mc-q4
          output       : 0 packets, 0 bytes
          dropped      : 0 packets, 0 bytes

    Class-map (queuing): mc-q5
          output       : 0 packets, 0 bytes
          dropped      : 0 packets, 0 bytes

    Class-map (queuing): mc-q6
          output       : 0 packets, 0 bytes
```



```
      dropped      : 0 packets, 0 bytes

Class-map (queuing): mc-q7
      output       : 808 packets, 67946 bytes
      dropped      : 0 packets, 0 bytes

Wred Drop Statistics :
----------------------
 green  : 0 packets
 yellow : 0 packets
 red    : 0 packets
```

CHAPTER 20 MPLS Statistics Configuration

This chapter provides the configuration required for configuring MPLS LSPs and verifying the statistics of packets captured at the supported interfaces, in terms of both packet count and bytes, when traffic is sent.

Configure LDP-LSP

Topology

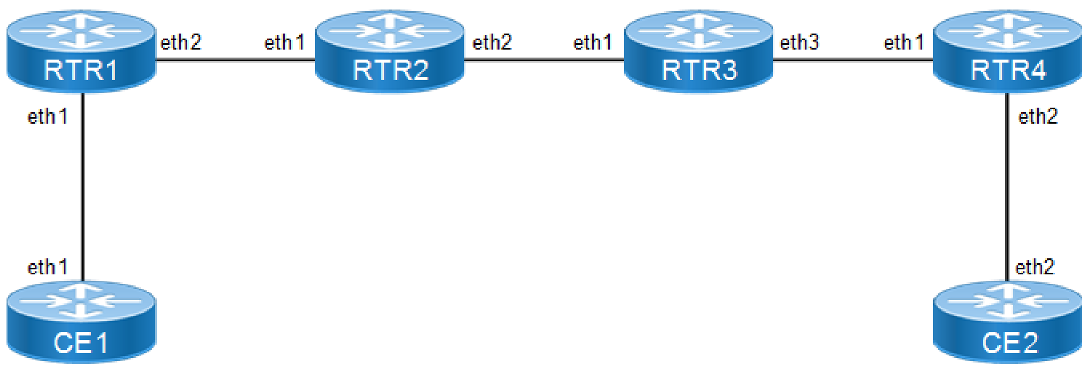


Figure 20-1: MPLS Statistics Topology

RTR1

Loopback Interface configuration

`#configure terminal`	Enter configure mode.
`(config)#interface lo`	Specify the interface `(lo)` to be configured.
`(config-if)#ip address 11.11.11.11/32 secondary`	Configure IP address on loopback interface
`(config-if)#exit`	Exit interface mode.

Global LDP configuration

`(config)#router ldp`	Enter `Router` mode for LDP.
`(config-router)#transport-address ipv4 11.11.11.11`	Configure the loopback address as transport-address
`(config-router)#targeted-peer ipv4 44.44.44.44`	Configure the loopback address of RTR4 as targeted peer.
`(config-router-targeted-peer)#exit`	Exit router-targeted-peer mode and enter config-router mode
`(config-router)#end`	Exit router and configure mode

Enabling LDP and label switching on interface

#configure terminal	Enter configure mode.
(config)#interface eth2	Enter interface mode for eth2.
(config-if)#enable-ldp ipv4	Enable LDP on the interface.
(config-if)#label-switching	Enable Label switching on the interface.
(config-if)#ip address 10.10.10.1/24	Configure IP address on the interface.
(config-if)#exit	Exit interface mode.

Global OSPF configuration

(config)#router ospf 100	Enter the Router OSPF mode.
(config-router)#network 11.11.11.11/32 area 0	Advertise loopback address in OSPF.
(config-router)#network 10.10.10.0/24 area 0	Advertise network address (eth2) in OSPF.
(config-router)#exit	Exit Router OSPF mode and return to Configure mode.

RTR2

Loopback Interface configuration

#configure terminal	Enter configure mode.
(config)#interface lo	Specify the interface (lo) to be configured.
(config-if)#ip address 22.22.22.22/32 secondary	Configure IP address on loopback interface
(config-if)#exit	Exit interface mode.

Global LDP configuration

(config)#router ldp	Enter Router mode for LDP.
(config-router)#transport-address ipv4 22.22.22.22	Configure the loopback address as transport-address
(config-router)#end	Exit router and configure mode

Enabling LDP and label switching on interface

#configure terminal	Enter configure mode.
(config)#interface eth1	Enter interface mode for eth1.
(config-if)#enable-ldp ipv4	Enable LDP on the interface.
(config-if)#label-switching	Enable Label switching on the interface.
(config-if)#ip address 10.10.10.2/24	Configure IP address on the interface.
(config-if)#exit	Exit interface mode.

(config)#interface eth2	Enter interface mode for eth2.
(config-if)#enable-ldp ipv4	Enable LDP on the interface.
(config-if)#label-switching	Enable Label switching on the interface.
(config-if)#ip address 20.20.20.1/24	Configure IP address on the interface.
(config-if)#exit	Exit interface mode.

OSPF Configuration

(config)#router ospf 100	Enter the Router OSPF mode
(config-router)#network 22.22.22.22/32 area 0.0.0.0	Advertise loopback address in OSPF
(config-router)#network 10.10.10.2/24 area 0.0.0.0	Advertise network address (eth1) in OSPF.
(config-router)#network 20.20.20.1/24 area 0.0.0.0	Advertise network address (eth2) in OSPF.
(config-router)#exit	Exit OSPF router configuration mode.

RTR3

Loopback Interface configuration

#configure terminal	Enter configure mode.
(config)#interface lo	Specify the interface (lo) to be configured.
(config-if)#ip address 33.33.33.33/32 secondary	Configure IP address on loopback interface
(config-if)#exit	Exit interface mode.

Global LDP configuration

(config)#router ldp	Enter Router mode for LDP.
(config-router)#transport-address ipv4 33.33.33.33	Configure the loopback address as transport-address
(config-router)#end	Exit router and configure mode

Enabling LDP and label switching on interface

#configure terminal	Enter configure mode.
(config)#interface eth1	Enter interface mode for eth1.
(config-if)#enable-ldp ipv4	Enable LDP on the interface.
(config-if)#label-switching	Enable Label switching on the interface.
(config-if)#ip address 20.20.20.2/24	Configure IP address on the interface.
(config-if)#exit	Exit interface mode.

(config)#interface eth2	Enter interface mode for eth2.
(config-if)#enable-ldp ipv4	Enable LDP on the interface.
(config-if)#label-switching	Enable Label switching on the interface.
(config-if)#ip address 30.30.30.1/24	Configure IP address on the interface.
(config-if)#exit	Exit interface mode.

OSPF Configuration

(config)#router ospf 100	Enter the Router OSPF mode
(config-router)#network 33.33.33.33/32 area 0.0.0.0	Advertise loopback address in OSPF
(config-router)#network 20.20.20.2/24 area 0.0.0.0	Advertise network address (eth1) in OSPF.
(config-router)#network 30.30.30.1/24 area 0.0.0.0	Advertise network address (eth2) in OSPF.
(config-router)#exit	Exit OSPF router configuration mode.

RTR4

Loopback Interface configuration

#configure terminal	Enter configure mode.
(config)#interface lo	Specify the interface (lo) to be configured.
(config-if)#ip address 44.44.44.44/32 secondary	Configure IP address on loopback interface
(config-if)#exit	Exit interface mode.

Global LDP configuration

(config)#router ldp	Enter Router mode for LDP.
(config-router)#transport-address ipv4 44.44.44.44	Configure the loopback address as transport-address
(config-router)#targeted-peer ipv4 11.11.11.11	Configure the loopback address of RTR1 as targeted peer.
(config-router-targeted-peer)#exit	Exit router-targeted-peer mode and enter config-router mode
(config-router)#end	Exit router and configure mode

Enabling LDP and label switching on interface

#configure terminal	Enter configure mode.
(config)#interface eth1	Enter interface mode for eth1.

(config-if)#enable-ldp ipv4	Enable LDP on the interface.
(config-if)#label-switching	Enable Label switching on the interface.
(config-if)#ip address 30.30.30.2/24	Configure IP address on the interface.
(config-if)#exit	Exit interface mode.

Global OSPF Configuration

(config)#router ospf 100	Enter the Router OSPF mode
(config-router)#network 44.44.44.44/32 area 0.0.0.0	Advertise loopback address in OSPF
(config-router)#network 30.30.30.2/24 area 0.0.0.0	Advertise network address (eth1) in OSPF.
(config-router)#exit	Exit OSPF router configuration mode.

Virtual Circuit Configuration

RTR1

Global VC Configuration

(config)#mpls l2-circuit t1 100 44.44.44.44	Enter the VC configuration command in router mode.
(config)#bridge 1 protocol ieee vlan-bridge	Creating a VLAN-bridge in router mode.

Interface Configuration

(config)#service-template st1	Template configuration
(config-svc)#exit	Exit service template configuration
(config)#interface eth1	Enter interface mode for eth1.
(config-if)#switchport	Enable switchport on the interface.
(config-if)#mpls-l2-circuit t1 service-template st1	Bind the interface to VC created in ethernet mode.
(config-if)#exit	Exit interface mode.

RTR4

Global VC Configuration

(config)#mpls l2-circuit t1 100 11.11.11.11	Enter the VC configuration command in router mode.
(config)#bridge 1 protocol ieee vlan-bridge	Creating a VLAN-bridge in router mode.

Interface Configuration

(config)#service-template st1	Template configuration
(config-svc)#exit	Exit service template mode
(config)#interface eth2	Enter interface mode for eth2.

(config-if)#switchport	Enable switchport on the interface.
(config-if)#mpls-l2-circuit t1 service-template st1	Bind the interface to VC created in ethernet mode.
(config-if)#exit	Exit interface mode.

Configure Static-LSP

RTR1

Global Static configuration

(config)#mpls ftn-entry 44.44.44.44/32 100 10.10.10.2 eth2	Configure FTN entry for rtr4 loopback.
(config)#mpls ilm-entry 900 pop	Pop the incoming label

Enabling label switching on interface

(config)#interface eth2	Enter interface mode for eth2.
(config-if)#label-switching	Enable Label switching on the interface.
(config-if)#exit	Exit interface mode.

RTR2

Global Static configuration

mpls ilm-entry 100 swap 200 eth2 20.20.20.2 44.44.44.44/32	Swap the incoming label
mpls ilm-entry 800 swap 900 eth1 10.10.10.1 11.11.11.11/32	Swap the incoming label

Enabling label switching on interface

(config)#interface eth1	Enter interface mode for eth1.
(config-if)#label-switching	Enable Label switching on the interface.
(config-if)#exit	Exit interface mode.
(config)#interface eth2	Enter interface mode for eth2.
(config-if)#label-switching	Enable Label switching on the interface.
(config-if)#exit	Exit interface mode.

RTR3

Global Static configuration

`(config)#mpls ilm-entry 200 swap 300 eth2 30.30.30.2 44.44.44.44/32`	Swap the incoming label
`(config)#mpls ilm-entry 700 swap 800 eth1 20.20.20.1 11.11.11.11/32`	Swap the incoming label

Enabling label switching on interface

`(config)#interface eth1`	Enter interface mode for eth1.
`(config-if)#label-switching`	Enable Label switching on the interface.
`(config-if)#exit`	Exit interface mode.
`(config)#interface eth2`	Enter interface mode for eth2.
`(config-if)#label-switching`	Enable Label switching on the interface.
`(config-if)#exit`	Exit interface mode.

RTR4

Global Static configuration

`(config)#mpls ftn-entry 11.11.11.11/32 700 30.30.30.1 eth1`	Configure FTN entry for RTR1 loopback.
`(config)mpls ilm-entry 300 pop`	Pop the incoming label.

Enabling label switching on interface

`(config)#interface eth1`	Enter interface mode for eth1.
`(config-if)#label-switching`	Enable Label switching on the interface.
`(config-if)#exit`	Exit interface mode.

Validation

Here, 1000 packets are transmitted between the PE nodes and the output of counters at each node is mentioned below.

For Static-LSP

```
RTR1#show mpls counters static
[FTN statistics]
+------------------+-----------+---------------------+---------------------+
|       FEC        | out-label |     Tx packets      |      Tx bytes       |
+------------------+-----------+---------------------+---------------------+
 44.44.44.44/32     100         49939                  807798
[ILM statistics]
+------------------+-----------+-----------+---------------------+-------------
-------+---------------------+---------------------+
|       FEC        | in-label  | out-label |     Rx packets      |       Rx
bytes      |      Tx packets      |       Tx bytes       |
```

```
+------------------+-----------+-----------+--------------------+------------
-------+--------------------+--------------------+
 0.0.0.0/0         900        n/a        40546              3486956
n/a                    n/a
RTR1#


RTR2#show mpls counters static
[FTN statistics]
+------------------+-----------+--------------------+--------------------+
|       FEC        | out-label |     Tx packets     |      Tx bytes      |
+------------------+-----------+--------------------+--------------------+

[ILM statistics]
+------------------+-----------+-----------+--------------------+------------
--
-----+--------------------+--------------------+
|       FEC        | in-label  | out-label |     Rx packets     |      Rx
bytes
     |     Tx packets     |      Tx bytes      |
+------------------+-----------+-----------+--------------------+------------
--
-----+--------------------+--------------------+
 44.44.44.44/32     100         200         9393                807798
     9393                807798
 11.11.11.11/32     800         900         40546               3486956
     40546               3486956
RTR2#


RTR3#show mpls counters static
[FTN statistics]
+------------------+-----------+--------------------+--------------------+
|       FEC        | out-label |     Tx packets     |      Tx bytes      |
+------------------+-----------+--------------------+--------------------+

[ILM statistics]
+------------------+-----------+-----------+--------------------+------------
-------+--------------------+--------------------+
|       FEC        | in-label  | out-label |     Rx packets     |      Rx
bytes      |     Tx packets     |      Tx bytes      |
+------------------+-----------+-----------+--------------------+------------
-------+--------------------+--------------------+
 44.44.44.44/32    200        300        9393               807798
9393                   807798
 11.11.11.11/32    700        800        40546              3486956
40546                  3486956
RTR3#


RTR4#show mpls counters static
[FTN statistics]
+------------------+-----------+--------------------+--------------------+
|       FEC        | out-label |     Tx packets     |      Tx bytes      |
+------------------+-----------+--------------------+--------------------+
 11.11.11.11/32     700         49939               3486956

[ILM statistics]
```

```
+-----------------+----------+----------+------------------+-------------
--
-----+------------------+------------------+
|       FEC       | in-label  | out-label |     Rx packets     |       Rx
bytes
     |     Tx packets     |      Tx bytes      |
+-----------------+----------+----------+------------------+-------------
--
-----+------------------+------------------+
 0.0.0.0/0         300        n/a        9393                  807798
     n/a                 n/a
RTR4#
```

For LDP-LSP

```
RTR1#show mpls counters ldp
[FTN statistics]
+-----------------+-----------+-------------------+-------------------+
|       FEC         | out-label |   Tx packets    |      Tx bytes      |
+-----------------+-----------+-------------------+-------------------+
 44.44.44.44/32     52483          1000                 1004000
[ILM statistics]
+-----+---------+-----------+-----------+---------+-----------+---------+
| FEC |in-label | out-label | Rx packets | Rx bytes| Tx packets| Tx bytes|
+-----+---------+-----------+-----------+---------+-----------+---------+

RTR2#show mpls counters ldp
[FTN statistics]
+-----------------+-----------+-------------------+-------------------+
|       FEC       | out-label |     Tx packets     |      Tx bytes      |
+-----------------+-----------+-------------------+-------------------+
[ILM statistics]
+-----+----------+-----------+-----------+----------+-----------+----------+
| FEC | in-label | out-label | Rx packets | Rx bytes | Tx packets | Tx bytes |
+-----+----------+-----------+-----------+----------+-----------+----------+
44.44.44.44/32     52483   52483  1000        1004000   1000         1004000
```

For LDP-VC

```
R1#show mpls l2-circuit t1 statistics
MPLS Layer-2 Virtual Circuit: t1, id 100
 Access port statistics:
   RX:  Input packets  : 0
        Input bytes    : 0
   TX:  Output packets : 4642811
        Output bytes   : 297139904

 Network port statistics:
   RX:  Input packets  : 4642804
        Input bytes    : 399281144
   TX:  Output packets : 0
        Output bytes   : 0


R4#show mpls l2-circuit t1 statistics
MPLS Layer-2 Virtual Circuit: t1, id 100
```



```
Access port statistics:
  RX:  Input packets  : 4633957
       Input bytes    : 296573248
  TX:  Output packets : 0
       Output bytes   : 0

Network port statistics:
  RX:  Input packets  : 0
       Input bytes    : 0
  TX:  Output packets : 4633960
       Output bytes   : 398520560
```

CHAPTER 21 L3VPN GR Configuration

Using BGP graceful restart, the data-forwarding plane of a router can continue to process and forward packets even if the control plane - which is responsible for determining best paths - fails. Graceful restart also reduces routing flaps, stabilizing the network and reducing control-plane resource consumption.

By exchanging a new BGP capability (BGP capability code 64) in the initial BGP open messages that establish the session, the restarting router and its peers show that they are aware of the BGP graceful restart mechanism when the initial BGP connection is established. In addition, the restarting router provides its peers with a list of supported address-families (VPNv4, IPv4, and IPV6) for which it can maintain a forwarding state across a BGP restart.

The peer router's TCP connection might be cleared, when the router's BGP process is restarted. Under normal circumstances, this would cause the peer router to clear all routes associated with the restarting router. But with a BGP graceful restart, this doesn't happen. Instead, in expectation of the restarting router shortly re-establishing the BGP session, the peer router marks all routes as “stale” yet continues to use them to forward packets. Likewise, the restarting router also continues forwarding packets in the interim.

When the restarting router opens the new BGP session, it will again send BGP capability 64 to its peers. But this time, flags will be set in the graceful restart capabilities exchange to let the peer router know that the BGP process has restarted.

The goal of the BGP graceful restart was to minimize the duration and reach of an outage associated with a failed BGP process. To do this, the software extensions must be deployed on both the router restarting the BGP process and the BGP peers of that router. The peers help the BGP process regain lost forwarding information and also help isolate failures from the rest of the network.

While forwarding packets, the peer router will refresh the restarting router with any relevant BGP routing information base (RIB) updates. The peer signals that it has finished sending the updates with an "End-of-RIB" (EOR) marker - an “empty” BGP update message. EOR markers help speed convergence because once the restarting router has received them from all peers, it can begin best-path selection again using the new routing information. Similarly, the restarting router then sends any updates to its peer routers and uses the EOR marker to indicate the completion of the process.

As part of this feature, we will be extending the feature for VPNv4 AF.

Topology

In the below example shows to configure BGP VPNv4 neighborship between PE1 and PE2.

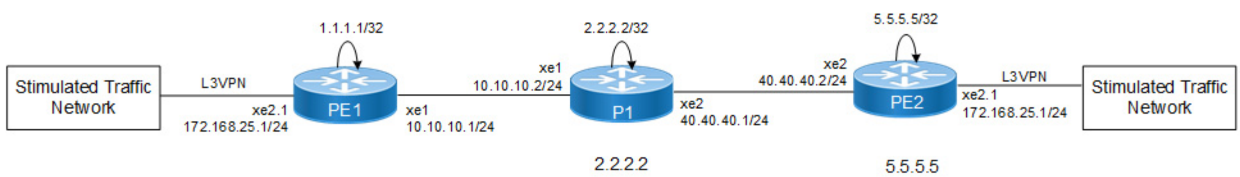


Figure 21-2: L3VPN GR Topology

L3VPN GR Configuration

Configuration

Below are the configurations and validations of L3VPN GR with OSPF as IGP. We can also configure ISIS as IGP and LDP/RSVP as transport.

PE1

#configure terminal	Enter configuration mode.
(config)#interface lo	Specify the loopback (lo) interface to be configured.
(config-if)#ip address 1.1.1.1/32 secondary	Set the IP address of the loopback interface to 1.1.1.1/32
(config-if)#exit	Exit interface mode.
(config)#ip vrf l3vpn	Configure IP VRF L3VPN.
(config-vrf)#rd 1:300	Enter RD value.
(config-vrf)#route-target both 300:400	Enter RT value.
(config-vrf)#exit	Exiting from VRF mode.
(config)#router ldp	Enter router mode for LDP.
(config-router)#router-id 1.1.1.1	Set the router ID to IP address 1.1.1.1.
(config-router)#targeted-peer ipv4 2.2.2.2	Configure targeted peer.
(config-router-targeted-peer)#exit-targeted- peer-mode	Exit-targeted-peer-mode
(config-router)#targeted-peer ipv4 5.5.5.5	Configure targeted peer.
(config-router-targeted-peer)#exit-targeted- peer-mode	Exit-targeted-peer-mode
(config-router)#exit	Exit router mode
(config)#interface xe1	Enter interface mode.
(config-if)#ip address 10.10.10.1/24	Configure IPv4 address for xe1.
(config-if)#label-switching	Enable label switching on interface xe1.
(config-if)#enable-ldp ipv4	Enable LDP for IPv4 on xe1.
(config-if)#exit	Exit interface mode
(config)#interface xe2.1	Configure access-port .
(config-if)#description MPLS-L3VPN	Giving Interface Description
(config-if)#encapsulation dot1q 4	Setting Encapsulation to dot1q with VLAN ID 4
(config-if)#load-interval 30	Load interval setting
(config-if)#ip vrf forwarding l3vpn	Bind the interface connected to the CE router with VRF l3vpn
(config-if)#ip address 172.168.25.2/24	Assign the IPv4 address.
(config)#router ospf 1	Configure the routing process and specify the Process ID 100. The Process ID should be a unique positive integer identifying the routing process.
(config)#ospf router-id 1.1.1.1	Configure OSPF router-ID same as loopback interface IP address

(config-router) #network 1.1.1.1/32 area 0	Define the interface on which OSPF runs and associate the area ID (0) with the interface.
(config-router) #network 10.10.10.0/24 area 0	Define the interface on which OSPF runs and associate the area ID (0) with the interface.
(config-if)#exit	Exit interface mode.
(config)#router bgp 100	Enter router BGP mode
(config-router)#bgp router-id 1.1.1.1	Configuring the BGP router id 1.1.1.1.
(config-router)#bgp graceful-restart restart-time 100	Enable BGP GR with restart timer 100.
(config-router)#neighbor 5.5.5.5 remote-as 100	Configure neighbor 5.5.5.5.
(config-router)#neighbor 5.5.5.5 update-source lo	Update source lo for neighbor 5.5.5.5.
(config-router)#address-family ipv4 unicast	Enter address-family IPv4 unicast.
(config-router-af)#redistribute connected	Redistribute connected.
(config-router)#neighbor 5.5.5.5 activate	Activate neighbor.
(config-router)#address-family vpnv4 unicast	Entering Address family VPNv4 unicast.
(config-router-af)#neighbor 5.5.5.5 activate	Activate the neighbor 5.5.5.5.
(config-router-af)#neighbor 5.5.5.5 capability graceful-restart	Activate capability graceful restart for neighbor 5.5.5.5.
(config-router-af)#exit-address-family	Exit address family.
(config-router)#address-family ipv4 vrf l3vpn	Entering address family.
(config-router-af)#redistribute connected	Redistribute connected.
(config-router)#neighbor 172.168.25.1 remote-as 600	Configure neighbor 172.168.25.1.
(config-router)#neighbor 172.168.25.1 activate	Activate neighbor.
(config-router-af)#commit	Commit all the transactions.

P1

#configure terminal	Enter configuration mode.
(config)#interface lo	Specify the loopback (lo) interface to be configured.
(config-if)#ip address 2.2.2.2/32 secondary	Set the IP address of the loopback interface to 2.2.2.2/32.
(config-if)#exit	Exit interface mode.
(config)#router ldp	Enter router mode for LDP.
(config-router)#router-id 2.2.2.2	Set the router ID to IP address 2.2.2.2.
(config-router)#transport-address ipv4 2.2.2.2 0	Configure the transport address for IPV4 (for IPV6, use ipv6) to be used for a TCP session over which LDP will run.
Note:	It is preferable to use the loopback address as the transport address.
(config-router)#targeted-peer ipv4 1.1.1.1	Configure targeted peer.
(config-router-targeted-peer)#exit-targeted- peer-mode	Exit-targeted-peer-mode.
(config-router)#targeted-peer ipv4 5.5.5.5	Configure targeted peer.

`(config-router-targeted-peer)#exit-targeted- peer-mode`	Exit-targeted-peer-mode.
`(config-router)#exit`	Exit-targeted-peer-mode.
`(config-if)#exit`	Exit router mode.
`(config)#interface xe1`	Enter interface mode.
`(config-if)#ip address 10.10.10.2/24`	Configure IPv4 address for xe1.
`(config-if)#label-switching`	Enable label switching on interface xe1.
`(config-if)#enable-ldp ipv4`	Enable LDP for IPv4 on xe1.
`(config-if)#exit`	Exit interface mode.
`(config)#interface xe2`	Enter interface mode.
`(config-if)#ip address 40.40.40.1/24`	Configure IPv4 address for xe2.
`(config-if)#label-switching`	Enable label switching on interface xe2.
`(config-if)#enable-ldp ipv4`	Enable LDP for IPv4 on xe2.
`(config-if)#exit`	Exit interface mode.
`(config)#router ospf 1`	Configure the routing process and specify the Process ID. The Process ID should be a unique positive integer identifying the routing process.
`(config)#ospf router-id 2.2.2.2`	Configure OSPF router-ID same as loopback interface IP address.
`(config-router) #network 2.2.2.2/32 area 0`	Define the interface on which OSPF runs and associate the area ID (0) with the interface.
`(config-router) #network 10.10.10.0/24 area 0`	Define the interface on which OSPF runs and associate the area ID (0) with the interface.
`(config-router)#network 40.40.40.0/24 area 0`	Define the interface on which OSPF runs and associate the area ID (0) with the interface.
`(config-router)#bfd all-interfaces`	Enable the OSPF enabled interfaces with BFD.
`(config-if)#exit`	Exit interface mode.

PE-2

`#configure terminal`	Enter configuration mode.
`(config)#interface lo`	Specify the loopback (lo) interface to be configured.
`(config-if)#ip address 5.5.5.5/32 secondary`	Set the IP address of the loopback interface to 5.5.5.5/32.
`(config-if)#exit`	Exit interface mode.
`(config)#ip vrf l3vpn`	Configure IP VRF L3VPN.
`(config-vrf)#rd 1:300`	Enter RD value.
`(config-vrf)#route-target both 300:400`	Enter RT value.
`(config-vrf)#exit`	Exiting from VRF mode.
`(config)#router ldp`	Enter router mode for LDP.
`(config-router)#router-id 5.5.5.5`	Set the router ID to IP address 5.5.5.5.
`(config-router)#targeted-peer ipv4 1.1.1.1`	Configure targeted peer.
`(config-router-targeted-peer)#exit-targeted- peer-mode`	Exit-targeted-peer-mode.
`(config-router)#targeted-peer ipv4 2.2.2.2`	Configure targeted peer.

`(config-router-targeted-peer)#exit-targeted-peer-mode`	Exit-targeted-peer-mode.
`(config-router)#exit`	Exit router mode.
`(config)#interface xe1`	Enter interface mode.
`(config-if)#ip address 40.40.40.2/24`	Configure IPv4 address for xe1.
`(config-if)#label-switching`	Enable label switching on interface xe1.
`(config-if)#enable-ldp ipv4`	Enable LDP for IPv4 on xe1.
`(config-if)#exit`	Exit interface mode.
`(config-if)#exit`	Exit interface mode.
`(config)#interface xe2.1`	Enter interface mode.
`(config-if)#description MPLS-L3VPN`	Giving Interface Description.
`(config-if)#encapsulation dot1q 4`	Setting Encapsulation to dot1q with VLAN ID 4.
`(config-if)#load-interval 30`	Load interval setting.
`(config-if)#ip vrf forwarding l3vpn`	Bind the interface connected to the CE router with VRF L3VPN.
`(config-if)#ip address 172.168.25.2/24`	Assign the IPv4 address.
`(config)#router ospf 1`	The Process ID should be a unique positive integer identifying the routing process.
`(config)#ospf router-id 5.5.5.5`	Configure OSPF router-ID same as loopback interface IP address.
`(config-router) #network 5.5.5.5/32 area 0`	Define the interface on which OSPF runs and associate the area ID (0) with the interface.
`(config-router) #network 40.40.40.0/24 area 0`	Define the interface on which OSPF runs and associate the area ID (0) with the interface.
`(config-if)#exit`	Exit interface mode.
`(config)#router bgp 100`	Enter router BGP mode
`(config-router)#bgp router-id 5.5.5.5`	Configuring the bgp router id 1.1.1.1.
`(config-router)#bgp graceful-restart restart-time 100`	Enable BGP GR with restart timer 100.
`(config-router)#neighbor 1.1.1.1 remote-as 100`	Configure neighbor 1.1.1.1.
`(config-router)#neighbor 1.1.1.1 update-source lo`	Update source lo for neighbor 1.1.1.1.
`(config-router)#address-family ipv4 unicast`	Enter address-family ipv4 unicast.
`(config-router-af)#redistribute connected`	Redistribute connected.
`(config-router)#neighbor 1.1.1.1 activate`	Activate neighbor.
`(config-router)#address-family vpnv4 unicast`	Entering Address family VPNv4 unicast.
`(config-router-af)#neighbor 1.1.1.1 activate`	Activate the neighbor 1.1.1.1.
`(config-router-af)#neighbor 1.1.1.1 capability graceful-restart`	Activate capability graceful restart for neighbor 1.1.1.1.
`(config-router-af)#exit-address-family`	Exit address family.
`(config-router)#address-family ipv4 vrf l3vpn`	Entering address family.
`(config-router-af)#redistribute connected`	Redistribute connected.

(config-router)#neighbor 172.168.26.1 remote-as 700	Configure neighbor 172.168.26.1.
(config-router)#neighbor 172.168.26.1 activate	Activate neighbor.
(config-router-af)#commit	Commit all the transactions.

Validation

Restart BGP Gracefully

PE1:

```
PE1#restart bgp graceful
%Warning : BGP process will stop and needs to restart manually,
You may lose bgp configuration,if not saved
Proceed for graceful restart? (y/n):y
%% Managed module is down or crashed

R1#show mpls ilm-table
Codes: > - installed ILM, * - selected ILM, p - stale ILM
      K - CLI ILM, T - MPLS-TP, s - Stitched ILM
       S - SNMP, L - LDP, R - RSVP, C - CRLDP
       B - BGP , K - CLI , V - LDP_VC, I - IGP_SHORTCUT
       O - OSPF/OSPF6 SR, i - ISIS SR, k - SR CLI
       P - SR Policy, U - unknown

Code    FEC/VRF/L2CKT    ILM-ID     In-Label    Out-Label   In-Intf    Out-Intf/VRF
Nexthop                    LSP-Type
                         LSP_DEFAULT
   B> p 77.77.80.0/24      7           24323       Nolabel     N/A        l3vpn
N/A                        LSP_DEFAULT
   B> p 77.77.78.0/24      5           24321       Nolabel     N/A        l3vpn
N/A                        LSP_DEFAULT
   B> p 77.77.77.0/24      4           24320       Nolabel     N/A        l3vpn
N/A                        LSP_DEFAULT
   B> p 77.77.79.0/24      6           24322       Nolabel     N/A        l3vpn
N/A                        LSP_DEFAULT
   B> p 77.77.81.0/24      8           24324       Nolabel     N/A        l3vpn
N/A                        LSP_DEFAULT
   B> p 172.168.25.0/24    9           24325       Nolabel     N/A        l3vpn
N/A                        LSP_DEFAULT

   V    l2ckt:900         1          24960       Nolabel     po1        xe1             N/
A                        LSP_DEFAULT

PE1#show mpls vrf-forwarding-table
Codes: > - installed FTN, * - selected FTN, p - stale FTN, B - BGP FTN
(m) - Service mapped over multipath transport

Code     FEC                   FTN-ID    Tunnel-id   Pri   LSP-Type     Out-Label    Out-
Intf     Nexthop
```

```
  B> p 88.88.88.0/24      1        0          Yes   LSP_DEFAULT  24321       -
5.5.5.5
  B>p 88.88.89.0/24      2        0          Yes   LSP_DEFAULT  24321       -
5.5.5.5
   B> p 88.88.90.0/24      3        0          Yes   LSP_DEFAULT  24321       -
5.5.5.5
   B >p 88.88.91.0/24      4        0          Yes   LSP_DEFAULT  24321       -
5.5.5.5
   B >p 88.88.92.0/24      5        0          Yes   LSP_DEFAULT  24321       -
5.5.5.5
   B> p 172.168.26.0/24    6        0          Yes   LSP_DEFAULT  24321       -
5.5.5.5

PE1#show nsm forwarding-timer
Protocol-Name  GR-State  Time Remaining (sec)   Disconnected-time
     BGP        ACTIVE            74          2022/01/13 16:33:43

PE#show run bgp
!
PE1#show ip bgp vpnv4 all
```

PE2:

```
PE2#show ip bgp vpnv4 all
Status codes: s suppressed, d damped, h history, a add-path, * valid, > best, i -
internal, l - labeled
              S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

    Network          Next Hop            Metric    LocPrf      Weight Path
Route Distinguisher: 1:300 (Default for VRF l3vpn)
*>i  77.77.77.0/24    1.1.1.1              0        100       0   600 i
*>i  77.77.78.0/24    1.1.1.1              0        100       0   600 i
*>i  77.77.79.0/24    1.1.1.1              0        100       0   600 i
*>i  77.77.80.0/24    1.1.1.1              0        100       0   600 i
*>i  77.77.81.0/24    1.1.1.1              0        100       0   600 i
*> l 88.88.88.0/24    172.168.26.1         0        100       0   700 i
*> l 88.88.89.0/24    172.168.26.1         0        100       0   700 i
*> l 88.88.90.0/24    172.168.26.1         0        100       0   700 i
*> l 88.88.91.0/24    172.168.26.1         0        100       0   700 i
*> l 88.88.92.0/24    172.168.26.1         0        100       0   700 i
*>i  172.168.25.0/24  1.1.1.1              0        100       0    ?
*> l 172.168.26.0/24  0.0.0.0              0        100       32768  ?
 Announced routes count = 6
 Accepted routes count = 6
Route Distinguisher: 1:300
S>i  77.77.77.0/24    1.1.1.1              0        100       0   600 i
S>i  77.77.78.0/24    1.1.1.1              0        100       0   600 i
S>i  77.77.79.0/24    1.1.1.1              0        100       0   600 i
S>i  77.77.80.0/24    1.1.1.1              0        100       0   600 i
```

```
S>i  77.77.81.0/24    1.1.1.1              0        100       0   600 i
S>i  172.168.25.0/24  1.1.1.1              0        100       0    ?
 Announced routes count = 0
```

After Restarting the BGP Manually

PE1:

```
PE1#start-shell
bash-5.0$ su
Password:
root@PE1:/home/ocnos# cd /usr/local/sbin/
root@PE1:/usr/local/sbin# ./bgpd -d

PE1#show mpls ilm-table
Codes: > - installed ILM, * - selected ILM, p - stale ILM
      K - CLI ILM, T - MPLS-TP, s - Stitched ILM
       S - SNMP, L - LDP, R - RSVP, C - CRLDP
       B - BGP , K - CLI , V - LDP_VC, I - IGP_SHORTCUT
       O - OSPF/OSPF6 SR, i - ISIS SR, k - SR CLI
       P - SR Policy, U - unknown

Code    FEC/VRF/L2CKT    ILM-ID     In-Label    Out-Label   In-Intf    Out-Intf/VRF
Nexthop                    LSP-Type
   B> 77.77.80.0/24      7          24323       Nolabel     N/A        l3vpn           N/
A                        LSP_DEFAULT
   B> 77.77.78.0/24      5          24321       Nolabel     N/A        l3vpn           N/
A                        LSP_DEFAULT
   B> 77.77.77.0/24      4          24320       Nolabel     N/A        l3vpn           N/
A                        LSP_DEFAULT
   B> 77.77.79.0/24      6          24322       Nolabel     N/A        l3vpn           N/
A                        LSP_DEFAULT
   B> 77.77.81.0/24      8          24324       Nolabel     N/A        l3vpn           N/
A                        LSP_DEFAULT
   B> 172.168.25.0/24    9          24325       Nolabel     N/A        l3vpn           N/
A                        LSP_DEFAULT
   V    l2ckt:900         1          24960       Nolabel     po1        xe1             N/
A                        LSP_DEFAULT

PE1#show mpls vrf-forwarding-table
Codes: > - installed FTN, * - selected FTN, p - stale FTN, B - BGP FTN
(m) - Service mapped over multipath transport

Code     FEC                  FTN-ID    Tunnel-id   Pri   LSP-Type     Out-Label    Out-
Intf     Nexthop

  B>88.88.88.0/24       1         0           Yes   LSP_DEFAULT  24321        -
5.5.5.5
  B>88.88.89.0/24       2         0           Yes   LSP_DEFAULT  24321        -
5.5.5.5
   B>88.88.90.0/24       3         0           Yes   LSP_DEFAULT  24321        -
5.5.5.5
```



```
   B>88.88.91.0/24       4         0           Yes   LSP_DEFAULT  24321        -
5.5.5.5
   B>88.88.92.0/24       5         0           Yes   LSP_DEFAULT  24321        -
5.5.5.5
   B> 172.168.26.0/24     6         0           Yes   LSP_DEFAULT  24321        -
5.5.5.5
```

PE2:

```
PE2#show ip bgp vpnv4 all
Status codes: s suppressed, d damped, h history, a add-path, * valid, > best, i -
internal, l - labeled
              S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

    Network          Next Hop            Metric    LocPrf      Weight Path
Route Distinguisher: 1:300 (Default for VRF l3vpn)
*>i 77.77.77.0/24    1.1.1.1              0         100       0   600 i
*>i 77.77.78.0/24    1.1.1.1              0         100       0   600 i
*>i 77.77.79.0/24    1.1.1.1              0         100       0   600 i
*>i 77.77.80.0/24    1.1.1.1              0         100       0   600 i
*>i 77.77.81.0/24    1.1.1.1              0         100       0   600 i
*> l 88.88.88.0/24    172.168.26.1         0         100       0   700 i
*> l 88.88.89.0/24    172.168.26.1         0         100       0   700 i
*> l 88.88.90.0/24    172.168.26.1         0         100       0   700 i
*> l 88.88.91.0/24    172.168.26.1         0         100       0   700 i
*> l 88.88.92.0/24    172.168.26.1         0         100       0   700 i
*>i 172.168.25.0/24 1.1.1.1              0         100       0  ?
*> l 172.168.26.0/24 0.0.0.0              0         100       32768 ?
 Announced routes count = 6
 Accepted routes count = 6
Route Distinguisher: 1:300
>i 77.77.77.0/24    1.1.1.1              0         100       0   600 i
>i 77.77.78.0/24    1.1.1.1              0         100       0   600 i
>i 77.77.79.0/24    1.1.1.1              0         100       0   600 i
>i 77.77.80.0/24    1.1.1.1              0         100       0   600 i
>i 77.77.81.0/24    1.1.1.1              0         100       0   600 i
>i 172.168.25.0/24 1.1.1.1              0         100       0    ?
 Announced routes count = 0
```

CHAPTER 22 BGP Peer Groups for Address-Family L2VPN EVPN

BGP peer groups are used to simplify configuration and to improve performance. This is achieved by assigning the same outbound policy to each of the neighbors. Because UPDATEs are generated only once per peer group rather than multiple times for each neighboring router, peer groups save processing time when building neighbor updates. It reduces the amount of system resources (CPU and memory) necessary in an update generation.

A BGP peer group reduces the load on system resources by allowing the routing table to be checked only once, and updates to be replicated to all peer group members instead of being done individually for each peer in the peer group.

Topology

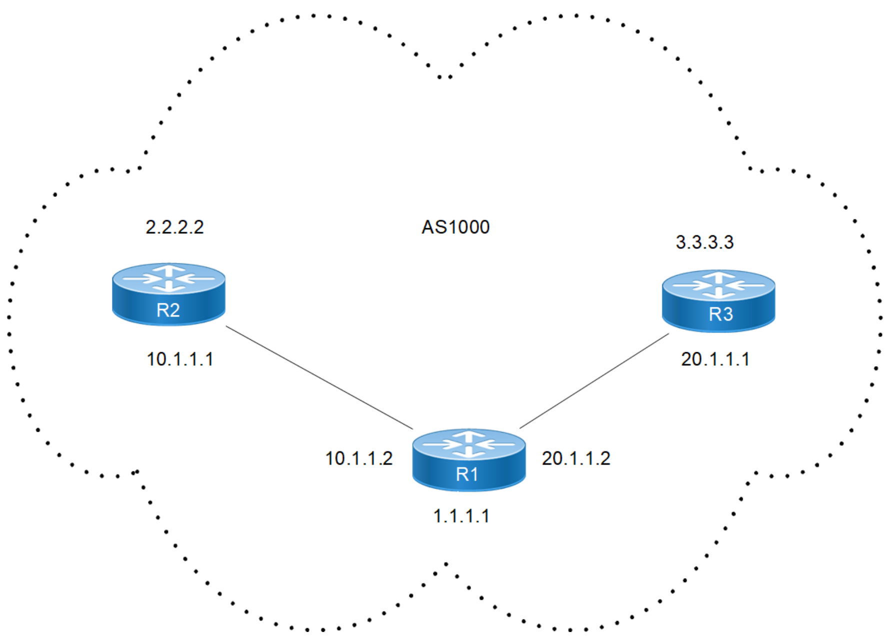


Figure 22-3: BGP Peer-Groups with L2VPN EVPN address-family

Configuration

R1

`#configure terminal`	Enter configure mode.
`(config)# interface lo`	Enter interface mode for Loopback
`(config-if)#ip address 1.1.1.1/32 secondary`	Configure ip address for Loopback interface
`(config-if)#exit`	Exit interface mode
`(config)# interface xe15`	Enter interface mode for xe15
`(config-if)#ip address 10.1.1.2/24`	Configure ip address

(config-if)#exit	Exit interface mode
(config)# interface ce0	Enter interface mode for ce0
(config-if)#ip address 20.1.1.2	Configure ip address
(config-if)#exit	Exit interface mode
(config)#router ospf 100	Configure the OSPF process (100)
(config-router)# ospf router-id 1.1.1.1	Configure OSPF router-id
(config-router)#network 1.1.1.1/32 area 0	Advertise the network in Area 0
(config-router)#network 10.1.1.0/24 area 0	Advertise the network in Area 0
(config-router)#network 20.1.1.0/24 area 0	Advertise the network in Area 0
(config-router)#exit	Exit Router mode and return to Configure mode
(config)#router bgp 100	Define the routing process. The number 100 specifies the AS number of R1.
(config-router)# bgp router-id 1.1.1.1	Configure BGP router-id
(config-router)#neighbor PG peer-group	Create a peer group named PG
(config-router)#neighbor PG remote-as 100	Assign options to the peer group named PG
(config-router)#neighbor PG update-source lo	Assign options to the peer group named PG
(config-router)#neighbor 2.2.2.2 peer-group PG	Define neighbor 2.2.2.2 (R2) as a peer group
(config-router)#neighbor 3.3.3.3 peer-group PG	Define neighbor 3.3.3.3 (R3) as a peer group member.
(config-router)#address-family l2vpn evpn	Enter address-family l2vpn evpn mode
(config-router-af)#neighbor PG activate	Activate the peer-group ABC for address-family l2vpn evpn
(config-router-af)# exit-address-family	Exit address-family ipv4 unicast mode
(config-router)#exit	Exit router bgp mode
(config)#commit	Commit the candidate configuration to the running configuration.

R2

#configure terminal	Enter configure mode.
(config)# interface lo	Enter interface mode for Loopback
(config-if)#ip address 2.2.2.2/32 secondary	Configure ip address for Loopback interface
(config-if)#exit	Exit interface mode
(config)# interface xe15	Enter interface mode for xe15
(config-if)#ip address 10.1.1.2/24	Configure ip address
(config-if)#exit	Exit interface mode
(config)# interface xe10	Enter interface mode for xe10
(config-if)#ip address 10.1.1.1/24	Configure ip address
(config-if)#exit	Exit interface mode
(config)#router ospf 100	Configure the OSPF process (100)
(config-router)# ospf router-id 2.2.2.2	Configure OSPF router-id
(config-router)#network 2.2.2.2/32 area 0	Advertise the network in Area 0
(config-router)#network 10.1.1.0/24 area 0	Advertise the network in Area 0

(config-router)#exit	Exit Router mode and return to Configure mode
(config)#router bgp 100	Define the routing process. The number 100 specifies the AS number of R1.
(config-router)# bgp router-id 2.2.2.2	Configure BGP router-id
(config-router)#neighbor PG peer-group	Create a peer group named PG
(config-router)#neighbor PG remote-as 100	Assign options to the peer group named PG
(config-router)#neighbor PG update-source lo	Assign options to the peer group named PG
(config-router)#neighbor 1.1.1.1 peer-group PG	Define neighbor 1.1.1.1 (R1) as a peer group member.
(config-router)#address-family l2vpn evpn	Enter address-family l2vpn evpn mode
(config-router-af)#neighbor PG activate	Activate the peer-group ABC for address-family l2vpn evpn
(config-router-af)# exit-address-family	Exit address-family ipv4 unicast mode
(config-router)#exit	Exit router bgp mode
(config)#commit	Commit the candidate configuration to the running configuration.

R3

#configure terminal	Enter configure mode.
(config)# interface lo	Enter interface mode for Loopback
(config-if)#ip address 3.3.3.3/32 secondary	Configure ip address for Loopback interface
(config-if)#exit	Exit interface mode
(config)# interface ce15	Enter interface mode for ce15
(config-if)#ip address 20.1.1.1/24	Configure ip address
(config-if)#exit	Exit interface mode
(config)# interface xe10	Enter interface mode for xe10
(config-if)#ip address 10.1.1.1/24	Configure ip address
(config-if)#exit	Exit interface mode
(config)#router ospf 100	Configure the OSPF process (100)
(config-router)# ospf router-id 3.3.3.3	Configure OSPF router-id
(config-router)#network 20.1.1.0/24 area 0	Advertise the network in Area 0
(config-router)#exit	Exit Router mode and return to Configure mode
(config)#router bgp 100	Define the routing process. The number 100 specifies the AS number of R1.
(config-router)# bgp router-id 3.3.3.3	Configure BGP router-id
(config-router)#neighbor PG peer-group	Create a peer group named PG
(config-router)#neighbor PG remote-as 100	Assign options to the peer group named PG
(config-router)#neighbor PG update-source lo	Assign options to the peer group named PG
(config-router)#neighbor 1.1.1.1 peer-group PG	Define neighbor 1.1.1.1 (R1) as a peer group member.
(config-router)#address-family l2vpn evpn	Enter address-family l2vpn evpn mode
(config-router-af)#neighbor PG activate	Activate the peer-group ABC for address-family l2vpn evpn
(config-router-af)# exit-address-family	Exit address-family ipv4 unicast mode

`(config-router)#exit`	Exit router bgp mode
`(config)#commit`	Commit the candidate configuration to the running configuration.

Validation

R1

```
R1#sh run bgp
!
router bgp 100
 bgp router-id 1.1.1.1
 neighbor PG peer-group
 neighbor PG remote-as 100
 neighbor PG update-source lo
 neighbor 2.2.2.2 peer-group PG
 neighbor 3.3.3.3 peer-group PG
 !
 address-family l2vpn evpn
 neighbor PG activate
 exit-address-family
R1#sh bgp neighbors
BGP neighbor is 2.2.2.2, remote AS 100, local AS 100, internal link
 Member of peer-group PG for session parameters
  BGP version 4, local router ID 1.1.1.1, remote router ID 2.2.2.2
  BGP state = Established, up for 01:20:53
  Last read 00:00:24, hold time is 90, keepalive interval is 30 seconds
  Neighbor capabilities:
    Route refresh: advertised and received (old and new)
    Address family L2VPN EVPN: advertised and received
  Received 192 messages, 0 notifications, 0 in queue
  Sent 191 messages, 0 notifications, 0 in queue
  Route refresh request: received 0, sent 0
  Minimum time between advertisement runs is 5 seconds
  Update source is lo
 For address family: L2VPN EVPN
  BGP table version 1, neighbor version 1
  Index 2, Offset 0, Mask 0x4
  PG peer-group member
  Community attribute sent to this neighbor (both)
  Large Community attribute sent to this neighbor
  0 accepted prefixes
  Accepted AD:0 MACIP:0 MCAST:0 ESI:0 PREFIX:0
  0 announced prefixes

 Connections established 1; dropped 0
Local host: 1.1.1.1, Local port: 42981
Foreign host: 2.2.2.2, Foreign port: 179
```



```
Nexthop: 1.1.1.1
Nexthop global: ::
Nexthop local: ::
BGP connection: non shared network

BGP neighbor is 3.3.3.3, remote AS 100, local AS 100, internal link
 Member of peer-group PG for session parameters
  BGP version 4, local router ID 1.1.1.1, remote router ID 3.3.3.3
  BGP state = Established, up for 01:36:13
  Last read 00:00:08, hold time is 90, keepalive interval is 30 seconds
  Neighbor capabilities:
    Route refresh: advertised and received (old and new)
    Address family L2VPN EVPN: advertised and received
  Received 227 messages, 0 notifications, 0 in queue
  Sent 229 messages, 0 notifications, 0 in queue
  Route refresh request: received 0, sent 0
  Minimum time between advertisement runs is 5 seconds
  Update source is lo
 For address family: L2VPN EVPN
  BGP table version 1, neighbor version 1
  Index 3, Offset 0, Mask 0x8
  PG peer-group member
  Community attribute sent to this neighbor (both)
  Large Community attribute sent to this neighbor
  0 accepted prefixes
  Accepted AD:0 MACIP:0 MCAST:0 ESI:0 PREFIX:0
  0 announced prefixes

 Connections established 1; dropped 0
Local host: 1.1.1.1, Local port: 179
Foreign host: 3.3.3.3, Foreign port: 32857
Nexthop: 1.1.1.1
Nexthop global: ::
Nexthop local: ::
BGP connection: non shared network
R1#sh ip ospf neighbor

Total number of full neighbors: 2
OSPF process 100 VRF(default):
Neighbor ID     Pri   State            Dead Time   Address         Interface
Instance ID
2.2.2.2          1   Full/Backup     00:00:38   10.1.1.1       xe15                 0
3.3.3.3          1   Full/Backup     00:00:34   20.1.1.1       ce0                  0
R1#sh bgp l2vpn evpn summary
BGP router identifier 1.1.1.1, local AS number 100
BGP table version is 1
1 BGP AS-PATH entries
0 BGP community entries

Neighbor                V   AS   MsgRcv    MsgSen TblVer   InQ   OutQ    Up/Down   State/
PfxRcd     AD  MACIP  MCAST    ESI  PREFIX-ROUTE
```

```
2.2.2.2                4   100  193       191      1      0      0  01:21:07
0      0      0      0      0      0
3.3.3.3                4   100  227       229      1      0      0  01:36:27
0      0      0      0      0      0

Total number of neighbors 2

Total number of Established sessions 2
```

R2

```
R2#sh run bgp
!
router bgp 100
 bgp router-id 2.2.2.2
 neighbor PG peer-group
 neighbor PG remote-as 100
 neighbor PG update-source lo
 neighbor 1.1.1.1 peer-group PG
 !
 address-family l2vpn evpn
 neighbor PG activate
 exit-address-family
!
R2#sh bgp neighbors
BGP neighbor is 1.1.1.1, remote AS 100, local AS 100, internal link
 Member of peer-group PG for session parameters
  BGP version 4, local router ID 2.2.2.2, remote router ID 1.1.1.1
  BGP state = Established, up for 01:20:42
  Last read 00:00:20, hold time is 90, keepalive interval is 30 seconds
  Neighbor capabilities:
    Route refresh: advertised and received (old and new)
    Address family L2VPN EVPN: advertised and received
  Received 190 messages, 0 notifications, 0 in queue
  Sent 193 messages, 0 notifications, 0 in queue
  Route refresh request: received 0, sent 0
  Minimum time between advertisement runs is 5 seconds
  Update source is lo
 For address family: L2VPN EVPN
  BGP table version 1, neighbor version 1
  Index 2, Offset 0, Mask 0x4
  PG peer-group member
  Community attribute sent to this neighbor (both)
  Large Community attribute sent to this neighbor
  0 accepted prefixes
  Accepted AD:0 MACIP:0 MCAST:0 ESI:0 PREFIX:0
  0 announced prefixes

 Connections established 1; dropped 0
Local host: 2.2.2.2, Local port: 179
Foreign host: 1.1.1.1, Foreign port: 42981
```

```
Nexthop: 2.2.2.2
Nexthop global: ::
Nexthop local: ::
BGP connection: non shared network

R2#sh ip ospf neighbor

Total number of full neighbors: 1
OSPF process 100 VRF(default):
Neighbor ID     Pri   State           Dead Time   Address         Interface
Instance ID
1.1.1.1           1   Full/DR         00:00:30    10.1.1.2        xe10                   0
R2#sh bgp l2vpn evpn summary
BGP router identifier 2.2.2.2, local AS number 100
BGP table version is 1
0 BGP AS-PATH entries
0 BGP community entries

Neighbor                V   AS   MsgRcv    MsgSen TblVer   InQ   OutQ    Up/Down   State/
PfxRcd     AD  MACIP  MCAST    ESI  PREFIX-ROUTE
1.1.1.1                4   100  192       195      1      0      0  01:21:28
0      0      0      0      0      0

Total number of neighbors 1

Total number of Established sessions 1
```

R3

```
R3#sh run bgp
!
router bgp 100
 bgp router-id 3.3.3.3
 neighbor PG peer-group
 neighbor PG remote-as 100
 neighbor PG update-source lo
 neighbor 1.1.1.1 peer-group PG
 !
 address-family l2vpn evpn
 neighbor PG activate
 exit-address-family
!
R3#sh bgp neighbors
BGP neighbor is 1.1.1.1, remote AS 100, local AS 100, internal link
 Member of peer-group PG for session parameters
  BGP version 4, local router ID 3.3.3.3, remote router ID 1.1.1.1
  BGP state = Established, up for 01:36:07
  Last read 00:00:06, hold time is 90, keepalive interval is 30 seconds
  Neighbor capabilities:
    Route refresh: advertised and received (old and new)
    Address family L2VPN EVPN: advertised and received
```

```
  Received 228 messages, 0 notifications, 0 in queue
  Sent 227 messages, 0 notifications, 0 in queue
  Route refresh request: received 0, sent 0
  Minimum time between advertisement runs is 5 seconds
  Update source is lo
 For address family: L2VPN EVPN
  BGP table version 1, neighbor version 1
  Index 2, Offset 0, Mask 0x4
  PG peer-group member
  Community attribute sent to this neighbor (both)
  Large Community attribute sent to this neighbor
  0 accepted prefixes
  Accepted AD:0 MACIP:0 MCAST:0 ESI:0 PREFIX:0
  0 announced prefixes

 Connections established 1; dropped 0
Local host: 3.3.3.3, Local port: 32857
Foreign host: 1.1.1.1, Foreign port: 179
Nexthop: 3.3.3.3
Nexthop global: ::
Nexthop local: ::
BGP connection: non shared network
R3#sh ip os neighbor

Total number of full neighbors: 1
OSPF process 100 VRF(default):
Neighbor ID     Pri   State            Dead Time   Address         Interface
Instance ID
1.1.1.1          1   Full/DR         00:00:37    20.1.1.2       ce15                   0
R3#sh bgp l2vpn evpn summary
BGP router identifier 3.3.3.3, local AS number 100
BGP table version is 1
0 BGP AS-PATH entries
0 BGP community entries

Neighbor                V   AS   MsgRcv    MsgSen TblVer   InQ   OutQ    Up/Down   State/
PfxRcd     AD  MACIP  MCAST    ESI  PREFIX-ROUTE
1.1.1.1                4   100  232       231      1     0     0  01:37:55
0      0      0      0      0      0

Total number of neighbors 1

Total number of Established sessions 1
```

CHAPTER 23 DHCP Relay Agent Over L3VPN Configuration

The DHCP Relay feature was designed to forward DHCP broadcast requests as unicast packets to a configured DHCP server or servers for redundancy. In the L3VPN case, there is a special tunnel which gets created through which all the communication happens. In OcNOS, the interface created is named as tunmpls. This tunnel name is not exposed to the OcNOS control plane .This interface is directly created in the kernel.

DHCP Relay Over L3 VPN for IPv4

Before configuring DHCP Relay, make sure DHCP server and client configurations are done.

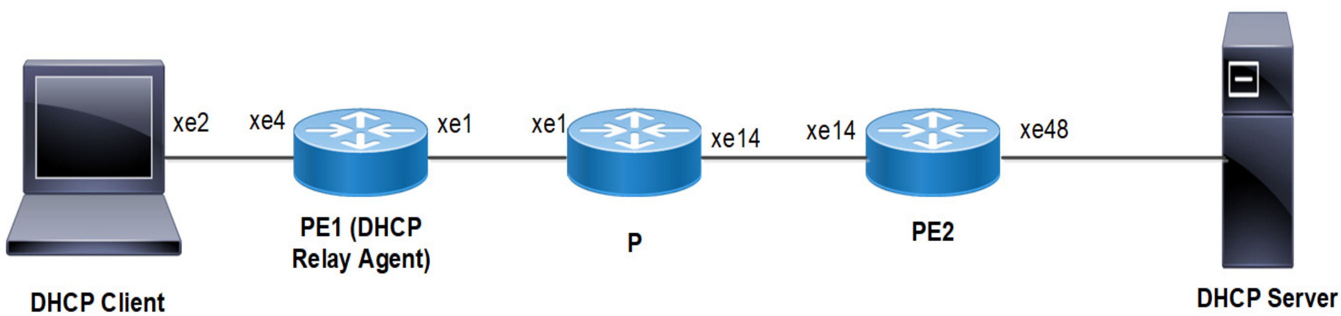


Figure 23-4: DHCP Relay Over L3 VPN Configuration

DHCP Client

`#configure terminal`	Enter configure mode.
`(config)#interface xe2`	Enter interface mode.
`(config-if)#ip address dhcp`	Enable DHCP on interface
`(config-if)#commit`	Commit the candidate configuration to the running configuration

PE1(DHCP Relay Agent)

`#configure terminal`	Enter configure mode.
`(config)#ip dhcp relay`	By default this will be enabled. It starts the ip dhcp relay service.
`(config)#ip vrf vrf1`	Configuring non default vrf vrf1
`(config-vrf)# rd 10:10`	Assign a route distinguisher to VRF
`(config-vrf)# route-target both 10:10`	Configure a route target for vrf1.
`(config-vrf)#ip dhcp relay address 11.11.0.1`	Configure DHCP server address.
`(config-vrf)# ip dhcp relay uplink l3vpn`	configure IPv4 DHCP Relay over L3VPN.
`(config)#interface xe4`	Enter interface mode.
`(config-if)#ip vrf forwarding vrf1`	Configure vrf forwarding for vrf1
`(config-if)#ip address 50.50.50.1/24`	Add IP address.
`(config-if)#ip dhcp relay`	Configure DHCP relay for the interface connecting to client.
`(config-if)#exit`	Exit from interface mode
`(config)#interface lo`	Enter interface mode
`(config-if)#ip address 1.1.1.1/32 secondary`	Set an IP address on the interface
`(config-if)#exit`	Exit from interface mode
`(config)#router ldp`	Enter the Router LDP mode.
`(config-router)#router-id 1.1.1.1`	Configure an LDP router ID.
`(config-router)#exit`	Exit from Router LDP mode
`(config)#interface xe1`	Enter interface mode
`(config-if)# ip address 10.1.1.1/24`	Add IP address.
`(config-if)# label-switching`	Enable label switching on the interface
`(config-if)# enable-ldp ipv4`	Enable IPv4 LDP configuration on the interface.
`(config-if)#exit`	Exit from interface mode
`(config)#router ospf 100`	Enter the Router OSPF mode.
`(config-router)#network 1.1.1.1/32 area 0.0.0.0`	Advertise loopback address in OSPF.
`(config-router)#network 10.1.1.0/24 area 0.0.0.0`	Advertise network address in OSPF.
`(config-router)#exit`	Exit Router OSPF mode and return to Configure mode.
`(config)# router bgp 100`	Enter the Router BGP mode, ASN: 100
`(config-router)# bgp router-id 1.1.1.1`	Configure a fixed Router ID (1.1.1.1)
`(config-router)# neighbor 3.3.3.3 remote-as 100`	Configuring PE2 as iBGP neighbor using it's loopback IP
`(config-router)# neighbor 3.3.3.3 update-source lo`	Source of routing updates as loopback
`(config-router)# address-family ipv4 unicast`	Entering into IPV4 unicast address family
`(config-router-af)# neighbor 3.3.3.3 activate`	Activate the neighbor in the IPV4 address family
`(config-router-af)#exit`	Exiting of Address family mode
`(config-router)# address-family vpnv4 unicast`	Entering into address family mode as vpnv4

(config-router-af)# neighbor 3.3.3.3 activate	Activate the neighbor in the vpnv4 address family
(config-router-af)#exit	Exiting of Address family mode
(config-router)# address-family ipv4 vrf vrf1	Entering into address family mode as ipv4 vrf vrf1
(config-router-af)# redistribute connected	Redistribute connected routes.
(config-router-af)#exit	Exiting of Address family mode
(config-router)# commit	Commit the candidate configuration to the running configuration

P

#configure terminal	Enter configure mode.
(config)#interface lo	Enter interface mode
(config-if)#ip address 2.2.2.2/32 secondary	Set an IP address on the interface
(config-if)#exit	Exit from interface mode
(config)#router ldp	Enter the Router LDP mode.
(config-router)#router-id 2.2.2.2	Configure an LDP router ID.
(config-router)#exit	Exit from Router LDP mode
(config)#interface xe14	Enter interface mode
(config-if)# ip address 20.1.1.1/24	Add IP address.
(config-if)# label-switching	Enable label switching on the interface
(config-if)# enable-ldp ipv4	Enable IPv4 LDP configuration on the interface.
(config-if)#exit	Exit from interface mode
(config)#interface xe1	Enter interface mode
(config-if)# ip address 10.1.1.2/24	Add IP address.
(config-if)# label-switching	Enable label switching on the interface
(config-if)# enable-ldp ipv4	Enable IPv4 LDP configuration on the interface.
(config-if)#exit	Exit from interface mode
(config)#router ospf 100	Enter the Router OSPF mode.
(config-router)#network 3.3.3.3/32 area 0.0.0.0	Advertise loopback address in OSPF.
(config-router)#network 20.1.1.0/24 area 0.0.0.0	Advertise network address in OSPF.
(config-router)#network 10.1.1.0/24 area 0.0.0.0	Advertise network address in OSPF.
(config-router)#exit	Exit Router OSPF mode and return to Configure mode.
(config)# commit	Commit the candidate configuration to the running configuration

PE2

`#configure terminal`	Enter configure mode.
`(config)#ip vrf vrf1`	Configuring non default vrf vrf1
`(config-vrf)# rd 10:10`	Assign a route distinguisher to VRF
`(config-vrf)# route-target both 10:10`	Configure a route target for vrf1.
`(config)#interface xe48`	Enter interface mode.
`(config-if)#ip vrf forwarding vrf1`	Configure vrf forwarding for vrf1
`(config-if)# commit`	Commit the candidate config
`(config-if)#ip address 11.11.0.2/24`	Add IP address.
`(config-if)#exit`	Exit from interface mode
`(config)#interface lo`	Enter interface mode
`(config-if)#ip address 3.3.3.3/32 secondary`	Set an IP address on the interface
`(config-if)#exit`	Exit from interface mode
`(config)#router ldp`	Enter the Router LDP mode.
`(config-router)#router-id 3.3.3.3`	Configure an LDP router ID.
`(config-router)#exit`	Exit from Router LDP mode
`(config)#interface xe14`	Enter interface mode
`(config-if)# ip address 20.1.1.2/24`	Add IP address.
`(config-if)# label-switching`	Enable label switching on the interface
`(config-if)# enable-ldp ipv4`	Enable IPv4 LDP configuration on the interface.
`(config-if)#exit`	Exit from interface mode
`(config)#router ospf 100`	Enter the Router OSPF mode.
`(config-router)#network 3.3.3.3/32 area 0.0.0.0`	Advertise loopback address in OSPF.
`(config-router)#network 20.1.1.0/24 area 0.0.0.0`	Advertise network address in OSPF.
`(config-router)#exit`	Exit Router OSPF mode and return to Configure mode.
`(config)# router bgp 100`	Enter the Router BGP mode, ASN: 100
`(config-router)# bgp router-id 3.3.3.3`	Configure a fixed Router ID (3.3.3.3)
`(config-router)# neighbor 1.1.1.1 remote-as 100`	Configuring PE1 as iBGP neighbor using it's loopback IP
`(config-router)# neighbor 1.1.1.1 update-source lo`	Source of routing updates as loopback
`(config-router)# address-family ipv4 unicast`	Entering into IPV4 unicast address family
`(config-router-af)# neighbor 1.1.1.1 activate`	Activate the neighbor in the IPV4 address family
`(config-router-af)#exit`	Exiting of Address family mode
`(config-router)# address-family vpnv4 unicast`	Entering into address family mode as vpnv4
`(config-router-af)# neighbor 1.1.1.1 activate`	Activate the neighbor in the vpnv4 address family
`(config-router-af)#exit`	Exiting of Address family mode
`(config-router)# address-family ipv4 vrf vrf1`	Entering into address family mode as ipv4 vrf vrf1

`(config-router-af)# redistribute connected`	Redistribute connected routes.
`(config-router-af)#exit`	Exiting of Address family mode
`(config-router)# commit`	Commit the candidate configuration to the running configuration

Validation

PE1 (DHCP Relay Agent)

```
PE1#show running-config dhcp
ip vrf vrf1
 ip dhcp relay address 11.11.0.1
 ip dhcp relay uplink l3vpn
interface xe4
 ip dhcp relay

PE1#show ip dhcp relay
DHCP relay service is Enabled.
VRF Name: vrf1
  Option 82: Disabled
  DHCP Servers configured: 11.11.0.1

  Interface                 Uplink/Downlink
  ---------                 -------------
  xe4                       Downlink
  l3vpn                     uplink
Incoming DHCPv4 packets which already contain relay agent option are FORWARDED u
nchanged.
```

PE1#show ip dhcp relay address

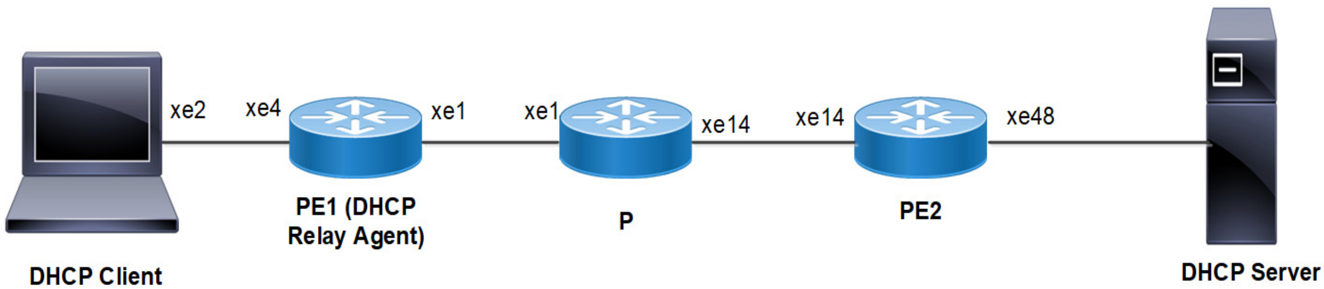
```
VRF Name: vrf1
  DHCP Servers configured: 11.11.0.1

Incoming DHCPv4 packets which already contain relay agent option are FORWARDED u
nchanged.
```

DHCP Client

```
#show ip interface brief | include xe2
  xe5   *50.50.50.2  up     up
```

DHCP Relay Over L3 VPN for IPv6

Before configuring DHCP Relay, make sure DHCP server and client configurations are done.



.

Figure 23-5: DHCP Relay Over L3 VPN Configuration

DHCP Client

`#configure terminal`	Enter configure mode.
`(config)#interface xe2`	Enter interface mode.
`(config-if)#ipv6 address dhcp`	Enable DHCP on interface
`(config-if)#commit`	Commit the candidate configuration to the running configuration

PE1(DHCP Relay Agent)

`#configure terminal`	Enter configure mode.
`(config)#ipv6 dhcp relay`	By default this will be enabled. It starts the ipv6 dhcp relay service.
`(config)#ip vrf vrf1`	Configuring non default vrf vrf1
`(config-vrf)# rd 10:10`	Assign a route distinguisher to VRF
`(config-vrf)# route-target both 10:10`	Configure a route target for vrf1.
`(config-vrf)# ipv6 dhcp relay address 2002::1`	Configure DHCP server address.
`(config-vrf)# ipv6 dhcp relay uplink l3vpn`	configure IPv6 DHCP Relay over L3VPN.
`(config)#interface xe4`	Enter interface mode.
`(config-if)#ip vrf forwarding vrf1`	Configure vrf forwarding for vrf1
`(config-if)# ipv6 address 2001::1/64`	Add IPv6 address.
`(config-if)#ipv6 dhcp relay`	Configure DHCP relay for the interface connecting to client.
`(config-if)#exit`	Exit from interface mode
`(config)#interface lo`	Enter interface mode
`(config-if)#ip address 1.1.1.1/32 secondary`	Set an IP address on the interface
`(config-if)#exit`	Exit from interface mode
`(config)#router ldp`	Enter the Router LDP mode.
`(config-router)#router-id 1.1.1.1`	Configure an LDP router ID.
`(config-router)#exit`	Exit from Router LDP mode
`(config)#interface xe1`	Enter interface mode
`(config-if)# ip address 10.1.1.1/24`	Add IP address.
`(config-if)# label-switching`	Enable label switching on the interface
`(config-if)# enable-ldp ipv4`	Enable IPv4 LDP configuration on the interface.
`(config-if)#exit`	Exit from interface mode
`(config)#router ospf 100`	Enter the Router OSPF mode.
`(config-router)#network 1.1.1.1/32 area 0.0.0.0`	Advertise loopback address in OSPF.
`(config-router)#network 10.1.1.0/24 area 0.0.0.0`	Advertise network address in OSPF.
`(config-router)#exit`	Exit Router OSPF mode and return to Configure mode.
`(config)# router bgp 100`	Enter the Router BGP mode, ASN: 100
`(config-router)# bgp router-id 1.1.1.1`	Configure a fixed Router ID (1.1.1.1)
`(config-router)# neighbor 3.3.3.3 remote-as 100`	Configuring PE2 as iBGP neighbor using it's loopback IP
`(config-router)# neighbor 3.3.3.3 update-source lo`	Source of routing updates as loopback
`(config-router)# address-family ipv4 unicast`	Entering into IPV4 unicast address family
`(config-router-af)# neighbor 3.3.3.3 activate`	Activate the neighbor in the IPV4 address family
`(config-router-af)#exit`	Exiting of Address family mode
`(config-router)# address-family vpnv4 unicast`	Entering into address family mode as vpnv4

`(config-router-af)# neighbor 3.3.3.3 activate`	Activate the neighbor in the vpnv4 address family
`(config-router-af)#exit`	Exiting of Address family mode
`(config-router)# address-family vpnv6 unicast`	Entering into address family mode as vpnv6
`(config-router-af)# neighbor 3.3.3.3 activate`	Activate the neighbor in the vpnv6 address family
`(config-router-af)#exit`	Exiting of Address family mode
`(config-router)# address-family ipv4 vrf vrf1`	Entering into address family mode as ipv4 vrf vrf1
`(config-router-af)# redistribute connected`	Redistribute connected routes.
`(config-router-af)#exit`	Exiting of Address family mode
`(config-router)# address-family ipv6 vrf vrf1`	Entering into address family mode as ipv6 vrf vrf1
`(config-router-af)# redistribute connected`	Redistribute connected routes.
`(config-router-af)#exit`	Exiting of Address family mode
`(config-router)# commit`	Commit the candidate configuration to the running configuration

P

`#configure terminal`	Enter configure mode.
`(config)#interface lo`	Enter interface mode
`(config-if)#ip address 2.2.2.2/32 secondary`	Set an IP address on the interface
`(config-if)#exit`	Exit from interface mode
`(config)#router ldp`	Enter the Router LDP mode.
`(config-router)#router-id 2.2.2.2`	Configure an LDP router ID.
`(config-router)#exit`	Exit from Router LDP mode
`(config)#interface xe14`	Enter interface mode
`(config-if)# ip address 20.1.1.1/24`	Add IP address.
`(config-if)# label-switching`	Enable label switching on the interface
`(config-if)# enable-ldp ipv4`	Enable IPv4 LDP configuration on the interface.
`(config-if)#exit`	Exit from interface mode
`(config)#interface xe1`	Enter interface mode
`(config-if)# ip address 10.1.1.2/24`	Add IP address.
`(config-if)# label-switching`	Enable label switching on the interface
`(config-if)# enable-ldp ipv4`	Enable IPv4 LDP configuration on the interface.
`(config-if)#exit`	Exit from interface mode
`(config)#router ospf 100`	Enter the Router OSPF mode.
`(config-router)#network 3.3.3.3/32 area 0.0.0.0`	Advertise loopback address in OSPF.
`(config-router)#network 20.1.1.0/24 area 0.0.0.0`	Advertise network address in OSPF.
`(config-router)#network 10.1.1.0/24 area 0.0.0.0`	Advertise network address in OSPF.
`(config-router)#exit`	Exit Router OSPF mode and return to Configure mode.
`(config)# commit`	Commit the candidate configuration to the running configuration

PE2

`#configure terminal`	Enter configure mode.
`(config)#ip vrf vrf1`	Configuring non default vrf vrf1
`(config-vrf)# rd 10:10`	Assign a route distinguisher to VRF
`(config-vrf)# route-target both 10:10`	Configure a route target for vrf1.
`(config)#interface xe48`	Enter interface mode.
`(config-if)#ip vrf forwarding vrf1`	Configure vrf forwarding for vrf1
`(config-if)# commit`	Commit the candidate config
`(config-if)# ipv6 address 2002::2/64`	Add IPv6 address.
`(config-if)#exit`	Exit from interface mode
`(config)#interface lo`	Enter interface mode
`(config-if)#ip address 3.3.3.3/32 secondary`	Set an IP address on the interface
`(config-if)#exit`	Exit from interface mode
`(config)#router ldp`	Enter the Router LDP mode.
`(config-router)#router-id 3.3.3.3`	Configure an LDP router ID.
`(config-router)#exit`	Exit from Router LDP mode
`(config)#interface xe14`	Enter interface mode
`(config-if)# ip address 20.1.1.2/24`	Add IP address.
`(config-if)# label-switching`	Enable label switching on the interface
`(config-if)# enable-ldp ipv4`	Enable IPv4 LDP configuration on the interface.
`(config-if)#exit`	Exit from interface mode
`(config)#router ospf 100`	Enter the Router OSPF mode.
`(config-router)#network 3.3.3.3/32 area 0.0.0.0`	Advertise loopback address in OSPF.
`(config-router)#network 20.1.1.0/24 area 0.0.0.0`	Advertise network address in OSPF.
`(config-router)#exit`	Exit Router OSPF mode and return to Configure mode.
`(config)# router bgp 100`	Enter the Router BGP mode, ASN: 100
`(config-router)# bgp router-id 3.3.3.3`	Configure a fixed Router ID (3.3.3.3)
`(config-router)# neighbor 1.1.1.1 remote-as 100`	Configuring PE1 as iBGP neighbor using it's loopback IP
`(config-router)# neighbor 1.1.1.1 update-source lo`	Source of routing updates as loopback
`(config-router)# address-family ipv4 unicast`	Entering into IPV4 unicast address family
`(config-router-af)# neighbor 1.1.1.1 activate`	Activate the neighbor in the IPV4 address family
`(config-router-af)#exit`	Exiting of Address family mode
`(config-router)# address-family vpnv4 unicast`	Entering into address family mode as vpnv4
`(config-router-af)# neighbor 1.1.1.1 activate`	Activate the neighbor in the vpnv4 address family
`(config-router-af)#exit`	Exiting of Address family mode
`(config-router)# address-family vpnv6 unicast`	Entering into address family mode as vpnv6

`(config-router-af)# neighbor 1.1.1.1 activate`	Activate the neighbor in the vpnv6 address family
`(config-router-af)#exit`	Exiting of Address family mode
`(config-router)# address-family ipv4 vrf vrf1`	Entering into address family mode as ipv4 vrf vrf1
`(config-router-af)# redistribute connected`	Redistribute connected routes.
`(config-router-af)#exit`	Exiting of Address family mode
`(config-router)# address-family ipv6 vrf vrf1`	Entering into address family mode as ipv6 vrf vrf1
`(config-router-af)# redistribute connected`	Redistribute connected routes.
`(config-router-af)#exit`	Exiting of Address family mode
`(config-router)# commit`	Commit the candidate configuration to the running configuration

Validation

PE1 (DHCP Relay Agent)

```
PE1#show running-config dhcp
ip vrf vrf1
 ipv6 dhcp relay address 2002::1
 ipv6 dhcp relay uplink l3vpn
interface xe4
 ipv6 dhcp relay

PE1#show ipv6 dhcp relay
IPv6 DHCP relay service is Enabled.
VRF Name: vrf1
  Option 82: Enabled
  DHCPv6 Servers configured: 2002::1
  DHCPv6 IA_PD Route injection: Disabled
  Interface                Uplink/Downlink
  ---------                -------------
  xe4                      Downlink
  l3vpn                    uplink
PE1#show ip dhcp relay address
VRF Name: vrf1
  DHCPv6 Servers configured: 2002::1
```

DHCP Client

```
#show ipv6 interface brief | include xe2
  xe5   *2001::200  up     up
```

Multi-Protocol Label Switching Command Reference

CHAPTER 1 MPLS Commands

This chapter is a reference for the MPLS commands:

- bandwidth
- clear mpls counters ldp
- clear mpls counters rsvp
- clear mpls counters static
- clear mpls l2-circuit statistics
- clear mpls l2-circuit statistics
- control-word
- label-switching
- match vlan
- mpls ac-group
- mpls admin-groups
- mpls bandwidth-class
- mpls ftn-ecmp ldp
- mpls ftn-entry tunnel-id
- mpls ftn-entry
- mpls ilm-ecmp ldp
- mpls ilm-entry pop
- mpls ilm-entry swap
- mpls ilm-entry vpnpop
- mpls ingress-ttl
- mpls l2-circuit
- mpls-l2-circuit NAME
- mpls l2-circuit-fib-entry
- mpls label mode
- mpls local-packet-handling
- mpls lsp-model
- mpls lsp-stitching
- mpls map-route
- mpls min-label-value
- mpls propagate-ttl
- mpls traffic-eng
- mpls traffic-eng srlg
- ping mpls

bandwidth

Use this command to specify the maximum bandwidth to be used for a band-class. The bandwidth value is in bits.

Note: Run this command in the Bandwidth-class mode (refer to mpls bandwidth-class).

Command Syntax

```
bandwidth BANDWIDTH setup-priority <0-7> hold-priority <0-7>
```

Parameter

`BANDWIDTH`	<1-999>k for 1 to 999 kilo bits/s
	<1-999>m for 1 to 999 mega bits/s
	<1-100>g for 1 to 100 giga bits/s
`setup-priority`	Indicate the `setup-priority` parameter
`<0-7>`	The actual setup priority value
`hold-priority`	Indicate the `hold-priority` parameter
`<0-7>`	The actual hold priority value

Default

By default, bandwidth priority is 0

Command Mode

Bandwidth-class mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#mpls bandwidth-class new-BC
(config-mpls-bw)#bandwidth 100m setup-priority 1 hold-priority 1
```

clear mpls counters ldp

Use this command to clear traffic statistics for FTNs and ILMs configured by LDP.

Command Syntax

```
clear mpls counters ldp ((ftn (|A.B.C.D/M)) | (ilm (|A.B.C.D/M)) |)
```

Parameter

`ftn`	FEC-to-NHLFE map counters
`A.B.C.D/M`	FEC prefix
`ilm`	Incoming label map counters
`A.B.C.D/M`	FEC prefix

Command Mode

Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#clear mpls counters ldp
```


clear mpls counters rsvp

Use this command to clear traffic statistics for LSPs configured by RSVP.

Command Syntax

```
clear mpls counters rsvp ((tunnel-name NAME) | (tunnel-id TUNNEL_ID) | (node-role
  (ingress | transit | egress)) |)
```

Parameter

`NAME`	RSVP tunnel name
`TUNNEL_ID`	RSVP tunnel identifier
`ingress`	LSP role is ingress
`transit`	LSP role is transit
`egress`	LSP role is egress

Command Mode

Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#clear mpls counters rsvp
```

clear mpls counters static

Use this command to clear traffic statistics for statically configured FTNs and ILMs.

Command Syntax

```
clear mpls counters static ((ftn (|A.B.C.D/M)) | (ilm (|A.B.C.D/M)) |)
```

Parameter

`ftn`	FEC-to-NHLFE map counters
`A.B.C.D/M`	FEC prefix
`ilm`	Incoming label map counters
`A.B.C.D/M`	FEC prefix

Command Mode

Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#clear mpls counters static
```

clear mpls l2-circuit statistics

Use this command to clear MPLS traffic statistics for l2 circuit.

Command Syntax

```
clear mpls l2-circuit NAME statistics(access-port|network-port|)
```

Parameters

`name`	Name of L2 circuit
`access-port`	Displays the access port statistics
`network-port`	Displays the network port statistics

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#clear mpls l2-circuit vcl statistics
```


group-id

Use this command to configure a specific group identifier to existing group with a group name in the MPLS layer-2 virtual circuit.

Use the no parameter with this command to remove group identifier from the MPLS layer-2 virtual circuit

Command Syntax

```
group-id <1-4294967295>
no group-id
```

Parameters

`<1-4294967295>` Value for group identifier

Default

By default, group-id is disabled. If group-name is configured, default group-id is the first available identifier.

Command Mode

Configure Pseudowire mode

Applicability

This command was introduced before OcNOS version 1.X

Example

```
#configure terminal
(config)#mpls l2-circuit mycircuit 45678 1.2.3.4
(config-pseudowire)#group-name group-1
(config-pseudowire)#group-id 11
```

group-name

Use this command to map the MPLS layer-2 virtual circuit with a specific group.

Use the no parameter with this command to remove group from the MPLS layer-2 virtual circuit

Command Syntax

```
group-name NAME
no group-name
```

Parameters

NAME	String identifying group NAME

Default

By default, group-name is disabled

Command Mode

Configure Pseudowire mode

Applicability

This command was introduced before OcNOS version 1.X

Example

```
#configure terminal
(config)#mpls l2-circuit mycircuit 45678 1.2.3.4
(config-pseudowire)#group-name group-1
```

control-word

Use this command to enable control word for the MPLS layer-2 virtual circuit.

Use the no parameter with this command to disable control word from the MPLS layer-2 virtual circuit.

Command Syntax:

```
control-word
no control-word
```

Parameters

NA

Default

By default, control-word is disabled

Command Mode

Configure Pseudowire mode

Applicability

This command was introduced before OcNOS version 1.X

Example

```
#configure terminal
(config)#mpls l2-circuit mycircuit 45678 1.2.3.4
(config-pseudowire)#control-word
```

label-switching

Use this command to either enable label-switching on an interface or to modify the label-space to which this interface is bound.

Use the `no` parameter and the interface is bound to the platform-wide (zero) label-space.

Note: When label-switching enabled on VLAN interface, MTU value must be manually increased by at least 20 bytes on Parent interfaces of VLAN. Example, default MTU must be set as 1520 instead of 1500 on label-switching parent interface label switched VLAN interface. (Parent Interface MTU >= label switched VLAN interface MTU + 20).

Command Syntax

```
label-switching
label-switching <0-60000>
no label-switching
```

Parameter

`<0-60000>`	Label space value in this range

Default

By default, label switching is disabled

Command Mode

Interface mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

This example shows the enabling of label switching on the `eth0` interface.

```
#configure terminal
(config)#interface eth0
(config-if)#label-switching 654
```

match vlan

Use this command to configure a match VLAN action for a service template.

Use the `no` parameter to remove a match VLAN action for a service template.

Command Syntax

```
match (all | double-tag outer-vlan <2-4094> inner-vlan VLAN_RANGE | outer-vlan
  VLAN_RANGE | untagged)
no match (double-tag outer-vlan <2-4094> inner-vlan VLAN_RANGE | outer-vlan
  VLAN_RANGE | untagged)
```

Parameter

`all`	Accept all matches
`double-tag`	Double tag match
`outer-vlan`	Double tag outer VLAN
`<2-4094>`	Outer VLAN identifier
`inner-vlan`	Double tag inner VLAN
`VLAN_RANGE`	VLAN identifier <2-4094> range: 2-5,10 or 2-5,7-19
`outer-vlan`	Single tag outer-VLAN
`VLAN_RANGE`	VLAN identifier <2-4094> range: 2-5,10 or 2-5,7-19
`untagged`	Match untagged. This parameter depends on the `switchport dot1q ethertype` configuration. Packets received with a TPID other than 0x8100 (default value) and the TPID value configured by `switchport dot1q ethertype` are treated as untagged. For example, if you give the command: `switchport dot1q ethertype 0x8888` then packets received with TPID 0x8100 or 0x88a8 are treated as tagged. Packets received with other TPIDs are treated as untagged.

Command Mode

MPLS SVC mode

Applicability

This command was introduced before OcNOS version 1.3 and updated in OcNOS-SP version 1.0.

The inner vlan range option added in OcNOS-SP version 4.1.

Example

```
#configure terminal
(config)#service-template C2
(config-svc)#match double-tag outer-vlan 10 inner-vlan 20
(config-svc)#exit
(config)#service-template C2
(config-svc)#no match double-tag outer-vlan 10 inner-vlan 20
(config-svc)#exit
#configure terminal
```



```
(config)#service-template C3
(config-svc)#match double-tag outer-vlan 10 inner-vlan 200-300
(config-svc)#exit
(config)#service-template C4
(config-svc)#no match double-tag outer-vlan 10 inner-vlan 200-300
(config-svc)#exit
#configure terminal
(config)#service-template t1
(config-svc)#match untagged
(config-svc)#rewrite ingress push 100
```

mpls ac-group

Use this command to create a new access circuit group for MPLS.

Use the `no` parameter with this command to remove an access circuit group.

Command Syntax

```
mpls ac-group NAME <1-4294967295>
no mpls ac-group NAME
```

Parameter

NAME	The name of the access circuit group
<1-4294967295>	The identifier for the group; used in LDP

Default

By default, mpls ac group is disabled

Command Mode

Configure mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#mpls ac-group new-ac 123

(config)#no mpls ac-group new-ac
```

mpls admin-groups

Use this command to create a name-to-value binding for an administrative group.

Note: Only 32 administrative groups can be configured at one time.

Use the `no` parameter with this command to remove a named administrative group.

Command Syntax

```
mpls admin-group NAME <0-31>
no mpls admin-group NAME <0-31>
```

Parameters

NAME	Name of administrative group
<0-31>	The value of the administrative group

Default

By default, mpls admin group is disabled

Command Mode

Configure mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#mpls admin-group mygroup 3
```

mpls bandwidth-class

Use this command to create a new bandwidth class name. Using this command changes the command mode to Bandwidth-class mode.

Use the `no` parameter with this command to remove a bandwidth class name.

Command Syntax

```
mpls bandwidth-class NAME
no mpls bandwidth-class NAME
```

Parameter

NAME	Name of the bandwidth class

Default

By default, mpls bandwidth-class is disabled

Command Mode

Configure mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#mpls bandwidth-class new-BC
(config-mpls-bw)#

(config)#no mpls bandwidth-class new-BC
```


mpls ftn-ecmp ldp

Use this command to enable (Equal-Cost Multi-Path) ECMP for Label Distribution Protocol (LDP) Forwarding Table Entry (FTN). FTN contains the details of forwarding the labeled packets.

Use `no` command to disable ECMP for LDP FTN.

Command Syntax

```
mpls ftn-ecmp ldp
no mpls ftn-ecmp ldp
```

Parameter

None

Default

LDP ECMP on the ingress node is enabled by default, and FTN is configured in the forwarder with only the first path.

Command Mode

Configure mode

Applicability

This command was introduced before OcNOS version 6.4.1.

Examples

The below example shows how to enable and disable ECMP for LDP FTN:

```
#configure terminal
(config)#mpls ftn-ecmp ldp
(config)# commit
(config)# no mpls ftn-ecmp ldp
(config)# commit
```

mpls ftn-entry tunnel-id

This command will be used to create a static tunnel.

In hardware, it creates a logical interface to which services can be mapped.

Command Syntax

```
mpls ftn-entry tunnel-id <1-5000> A.B.C.D/M LABEL A.B.C.D IFNAME
  (primary|secondary|)
mpls ftn-entry tunnel-id <1-5000> A.B.C.D A.B.C.D LABEL A.B.C.D IFNAME
  (primary|secondary|)
mpls ftn-entry tunnel-id <1-5000> (A.B.C.D/M|A.B.C.D A.B.C.D) <16-1048575> A.B.C.D
  IFNAME ((secondary|primary)|)

no mpls ftn-entry tunnel-id <1-5000> A.B.C.D/M WORD A.B.C.D IFNAME
  (primary|secondary|)
no mpls ftn-entry tunnel-id <1-5000> A.B.C.D A.B.C.D WORD A.B.C.D IFNAME
  (primary|secondary|)
```

Command Syntax

```
mpls ftn-entry tunnel-id <1-5000> X:X::X:X/M <16-1048575> X:X::X:X IFNAME
  ((secondary|primary)|)
mpls ilm-entry <16-52443> swap <16-52443> IFNAME X:X::X:X X:X::X:X/M
mpls ilm-entry <16-52443> IFNAME swap <16-52443> IFNAME X:X::X:X X:X::X:X/M

no mpls ftn-entry tunnel-id <1-5000> X:X::X:X/M <16-1048575> X:X::X:X IFNAME
  ((secondary|primary)|)
no mpls ilm-entry <16-52443> swap <16-52443> IFNAME X:X::X:X X:X::X:X/M
no mpls ilm-entry <16-52443> IFNAME swap <16-52443> IFNAME X:X::X:X X:X::X:X/M
```

Parameters

`<1-5000>`	The tunnel ID value
`A.B.C.D/M`	Forwarding equivalence class with mask
`A.B.C.D`	Mask for forwarding equivalency class
`LABEL`	Outgoing label
`A.B.C.D`	Nexthop IPv4 address
`IFNAME`	Outgoing interface name
`INDEX`	FTN index for update

Note: When the INDEX parameter is passed, the FTN entry is updated. When INDEX is not used, a new FTN entry is created.

`primary`	The primary LSP; default is primary
`secondary`	The secondary LSP Command Mode

Default

By default, mpls ftn-entry tunnel-id are disabled

Command mode

Configure mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#mpls ftn-entry tunnel-id 2 10.10.0.0/24 16 1.2.3.4 eth1 secondary
(config)#no mpls ftn-entry tunnel-id 2 10.10.0.0/24 16 1.2.3.4 eth1 secondary
```


mpls ftn-entry

Use this command to create a static LSP. In the hardware, this command creates an IP route with outgoing MPLS parameters.

Command Syntax

```
mpls ftn-entry (A.B.C.D/M|A.B.C.D A.B.C.D) <16-52443> A.B.C.D IFNAME
no mpls ftn-entry A.B.C.D/M LABEL A.B.C.D IFNAME
```

Parameters

A.D.C.D/M	Forwarding Equivalence Class with Mask
LABEL	Outgoing label <16-1048575>
A.B.C.D	Nexthop IPv4 address
IFNAME	Outgoing interface name
INDEX	FTN index for update

Default

By default, mpls ftn-entry are disabled

Command Mode

Configure mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)# mpls ftn-entry 2.2.2.2/32 111 20.0.0.2 eth1
(config)# no mpls ftn-entry 2.2.2.2/32 111 20.0.0.2 eth1
```


mpls ilm-ecmp ldp

Use this to enable ECMP for LDP Incoming Label Map (ILM).

Use `no` of this to disable ECMP for LDP ILM.

Note: Entropy is also required to be configured for load-balancing to work.

Note: LDP has to be configured with no-php for entropy to work (Q1 platforms).

Command Syntax

```
mpls ilm-ecmp ldp
no mpls ilm-ecmp ldp
```

Parameters

None

Default

LDP ECMP on transit nodes is disabled. If LDP load-balancing is required on transit nodes, enable this option.

Command Mode

Configure mode

Applicability

This command was introduced before OcNOS version 6.1.0.

Example

```
#configure terminal
(config)#mpls ilm-ecmp ldp
(config)#no mpls ilm-ecmp ldp
```

mpls ilm-entry pop

Use this command to create an ILM entry in the ILM table to which a POP incoming interface is bound. Upon receipt of a labeled packet on an MPLS-enabled router, a lookup is done based on the incoming label in the ILM table. If a match is found, the packet may either be label-switched downstream, or popped and passed over IP. In a pop operation, an outgoing label is not needed as is either accepted or forwarded over IP. The nexthop option is also not mandatory because the FEC IP address could be a local IP address.

Use the `no` option with the command to delete an ILM entry. If there is no match, an error message displays.

Command Syntax

```
mpls ilm-entry LABEL IFNAME (pop)
no mpls ilm-entry LABEL IFNAME (pop)
```

Parameters

`LABEL`	Incoming label value
`IFNAME`	Incoming interface name
`pop`	Pop the incoming label

Default

By default, mpls ilm-entry are disabled

Command Mode

Configure mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#mpls ilm-entry 100 eth0 pop
```


mpls ilm-entry swap

Use this command to create an ILM entry in the ILM table to which a swap incoming interface is bound. Upon receipt of a labeled packet on an MPLS-enabled router, a lookup is done based on the incoming label in the ILM table. If a match is found, the packet may either be label-switched downstream, or popped and passed over IP.

Use the `no` option with the command to delete an ILM entry. If there is no match, an error message displays.

Command Syntax

```
mpls ilm-entry <16-52443> swap <16-52443> IFNAME A.B.C.D (A.B.C.D/M|A.B.C.D
  A.B.C.D)
mpls ilm-entry <16-52443> IFNAME swap <16-52443> IFNAME A.B.C.D (A.B.C.D/M|A.B.C.D
  A.B.C.D)

no mpls ilm-entry <16-52443> swap <16-52443> IFNAME A.B.C.D (A.B.C.D/M|A.B.C.D
  A.B.C.D)
no mpls ilm-entry <16-52443> IFNAME swap <16-52443> IFNAME A.B.C.D (A.B.C.D/
  M|A.B.C.D A.B.C.D)
```

Parameters

`LABEL`	Incoming label value range <16-1048575>
`IFNAME`	Incoming interface name
`swap`	Specify swap for the incoming label
`LABEL`	Configure an outgoing label with a value from <16-1048575>

Note: A value of 2 indicates explicit NULL and a value of 3 indicates implicit NULL.

`IFNAME`	Outgoing interface name
`A.B.C.D`	Nexthop IPv4 address
`A.B.C.D`	The FEC for which this ILM entry is created
`A.B.C.D/M`	The FEC for which this ILM entry is created, plus mask
`A.B.C.D`	A mask for forwarding equivalence class mask
`<1-429496725>`	ILM index update

Note: When an ILM index value is passed, the ILM entry is updated. If the ILM index is not used, then a new ILM entry is created.

Default

By default, mpls ilm-entry are disabled

Command Mode

Configure mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#mpls ilm-entry 16 eth1 swap 17 eth2 1.1.1.1 1.1.1.1/3 1
```


mpls ilm-entry vpnpop

Use this command to create an ILM entry in the ILM table to which a VPN POP incoming interface is bound. Upon receipt of a labeled packet on an MPLS-enabled router, a lookup is done based on the incoming label in the ILM table. If a match is found, the packet may either be label-switched downstream, or popped and passed over IP.

Use the `no` option with the command to delete an ILM entry. If there is no match, an error message displays.

Note: This command is not supported for ZebIC releases.

Command Syntax

```
mpls ilm-entry LABEL IFNAME (vpnpop) LABEL IFNAME A.B.C.D (A.B.C.D/M|A.B.C.D
  A.B.C.D) (<1-4294967295>|)
```

```
no mpls ilm-entry LABEL IFNAME (vpnpop) LABEL IFNAME A.B.C.D (A.B.C.D/M|A.B.C.D
  A.B.C.D|) (<1-4294967295>|)
```

Parameters

`LABEL`	Incoming label value
`IFNAME`	Incoming interface name
`vpnpop`	Specify pop for the incoming label
`LABEL`	Configure an outgoing label with a value from <16-1048575>

Note: A value of 0 indicates explicit NULL and a value of 3 indicates implicit NULL.

`IFNAME`	Outgoing interface name
`A.B.C.D`	Nexthop IPv4 address
`A.B.C.D`	The FEC for which this ILM entry is created
`A.B.C.D/M`	The FEC for which this ILM entry is created, plus mask
`A.B.C.D`	A mask for forwarding equivalence class mask
`<1-429496725>`	ILM index update

Note: When an ILM index value is passed, the ILM entry is updated. If the ILM index is not used, then a new ILM entry is created.

Default

By default, mpls ilm-entry are disabled

Command Mode

Configure mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#mpls ilm-entry 100 eth0 vpnpop 200 eth1 1.2.3.4 10.10.0.0/24
```

mpls ingress-ttl

Use this command to set a Time to Live (TTL) value for LSPs for which this LSR is the ingress.

Use the `no` parameter with this command to unset the custom TTL value being used for LSPs for which this LSR is the ingress.

Command Syntax

```
mpls ingress-ttl <0-255>
no mpls ingress-ttl
```

Parameter

`<0-255>`	Set the TTL value to use

Default

By default, mpls ingress-ttl value is 64

Command Mode

Configure mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#mpls ingress-ttl 3
```


mpls l2-circuit

Use this command to create an instance of an MPLS layer 2 virtual circuit, without specifying a group to which the VC belongs. Refer to group-name for information on how to create an MPLS “with” a specific group. A Layer-2 MPLS Virtual Circuit instance may be bound to any interface on the router; however, only one interface may be bound to a Layer-2 circuit at a time.

Use the `no` parameter with this command to delete an instance of an MPLS Layer-2 Virtual Circuit.

Command Syntax

```
mpls l2-circuit NAME <1-4294967295> A.B.C.D
mpls l2-circuit NAME <1-4294967295> A.B.C.D mode raw
mpls l2-circuit NAME <1-4294967295> A.B.C.D mode tagged
no mpls l2-circuit NAME <1-4294967295> A.B.C.D
```

Parameters

`NAME`	String identifying the MPLS Layer-2 virtual circuit
`<1-4294967295>`	A 32-bit identifier to which the L2 circuit name should be mapped
`A.B.C.D`	IPv4 address for the MPLS L2 virtual circuit end-point

Default

By default, mpls l2-circuit is disabled

Command Mode

Configure mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#mpls l2-circuit mycircuit 45678 1.2.3.4
```

mpls-l2-circuit NAME

Use this command in the Interface mode to bind an interface to a MPLS Layer-2 Virtual Circuit created in the configure mode. The qos profiles cos-to-queue and queue-color-to-cos are optional parameters and are configurable dynamically on the virtual circuit by repeating mpls-l2-circuit command along with one or both profile options. In order to dynamically unbind the profile, same command pattern should be repeated by removing the profile which needs to be unbound from the command. Refer ‘qos profile’ commands from configuration guide for more details about qos profiles.

Use the `no` parameter with this command to delete this instance.

Note: QoS profiles are supported only on vlan based virtual circuits. For port based virtual circuits (service template with match-all option), qos profiles can be bound to interface which will take effect, otherwise default qos profile will take effect. Refer ‘qos map-profile’ command for binding qos profiles on interface.

Note: For untagged traffic forwarded via port based virtual circuits (service template with match-all option), queue will be 0 by default. In order to assign a non-zero queue for untagged traffic, use ‘qos untagged-priority <0-7>’ command on the interface.

Note: QoS profile queue-color-to-cos will take effect when MPLS model is uniform. For virtual circuit without rewrite option, ‘qos remark-cos’ need to be additionally configured to update cos. For virtual circuits with rewrite action pop, cos will always be updated based on qos profile irrespective of the MPLS model.

Command Syntax

```
mpls-l2-circuit NAME service-template NAME ({cos-to-queue NAME | queue-color-to-cos
  NAME}|) ((primary|secondary)|)
no  mpls-l2-circuit NAME
```

Parameters

`NAME`	A string identifying the MPLS Layer-2 Virtual Circuit
`primary`	Identify L2 circuit as the primary link
`secondary`	Identify L2 circuit as the secondary link; the secondary link is not activated unless the primary link fails
`service-template`	Customer service template
`NAME`	Name of Customer service template
`cos-to-queue`	Profile for cos to queue map
`NAME`	Profile name for cos to queue map
`queue-color-to-cos`	Profile for queue color to cos map
`NAME`	Profile name for queue color to cos map

Default

By default, mpls l2-circuit is disabled

Command Mode

Interface mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal

(config)#interface eth1
(config-if)#switchport
(config-if)#mpls-l2-circuit vc1 service-template C1

(config-if)#no mpls-l2-circuit vc1

(config)#interface eth2
(config-if)#switchport
(config-if)#mpls-l2-circuit vc2 service-template C2

(config-if)#no mpls-l2-circuit vc2

(config-if)#mpls-l2-circuit vc2 service-template C2
(config-if)#no mpls-l2-circuit vc2

(config)#interface eth2
(config-if)#switchport
(config-if)#mpls-l2-circuit vc2 service-template C2

(config-if)#no mpls-l2-circuit vc2

(config-if)#mpls-l2-circuit vc2 service-template C2
(config-if)#no mpls-l2-circuit vc2
```

mpls l2-circuit-fib-entry

Use this command to add a static Layer-2 MPLS Virtual Circuit FIB entry.

Use the `no` parameter with this command to delete a Layer-2 MPLS Virtual Circuit FIB entry.

Command Syntax

```
mpls l2-circuit-fib-entry VC-ID
mpls l2-circuit-fib-entry VC-ID LABEL LABEL A.B.C.D IFNAME NAME
no mpls l2-circuit-fib-entry VC-ID
```

Parameters

`VC-ID`	Virtual Circuit ID
`LABEL`	Incoming label in the range of <16-1048575>
`LABEL`	Outgoing label in the range of <16-1048585>
`A.B.C.D`	Nexthop IPv4 address
`IFNAME`	Provider-facing interface name
`NAME`	Access interface name or VC to be stitched to.

Default

By default, mpls l2-circuit is disabled

Command Mode

Configure mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#mpls l2-circuit-fib-entry 10 100 200 10.10.10.10 eth1 eth2
```


mpls label mode

Use this command to configure label allocation mode for VPNv4 and/or VPNv6 routes. Label allocation mode as per-vrf is the default mode in which single mpls-label is allocated for all VPN Routes in a VRF. Label allocation mode as per-prefix will allocate unique mpls-labels per VPN route in a VRF. If allocation model is disabled using no mpls label mode configuration, the configuration reverts back to default-mode .

Label allocation mode is the local property i.e. the VRF routes are distributed to BGP-peer as per the mode configured on local node. When per-vrf mode is configured, single label for all routes in the VRF will be distributed to peer node.

Label allocation mode can be set for all VRFs or selective VRFs by these commands:

```
mpls label mode vpnv4 all-vrfs per-vrf
```

- If the admin selects the per-vrf mode for the entire system, then all VRFs switches to per-vrf allocation mode except for the VRFs that has been explicitly configured using command mpls label mode vpnv4 vrf WORD per-prefix. Label allocation mode set using specific VRF takes precedence over all-vrf command.

```
mpls label mode vpnv6 vrf WORD per-vrf
```

- If the admin selects per-vrf mode for a particular vrf say vrf1, then only vrf1 switches to per-vrf mode and rest of the vrfs will remain in default allocation mode.

Command Syntax

```
mpls label mode (vpnv4|vpnv6|all-afs) (all-vrfs|vrf WORD) (per-prefix|per-vrf)

no mpls label mode (vpnv4|vpnv6|all-afs) (all-vrfs|vrf WORD) (per-prefix)


mpls label mode 6pe per-prefix

no mpls label mode 6pe per-prefix
```

Parameters

`vrf WORD`	Enter a string to identify the VRF
`all-vrfs`	All the VRFs
`per-prefix`	Unique MPLS labels are allocated per VPN route in a VRF
`per-vrf`	Single MPLS labels are allocated for all VPN routes in a VRF
`all-afs`	All the address families

Default

By default, per-vrf is enabled.

Command Mode

Configuration mode

Applicability

This command was introduced before OcNOS-SP version 1.0.

Example

```
#configure terminal
(config)#mpls label mode all-afs all-vrfs per-vrf
```

```
(config)#no mpls label mode all-afs all-vrfs

(config)#mpls label mode 6pe per-prefix

(config)#no mpls label mode 6pe per-prefix
```

mpls local-packet-handling

Use this command to enable the labeling of locally generated TCP packets. All other locally generated packets are not looked at by the MPLS Forwarder

Use the `no` parameter with this command to disable labeling of locally generated TCP packets.

Command Syntax

```
mpls local-packet-handling
no mpls local-packet-handling
```

Default

By default, mpls local packet handling is disabled

Parameters

None

Command Mode

Configure mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#mpls local-packet-handling
```

mpls lsp-model

Use this command to configure the MPLS LSP model as Uniform.

Use the `no` parameter with this command to configure the MPLS LSP model as Pipe or short-pipe.

Command Syntax

```
mpls lsp-model uniform
no mpls lsp-model uniform
```

Parameter

None

Default

By default, model configuration is pipe for XGS devices.

Qumran device has following default behavior:

For L3VPN services, model is short-pipe by default and pipe model can be achieved by configuring policy-maps with match exp and set queue.

For L2VPN services, short-pipe model is not supported and default model is pipe.

For L2VPN services with rewrite action pop, cos value will always be updated from qos profile irrespective of model.

For L2VPN services without rewrite, uniform model command doesn't take effect until 'qos remark-cos' is configured on egress interface.

Command Mode

Configure mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#mpls lsp-model uniform
(config)#exit

#configure terminal
(config)#no mpls lsp-model uniform
(config)#exit
```


mpls lsp-stitching

Use this command to stitch the LSP segment for an FEC created via a different label signaling protocol.

Use the `no` form of this command to disable this configuration.

Command Syntax

```
mpls lsp-stitching
no mpls lsp-stitching
```

Parameters

None

Default

By default, MPLS LSP stitching is disabled.

Command Mode

Configure mode

Applicability

This command was introduced in OcNOS-SP version 1.0.

Command Example

```
#configure terminal
(config)#mpls lsp-stitching
```

mpls map-route

Use this command to map a prefix to an FEC.

Use the `no` parameter with this command to disable this configuration.

Command Syntax

```
mpls map-route (A.B.C.D/M|A.B.C.D A.B.C.D) (A.B.C.D/M|A.B.C.D A.B.C.D)
no mpls map-route (A.B.C.D/M|A.B.C.D A.B.C.D)
```

Parameters

A.B.C.D	IPv4 prefix to map
A.B.C.D/M	IPv4 prefix to map, plus mask
A.B.C.D	Mask for IPv4 prefix to map
A.B.C.D/M	Mask for IPv4 prefix to map, plus mask.
A.B.C.D	IPv4 forwarding equivalence class for route to map
A.B.C.D	Mask for IPv4 forwarding equivalence class

Default

By default, mpls map-route is disabled

Command Mode

Configure mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

In the following examples 5.6.7.8/32 is the FEC for an LSP, and 1.2.3.4 is the prefix to be mapped.

```
#configure terminal
(config)#mpls map-route 1.2.3.4/32 5.6.7.8/32

#configure terminal
(config)#mpls map-route 1.2.3.4 255.255.255.255 5.6.7.8 255.255.255.255
```


mpls min-label-value

Use this command to configure minimum and maximum label value for a label space. Use module names (rsvp | ldp | bgp) to configure minimum and maximum label value for module in a label space, minimum and maximum label space value for a module should be within the range of label space being used. After setting minimum and maximum label value for a label space, make sure to bind the label space to an interface.

Use the `no` parameter with this command to use the default minimum and maximum label value for all the label pools.

Note: The system allows label-space range (maximum and minimum label values) changes for interface-specific label spaces only. The platform-wide label-space range cannot be modified.

Note: Only label-space 0 (global) is supported. Any label-space other than 0, is not supported.

Command Syntax

```
mpls (rsvp|ldp|bgp|) min-label-value <16-1048575> max-label-value <16-1048575>
  (label-space <0-60000>|)
```

```
no mpls min-label-value max-label-value (label-space <0-60000>|)
```

```
no mpls (rsvp|ldp|bgp) (label-space <0-60000>|))
```

Parameters

`rsvp`	Label range value for RSVP
`ldp`	Label range value for LDP
`bgp`	Label range value for BGP
`min-label-value`	Specify the minimum label value
`<16-1048575>`	Minimum size to be used for label pools or protocol range
`max-label-value`	Specify the maximum label value
`<16-1048575>`	Maximum size for all label pools
`label-space`	Label space for which the minimum value needs to be modified
`<0-60000>`	Range for label space

Default

By default, mpls min-label value is 16

Command Mode

Configure mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#mpls min-label-value 50000 max-label-value 80000 label-space 0
```

mpls propagate-ttl

Use this command to enable TTL propagation. Enabling TTL propagation causes the TTL value in the IP header to be copied onto the TTL field in the shim header, at the LSP ingress.

Use the `no` parameter with this command to disable TTL propagation.

Command Syntax

```
mpls propagate-ttl
no mpls propagate-ttl
```

Parameters

None

Default

By default, TTL propagation is disabled.

Command Mode

Configure mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#mpls propagate-ttl

#configure terminal
(config)#no mpls propagate-ttl
```

mpls traffic-eng

Use this command to configure a routing command level for MPLS Traffic Engineering (MPLS-TP).

Use the `no` parameter with this command to remove this configuration.

Command Syntax

```
mpls traffic-eng (level-1|level-2|router-id)
no mpls traffic-eng (level-1|level-2|router-id)
```

Parameters

`level-1`	Run MPLS-TE only at IS-IS level 1
`level-2`	Run MPLS-TE only at IS-IS level 2
`router-id`	Traffic Engineering stable IP address for system

Command Mode

IS-IS Router mode

Examples

```
#configure terminal
(config)#mpls traffic-eng level-1

(config-router)#no mpls traffic-eng level-1
```

mpls traffic-eng srlg

Use this command to create a Shared Risk Link Group (SRLG). An SRLG uses secondary backup LSPs or Fast Reroute bypass/detour LSPs that minimize the probability of "fate sharing" with the path of the primary LSP.

Use the `no` form of this command to remove an SRLG.

Note: An interface can be part of multiple SRLG groups upto a maximum of 255 SRLG groups.

Any addition or deletion of SRLG value on an interface will not recalculate Primary/Backup. It is advised to configure SRLG values before bringing UP rsvp sessions or clear rsvp sessions after updating SRLG values.

Command Syntax:

```
mpls traffic-eng srlg <0-4294967295>
no mpls traffic-eng srlg <0-4294967295>
```

Parameters

```
<0-4294967295> Risk group number
```

Command Mode

Interface mode

Example

```
#configure terminal
(config)#int eth1
(config-if)#mpls traffic-eng srlg 1
```

ping mpls

Use this command to start sending MPLS request packets using various parameters as defined below. Ping packets can be configured for LDP, RSVP, L2 circuit, VPLS, L3 VPN, or generic FEC types.

Command Syntax

```
ping mpls (ldp A.B.C.D/M|rsvp (tunnel-name NAME|egress A.B.C.D)|l2-circuit (vccv|)
  <1-4294967295> |vpls <1-10000> peer A.B.C.D/M|l3vpn VRFNAME A.B.C.D/M |ipv4
  A.B.C.D/M) ({reply-mode (1|2)|flags|destination A.B.C.D|source A.B.C.D|ttl <1-
  255>|timeout <1-500>|repeat <5-5000>|interval <2-20000>|force-explicit-
  null|detail}|)

ping mpls (ldp A.B.C.D/M|rsvp (tunnel-name NAME|egress A.B.C.D)|l2-circuit (vccv|)
  <1-4294967295> |vpls <1-10000> peer A.B.C.D/M|l3vpn VRFNAME A.B.C.D/M |ipv4
  A.B.C.D/M) ({reply-mode (1|2)|flags|destination A.B.C.D|source A.B.C.D|ttl <1-
  255>|timeout <1-500>|repeat <5-5000>|interval <2-20000>|force-explicit-
  null|detail}|)

ping mpls (l3vpn (VRFNAME A.B.C.D/M X:X::X:X/M source A.B.C.D destination A.B.C.D))
  ({timeout <1-500>|ttl <1-255>|repeat <5-5000>|interval <2-20000>|detail}|)

ping mpls (6pe default X:X::X:X/M source A.B.C.D destination A.B.C.D)) ({timeout
  <1-500>|ttl <1-255>|repeat <5-5000>|interval <2-20000>|detail}|)
```

Parameters

ldp	FEC type is LDP
A.B.C.D/M	LDP prefix address
rsvp	FEC type is RSVP
tunnel-name	RSVP tunnel name
NAME	Tunnel name string
egress	RSVP tunnel egress
A.B.C.D	RSVP tunnel egress address
l2-circuit	FEC type is L2 circuit
vccv	Virtual Circuit Connectivity Verification
<1-4294967295>	L2 circuit ID
vpls	FEC type is MPLS VPLS (L2-VPN)
<1-10000>	VPLS instance ID
peer	VPLS peer
A.B.C.D/M	VPLS peer address
l3vpn	FEC type is MPLS VPN (L3-VPN)
VRFNAME	VPN instance name
A.B.C.D./M	VPN prefix
X:X::X:X/M	VPNv6 prefix
6pe	FEC type (6PE)

`default`	VPN Instance Name (default)
`X:X::X:X/M`	6PE Prefix
`ipv4`	FEC type is generic; use for static/SNMP label switched paths
`A.B.C.D/M`	IPv4 prefix address
`reply-mode`	Reply mode, one of
`1`	Do not reply
`2`	Reply via UDP/IP packet (default)
`flags`	Validate FEC stack
`destination`	Destination address
`A.B.C.D`	IPv4 address of the destination
`source`	Source address
`A.B.C.D`	IPv4 address of the source
`ttl`	Trace packet Time-to-live
`<1-255>`	Trace packet TTL value
`repeat`	Repeat sending of ping packets
`<5-5000>`	Number of pings to send
`interval`	Interval between ping packets, in milliseconds
`<2-20000>`	Interval value
`timeout`	Time to wait before rejecting the probe as a failure, in seconds
`<1-500>`	Timeout value
`force-explicit-null`	Force Explicit NULL label
`detail`	Print detailed output of the ping

Defaults

Default TTL value is 255.

Default timeout value is 60 seconds.

Command Mode

Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#ping mpls ipv4 10.10.0.0/24 reply-mode 2 flags destination 127.1.2.3 source
10.10.0.1 ttl 226 timeout 65 repeat 6 interval 3 detail force-explicit-null

#ping mpls l2-circuit 3 reply-mode 2 flags destination 127.1.3.4 source 10.10.0.1
ttl 226 timeout 65 repeat 6 interval 3 detail force-explicit-null

#ping mpls l3vpn vrfa 10.10.0.0/24 reply-mode 2 flags destination 127.1.2.3 source
10.10.0.1 ttl 226 timeout 65 repeat 6 interval 3 detail force-explicit-null
```



```
#ping mpls ldp 10.10.0.0/24 reply-mode 2 flags destination 127.1.2.3 source
10.10.0.1 ttl 226 timeout 65 repeat 6 interval 3 detail force-explicit-null

#ping mpls rsvp egress 1.2.3.5 reply-mode 2 flags destination 127.1.2.3 source
10.10.0.1 ttl 226 timeout 65 repeat 6 interval 3 detail force-explicit-null

#ping mpls rsvp tunnel-name tun1 reply-mode 2 flags destination 127.1.2.3 source
10.10.0.1 ttl 226 timeout 65 repeat 6 interval 3 detail force-explicit-null

#ping mpls vpls 2 peer 10.10.0.0 reply-mode 2 flags destination 127.1.2.3 source
10.10.0.1 ttl 226 timeout 65 repeat 6 interval 3 detail force-explicit-null

Codes:
'!' - Success, 'Q' - request not sent, '.' - timeout,
'x' - Retcode 0, 'M' - Malformed Request, 'm' - Errored TLV,
'N' - LBL Mapping Err, 'D' - DS Mismatch,
'U' - Unknown Interface, 'R' - Transit (LBL Switched),
'B' - IP Forwarded, 'F' No FEC Found, 'f' - FEC Mismatch,
'P' - Protocol Error, 'X' - Unknown code,
'Z' - Reverse FEC Validation Failed

 Type 'Ctrl+C' to abort

! seq_num = 1 200.0.0.1 2.02 ms
! seq_num = 2 200.0.0.1 2.00 ms
! seq_num = 3 200.0.0.1 1.93 ms
! seq_num = 4 200.0.0.1 2.14 ms
! seq_num = 5 200.0.0.1 1.78 ms

Success Rate is 100.00 percent (5/5)
round-trip min/avg/max = 1.78/1.96/2.14
```


rewrite ingress

Use this command to configure a match VLAN action for a service template.

Use the `no` parameter with this command to remove a match VLAN action for a service template.

Command Syntax

```
rewrite ingress (((pop |translate <2-4094>)(|outgoing-tpid (dot1.ad |dot1.q)))|
  (push <2-4094>))
```

```
no rewrite ingress (pop |push |translate)
```

Parameters

pop	POP the outer VLAN identifier from ACCESS->NETWORK and PUSH the match outer VID to NETWORK->ACCESS
translate	Translate the outer VLAN identifier to configured action VID for ACCESS->NETWORK and translate to the match outer VID for NETWORK->ACESS
<2-4094>	Outer VLAN identifier
outgoing-tpid	Outgoing TPID, set the outer-tpid for the NETWORK->ACCESS
dot1.ad	Set TPID value as 0x88a8 for the traffic NETWORK->ACCESS
dot1.q	Set TPID value as 0x8100 for the traffic NETWORK->ACCESS
push	PUSH the outer VLAN identifier from ACESS->NETWORK and POP the Outer VID from NETWORK->ACCESS
<2-4094>	Outer VLAN identifier

Command Mode

MPLS SVC mode

Applicability

This command was introduced in OcNOS version 1.3.3, and changed in OcNOS-SP version 1.0.

Examples

```
#configure terminal
(config)#service-template C2
(config-svc)#match double-tag outer-vlan 9 inner-vlan 8
(config-svc)#rewrite ingress translate 7 outgoing-tpid dot1.ad
(config-svc)#exit

(config)#service-template C2
(config-svc)#no rewrite ingress translate
(config-svc)#exit
```


secondary srlg-disjoint

Use this command to set how to avoid the SRLGs (Shared Risk Link Groups) of a protected primary.

A fast-reroute/secondary path for an LSP that is disjoint from the primary ensures that a single point of failure on a particular link does not bring down both the primary and secondary paths in the LSP.

Note: The SRLG option configured in RSVP-TRUNK mode (this command) takes higher preference than the option configured in RSVP router mode (see 'srlg-disjoint').

Use the `no` form of this command to not avoid the SRLGs of a protected interface.

Command Syntax

```
secondary srlg-disjoint (forced|preferred)
no secondary srlg-disjoint
```

Parameters

`forced`	The router does not create the secondary/backup tunnel unless it avoids SRLGs of the primary-path/protected-interface.
`preferred`	With two explicit paths, the first explicit path tries to avoid the SRLGs of the primary-path/ protected interface. If that does not work, the secondary/backup tunne uses the second path (which ignores SRLGs).

Command Mode

RSVP -TRUNK mode

Example

```
#configure terminal
(config)#rsvp-trunk t1
(config-rsvp)# secondary srlg-disjoint forced
```

secondary-priority srlg-disjoint

Use this command to set how to avoid the SRLGs (Shared Risk Link Groups) of a protected primary.

A fast-reroute/secondary path for an LSP that is disjoint from the primary ensures that a single point of failure on a particular link does not bring down both the primary and secondary paths in the LSP.

Note: The SRLG option configured in RSVP-TRUNK mode (this command) takes higher preference than the option configured in RSVP router mode (see the srlg-disjoint command).

Use the `no` form of this command to not avoid the SRLGs of a protected interface.

Command Syntax

```
secondary-priority <1-5> srlg-disjoint (forced|preferred)
no secondary-priority <1-5> srlg-disjoint
```

Parameters

`forced`	The router does not create the secondary/backup tunnel unless it avoids SRLGs of the primary-path/protected-interface.
`preferred`	With two explicit paths, the first explicit path tries to avoid the SRLGs of the primary-path/ protected interface. If that does not work, the secondary/backup tunnel uses the second path (which ignores SRLGs).

Command Mode

RSVP -TRUNK mode

Example

```
#configure terminal
(config)#rsvp-trunk t1
(config-rsvp)# secondary-piority 1 srlg-disjoint forced
```


service-template

Use this command to configure a service template.

Use no form of this command to remove a service template.

Command Syntax

```
service-template NAME
no service-template NAME
```

Parameters

NAME	Name of the customer service template

Defaults

No default value is specified

Command Mode

Configure mode

Applicability

This command was introduced in OcNOS version 1.3.3.

Examples

```
#configure terminal
(config)#service-template C1
(config-svc)#
```

service-tpid

Use this command to configure service tpid for the MPLS layer-2 virtual circuit.

Use the no parameter with this command to delete service tpid from the MPLS layer-2 virtual circuit.

Command Syntax

```
service-tpid (dot1.q|dot1.ad|0x9100)
no service-tpid
```

Parameters

0x9100	Set tpid value as 0x9100
dot1.ad	Set tpid value as 0x88a8
dot1.q	Set tpid value as 0x8100

Default

By default, service-tpid is disabled

Command Mode

Configure Pseudowire mode

Applicability

This command was introduced before OcNOS version 1.X

Example

```
#configure terminal
(config)#mpls l2-circuit mycircuit 45678 1.2.3.4
(config-pseudowire)#service-tpid dot1.ad
```

show mpls

Use this command to display MPLS data.

Command Syntax

```
show mpls
```

Parameters

None

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

The following subsection displays a variety of `show mpls` commands.

```
#show mpls
Minimum label configured: 16
 Maximum label configured: 1048575
 Per label-space information:
   Label-space 0 is using minimum label: 16 and maximum label: 1048575
   Label-space 2342 is using minimum label: 556 and maximum label: 1048575
 Custom ingress TTL configured: none
 Custom egress TTL configured: none
 Log message detail: none
 Admin group detail: none
 Packets dropped IP:115167, dropped MPLS:0 sent to IP:490943, labeled:0, 
switch
d:0

MPLS Differentiated Services Supported Classes data:
CLASS       DSCP_value
  be           000000

MPLS Differentiated Services CLASS to EXP mapping data:
CLASS    DSCP_value     EXP_value
  be      000000           0
#
```

Table 1 explains the show command output fields.

Table 1: show mpls output field

Field	Description
Packets dropped IP	Displays the number of packets dropped over the internet protocol.
Dropped MPLS	Displays the number of packets dropped over the MPLS.

Table 1: show mpls output field

Field	Description
Sent to IP	Displays the number of packets transmitted to the internet protocol.
Labeled	Number of labeled packets in the interface. The MPLS-labeled packets are switched after a label lookup/switch instead of a lookup into the IP table. Labels of pop-and-forward mpls tunnel: P—Pop labels. D—Delegation labels.
Switch	Type of switching on the links needed for the MPLS.
Class	Creates a class map to be used for matching traffic to a specified class, and enters class-map configuration mode.
DSCP Value	The value of the DSCP and DSCP classifier is used for routing Layer 3 packets.
EXP value	Sets the value of the MPLS EXP field on all imposed label entries.

show mpls admin-groups

Use this command to display all configured administrative groups.

Command Syntax

```
show mpls admin-groups
```

Parameters

None

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

The following sample shows the output of the `show mpls admin-group` command.

```
#show mpls admin-groups
 Admin group detail:
  Value of 0 associated with admin group 'a'
  Value of 1 associated with admin group 'b'
  Value of 2 associated with admin group 'c'
  Value of 4 associated with admin group 'd'
#
```

Table 2 explains the show command output fields.

Table 2: show mpls admin-groups output field

Field	Description
Admin group detail	Display information about configured Multi Protocol Label Switching (MPLS) administrative groups.

show mpls bandwidth-class

Use this command to view bandwidth class parameters: bandwidth class name; allocated bandwidth; setup hold priority

Command Syntax

```
show mpls bandwidth-class
```

Parameters

None

Command Mode

Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
> show mpls bandwidth-class
Bandwidth-class: BW_1
Bandwidth:   6k        Setup-priority: 1  Class-type: 1
```

Table 3 explains the show command output fields.

Table 3: show mpls bandwidth-class output field

Field	Description
Bandwidth-class	Bandwidth for each class type.
Bandwidth	Bandwidth configured for the active MPLS.
Setup-Priority	The setup priority is compared with other setup priorities for established sessions on the link to determine whether some of them should be preempted to accommodate the new session. Sessions with lower hold priorities are preempted.
Class-type	Bandwidth allocated for the specified class type.

show mpls counters ldp

Use this command to display traffic statistics for FTNs and ILMs configured by LDP.

Command Syntax

```
show mpls counters ldp ((ftn (|A.B.C.D/M)) | (ilm (|A.B.C.D/M)) |)
```

Parameter

`ftn`	FEC-to-NHLFE map counters
`A.B.C.D/M`	FEC prefix
`ilm`	Incoming label map counters
`A.B.C.D/M`	FEC prefix

Command Mode

Exec mode

Applicability

This command was introduced in OcNOS version 1.3.2.

Note: For Qumran, counters are not available for transit nodes.

Examples

```
#show mpls counters ldp
[ FTN statistics ]
+-----------------+-----------+--------------------+--------------------+
|       FEC       | out-label |     Tx packets     |      Tx bytes      |
+-----------------+-----------+--------------------+--------------------+
 1.1.61.0/24       52480       0                    0
 1.1.62.0/24       52481       0                    0
 1.1.63.0/24       52482       0                    0
 1.1.64.0/24       52483       0                    0
 9.9.9.3/32        52485       0                    0

[ ILM statistics ]
+-----------------+-----------+-----------+--------------------+--------------------+--------------------+----------------+
|       FEC       | in-label  | out-label |     Rx packets     |      Rx bytes      |     Tx packets     |    Tx bytes    |
+-----------------+-----------+-----------+--------------------+--------------------+--------------------+----------------+
#
```

Table 4 explains the show command output fields.

Table 4: show mpls counters ldp output field

Field	Description
FTN statistics	Displays the statistics details of FTN.
ILM statistics	Displays the statistics details of ILM.
FEC	Displays the Forward Equivalency Class (FEC) for this entry.
In-label	Displays the ingress (incoming interface) label for this segment.

Table 4: show mpls counters ldp output field

Field	Description
Out-label	Displays the egress (outgoing interface) label for this segment.
Rx packets	Number of hello packets received from the neighbor.
Rx bytes	Size of hello packets received from the neighbor.
Tx packets	Number of hello packets sent to the neighbor.
Tx bytes	Size of hello packets sent to the neighbor.

show mpls counters rsvp

Use this command to display traffic statistics for LSPs configured by RSVP.

Command Syntax

```
show mpls counters rsvp ((tunnel-name NAME) | (tunnel-id TUNNEL_ID) | (node-role
  (ingress | transit | egress)) |)
```

Parameter

NAME	RSVP tunnel name
TUNNEL_ID	RSVP tunnel identifier
ingress	LSP role is ingress
transit	LSP role is transit
egress	LSP role is egress

Command Mode

Exec mode

Applicability

This command was introduced in OcNOS version 1.3.2.

Note: For Qumran, counters are not available for transit nodes.

Examples

```
#show mpls counters rsvp
Tunnel-id 5001 Extended Tunnel-ID 9.9.9.1 Egress 9.9.9.2
 lsp-name : t1-Primary                                 [Ingress]
 lsp-ingress : 9.9.9.1         lsp-id : 101
 Rx pkts : 0                   Rx bytes : 0
 Tx pkts : 0                   Tx bytes : 0

 lsp-name : t1-Secondary                               [Ingress]
 lsp-ingress : 9.9.9.1         lsp-id : 102
 Rx pkts : 0                   Rx bytes : 0
 Tx pkts : 0                   Tx bytes : 0

Tunnel-id 5002 Extended Tunnel-ID 9.9.9.1 Egress 9.9.9.3
 lsp-name : t2-Primary                                 [Ingress]
 lsp-ingress : 9.9.9.1         lsp-id : 104
 Rx pkts : 0                   Rx bytes : 0
 Tx pkts : 0                   Tx bytes : 0

 lsp-name : t2-Detour                                  [Ingress]
 lsp-ingress : 1.1.49.1        lsp-id : 104
 Rx pkts : 0                   Rx bytes : 0
 Tx pkts : 0                   Tx bytes : 0
```

Table 5 explains the show command output fields.

Table 5: show mpls counters rsvp output field

Field	Description
Tunnel-id	Tunnel identifier (destination port) for the RSVP session.
Extended Tunnel-ID	Extended Tunnel identifier (destination port) for the RSVP session.
Egress	Egress router is the final MPLS device that removes the last label before packets leave the MPLS network.
lsp-name	Name of the SPRING-TE LSP.
Ingress	The router at the beginning of an LSP. This router encapsulates IP packets with an MPLS Layer 2 frame and forwards it to the next router in the path.
lsp-ingress	The router at the beginning of an LSP.
lsp-id	Specify the generic LSP identifier.
Rx packets	Number of hello packets received from the neighbor.
Rx bytes	Size of hello packets received from the neighbor.
Tx packets	Number of hello packets sent to the neighbor.
Tx bytes	Size of hello packets sent to the neighbor.

show mpls counters static

Use this command to display traffic statistics for statically configured FTNs and ILMs.

Command Syntax

```
show mpls counters static ((ftn (A.B.C.D/M|)) | (ilm (A.B.C.D/M|)) |)
```

Parameter

`ftn`	FEC-to-NHLFE map counters
`A.B.C.D/M`	FEC prefix
`ilm`	Incoming label map counters
`A.B.C.D/M`	FEC prefix

Command Mode

Exec mode

Applicability

This command was introduced in OcNOS version 1.3.2.

Note: For Qumran, counters are not available for transit nodes.

Examples

```
#show mpls counters static
[ FTN statistics ]
+-------------------+-----------+--------------------+--------------------+
|       FEC         | out-label |     Tx packets     |      Tx bytes      |
+-------------------+-----------+--------------------+--------------------+
 192.168.1.0/24     100         0                    0
 192.168.2.0/24     200         0                    0

[ ILM statistics ]
+-------------------+-----------+-----------+--------------------+--------------------+--------------------+----------------+
|       FEC         | in-label  | out-label |     Rx packets     |      Rx bytes      |     Tx packets     |     Tx bytes   |
+-------------------+-----------+-----------+--------------------+--------------------+--------------------+----------------+
 0.0.0.0/0          201         n/a         0                    0                    n/a                  n/a
 0.0.0.0/0          101         n/a         0                    0                    n/a                  n/a
 192.168.3.0/24     301         302         0                    0                    0                    0
 192.168.4.0/24     401         402         0                    0                    0                    0
#
```

Table 6 explains the show command output fields.

Table 6: show mpls counters static output field

Field	Description
FTN statistics	Displays the statistics details of FTN.
ILM statistics	Displays the statistics details of ILM.
FEC	Displays the Forward Equivalency Class (FEC) for this entry.
In-label	Displays the ingress (incoming interface) label for this segment.

Table 6: show mpls counters static output field

Field	Description
Out-label	Displays the egress (outgoing interface) label for this segment.
Rx packets	Number of hello packets received from the neighbor.
Rx bytes	Size of hello packets received from the neighbor.
Tx packets	Number of hello packets sent to the neighbor.
Tx bytes	Size of hello packets sent to the neighbor.

show mpls cross-connect-table

Use this command to display detailed information for all entries created in the MPLS cross-connect table.

Command Syntax

```
show mpls cross-connect-table
```

Parameters

None

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

The following is a sample output of the show mpls cross-connect-table

```
#show mpls cross-connect-table
  Cross connect ix: 3, in intf: -, in label: 0, out-segment ix: 3
    Owner: RSVP, Persistent: No, Admin Status: Up, Oper Status: Up
   Out-segment with ix: 3, owner: RSVP, out intf: eth1, out label: 16
    Nexthop addr: 10.10.20.80, cross connect ix: 3, op code: Push

  Cross connect ix: 6, in intf: -, in label: 0, out-segment ix: 6
    Owner: RSVP, Persistent: No, Admin Status: Up, Oper Status: Up
   Out-segment with ix: 6, owner: RSVP, out intf: eth1, out label: 17
    Nexthop addr: 10.10.20.80, cross connect ix: 6, op code: Push
#
```

Table 7 explains the show command output fields.

Table 7: show mpls cross-connect-table output field

Field	Description
Cross connect ix	Displays the table index for the cross-connect.
In intf	Installed as a result of configuring an interface.
In label	Displays the ingress (incoming interface) label for this segment.
Out-segment ix	Displays the outbound segment index.
Owner	Displays the creator of this segment, typically a protocol such as BGP.
Persistent	Displays whether the tunnel is persistent – Yes or No.
Admin Status	Indicates whether the user can administratively disable a peer while still preserving its configuration. Up = Yes, Down = No.

Table 7: show mpls cross-connect-table output field

Field	Description
Oper Status	Displays the current status of the cross-connect segment – Up or Down
Nexthop addr	Displays the IP address of the next hop.
Op code	PUSH = Replace the top label with another and then push one or more additional labels onto the label stack SET = Set the next hop label.

show mpls forwarding-table

Use this command to view forwarding table entries.

Command Syntax

```
show mpls forwarding-table (count|)
```

Parameters

count	Count of IPv4 FTNs.

Command Mode

Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
show mpls forwarding-table
Codes: > - installed FTN, * - selected FTN, p - stale FTN, B - BGP FTN, K - CLI FTN, t -
tunnel
L - LDP FTN, R - RSVP-TE FTN, S - SNMP FTN, I - IGP-Shortcut,
U - unknown FTN, O - SR-OSPF FTN, i - SR-ISIS FTN, k - SR-CLI FTN

Code   FEC    FTN-ID   Tunnel-id  Pri  LSP-Type   Out- Label   ELC  Out-Intf  Nexthop
R(t)> 29.29.29.29/32 1  5001 Yes  LSP_DEFAULT 24322  yes
eth2  41.41.41.31
R(t)> 29.29.29.29/32 2   5001 No   LSP_DEFAULT 24322  yes
eth1  69.69.69.42

#show mpls forwarding-table count

---------------------------------------------
Num FTNs          : 3          [UP: 3, INSTALLED: 3]
  Primary FTNs    : 3          [UP: 3, INSTALLED: 3]
  Secondary FTNs : 0          [UP: 0, INSTALLED: 0]
---------------------------------------------
---------------------------------------------
Num  FTNs          : 0          [UP: 0]
  Primary  FTNs    : 0          [UP: 0]
  Secondary  FTNs : 0          [UP: 0]
---------------------------------------------
```

Table 8 shows the status codes displayed at the start of a route entry.

Table 8: status code output field

Status Code	Field	Description
P	Stale FTN	Stale marked FTN due to on-going Graceful Restart of MPLS module.
B	BGP FTN	FTN entry installed by BGP.
K	CLI FTN	Admin configured Static FTN entry.
L	LDP FTN	FTN entry installed by LDP.
R	RSVP-TE FTN	FTN entry installed by RSVP.
S	SNMP FTN	FTN entry installed via SNMP.
I	IGP-Shortcut	FTN entry installed by IGP shortcut.
U	Unknown FTN	FTN entry installed by unknown module.
O	SR-OSPF FTN	FTN entry installed by OSPF segment-Routing.
I	SR-ISIS FTN	FTN entry installed by ISIS segment-routing.
K	SR-CLI FTN	FTN entry installed by Static Segment Routing.

Table 9 explains the show command output fields.

Table 9: show mpls forwarding-table output field

Field	Description
FEC	Displays the Forward Equivalency Class (FEC) for this entry.
FTN-ID	FEC-to-NHLFE map counters identification.
Tunnel-ID	Tunnel identification to which packets with this label are going.
Pri	Primary.
LSP-Type	LSP type associated with each interface being protected.
Out-Label	Label received from downstream neighbor for route.
ELC	Whether the RSVP router has Entropy Label Capability.
Out-Intf	Short name of the physical interface through which traffic goes to the protected link.
Nexthop	Displays the IP address of the next hop.
Num FTNs	Number of FEC-to-NHLFE map counters in the interface.
Primary FTNs	Primary FEC-to-NHLFE in the interface.
Secondary FTNs	Secondary FEC-to-NHLFE in the interface.
Num FTNs	Number of FEC-to-NHLFE map counters in protocol.

Table 9: show mpls forwarding-table output field

Field	Description
Primary FTNs	Primary FEC-to-NHLFE map counters in protocol.
Secondary FTNs	Secondary FEC-to-NHLFE map counters in protocol.

show mpls ftn-table

Use this command to display FTN (FEC-To-NHLF) table information.

Command Syntax

```
show mpls ftn-table
```

Parameters

None

Command Mode

Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show mpls ftn-table
Primary FTN entry with FEC: 5.5.5.5/32, id: 2, row status: Active
  Owner: LDP, Action-type: Redirect to Tunnel, Exp-bits: 0x0, Incoming DSCP:
none
  Tunnel id: 0,   Protected LSP id: 0, QoS Resource id: 0, Description: N/A
    Matched bytes:0, pkts:0, TX bytes:0, Pushed pkts:0
     Cross connect ix: 1, in intf: - in label: 0 out-segment ix: 1
      Owner: LDP, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 1, owner: LDP, out intf: p9p1, out label: 3
    Nexthop addr: 40.0.0.2        cross connect ix: 1, op code: Push
     Cross connect ix: 3, in intf: - in label: 0 out-segment ix: 3
      Owner: LDP, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 3, owner: LDP, out intf: p8p1, out label: 3
    Nexthop addr: 30.0.0.2        cross connect ix: 3, op code: Push

 Primary FTN entry with FEC: 50.0.0.0/24, id: 6, row status: Active
  Owner: LDP, Action-type: Redirect to Tunnel, Exp-bits: 0x0, Incoming DSCP:
none
  Tunnel id: 0,   Protected LSP id: 0, QoS Resource id: 0, Description: N/A
    Matched bytes:0, pkts:0, TX bytes:0, Pushed pkts:0
     Cross connect ix: 3, in intf: - in label: 0 out-segment ix: 3
      Owner: LDP, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 3, owner: LDP, out intf: p8p1, out label: 3
    Nexthop addr: 30.0.0.2        cross connect ix: 3, op code: Push
```

Table 10 explains the show command output fields.

Table 10: show mpls ftn-table output field

Field	Description
Action-type	Packets flow direction in the tunnel.
Exp-bits	Experimental bits (EXP) field is a 3-bit field in the MPLS header.

Table 10: show mpls ftn-table output field

Field	Description
Incoming DSCP	Number of incoming packets in the DSCP.
Tunnel ID	Tunnel identifier (destination port) for the session.
Protected LSP ID	Identifier to protect the LSP in the interface.
QoS Resource ID	Resource identifier of the Quality of Service.
Description	Terms and concepts used to describe MPLS.
Matched bytes	Size of the matched packets.
Pkts	Number packets in the interface.
TX bytes	Size of the packets that transmitted to the neighbor.
Cross connect ix	Displays the table index for the cross-connect.
Pushed pkts	Number of hello packets pushed to the neighbor.
in intf	Installed as a result of configuring an interface.
in label	Displays the ingress (incoming interface) label for this segment.
out-segment ix	Displays the outbound segment index.
Persistent	Displays whether the tunnel is persistent – Yes or No.
Admin Status	Indicates whether the user can administratively disable a peer while still preserving its configuration. Up = Yes, Down = No.
Oper Status	Displays the current status of the cross-connect segment – Up or Down.
Out-Label	Label received from downstream neighbor for route.
Out-Intf	Short name of the physical interface through which traffic goes to the protected link.
Nexthop addr	Displays the IP address of the next hop.
OP code	PUSH = Replace the top label with another and then push one or more additional labels onto the label stack. SET = Set the next hop label.
Primary FTN entry with FEC	Primary FTN entry configured for the FEC.
ID	Displays the Opcode that identifies the specific PDU for this entry.
ROW status	Displays the current status of the row.

show mpls ilm-table

Use this command to view Incoming label mapping (ILM) table entries.

Command Syntax

```
show mpls ilm-table (count|)
```

Parameters

`count`	Count of entries in ILM table.

Command Mode

Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show mpls ilm-table
Codes: > - installed ILM, * - selected ILM, p - stale ILM
        K - CLI ILM,T - MPLS-TP

Code   FEC                    ILM-ID      In-Label     Out-Label    In-Intf   Out-
Intf      Nexthop                          LSP-Type
  >    63.63.63.63/32         151187      53121        3           N/A      xe6
6.6.6.63                             LSP_DEFAULT
  >    16.16.16.0/24          151186      53120        3           N/A      xe6
6.6.6.63                             LSP_DEFAULT
 K>    N/A                   151189      500          N/A         N/A      N/A
127.0.0.1                            LSP_DEFAULT
  >    65.65.65.65/32         151188      53122        3           N/A      xe1
1.1.1.65                             LSP_DEFAULT

#show mpls ilm-table count
--------------------------------------------
Num ILMs          : 4          [UP: 4, INSTALL: 4]
  Swap Entries    : 3          [UP: 3, INSTALL: 3]
  Pop Entries     : 1          [UP: 1, INSTALL: 1]
--------------------------------------------
```

Table 8 shows the status codes displayed at the start of a route entry.

Table 11: status code output field

Status Code	Field	Description
	Installed ILM	Number of ILM entry installed.
*	Selected ILM	ILM entry selected in the interface.
P	Stale ILM	Stale marked ILM due to on-going graceful restart of MPLS module.

Table 11: status code output field

Status Code	Field	Description
K	CLI ILM	Admin configured static ILM entry.
T	MPLS-TP	ILM entry installed by MPLS-TP.

Table 1 explains the show command output fields.

Table 12: show mpls ilm-table output field

Field	Description
FEC	Displays the Forward Equivalency Class (FEC) for this entry.
ILM-ID	ILM identifier for the session.
LSP-Type	LSP type associated with each interface being protected.
Out-Label	Label received from downstream neighbor for route.
Out-Intf	Short name of the physical interface through which traffic goes to the protected link.
In label	Displays the ingress (incoming interface) label for this segment.
In intf	Installed as a result of configuring an interface.
Nexthop	Displays the IP address of the next hop.
Num ILMs	Number of ILMs in the session.
Swap Entries	Number of packets in the entry.
Pop Entries	Number of POP entries.

show mpls in-segment-table

Use this command to display detailed information about all entries in the Incoming Label Map (also known as in-segment) table.

Command Syntax

```
show mpls in-segment-table
```

Parameters

None

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show mpls in-segment-table
  Owner: RSVP,#of pops: 1, fec: 192.168.0.5/32
    RX bytes:0, pkts:0, TX bytes:0, Swapped pkts:0, Popped pkts:0
LSP Type: ELSP_CONFIG
Class_Exp mapping:
CLASS    DSCP_value     EXP_value
  be      000000          0
     Cross connect ix: 1, in intf: eth0 in label: 52480 out-segment ix: 1
      Owner: RSVP, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 1, owner: RSVP, out intf: eth1, out label: 52480
        Nexthop addr: 20.30.0.3        cross connect ix: 1, op code: Swap
     Cross connect ix: 1, in intf: eth0 in label: 52480 out-segment ix: 2
      Owner: RSVP, Persistent: No, Admin Status: Up, Oper Status: Up
       Out-segment with ix: 2, owner: RSVP, out intf: eth2, out label: 52481
        Nexthop addr: 30.30.0.3        cross connect ix: 1, op code: Swap
#
```

Table 13 explains the show command output fields.

Table 13: show mpls in-segment-table output field

Field	Description
FEC	Displays the Forward Equivalency Class (FEC) for this entry.
RX bytes	Size of hello packets received from the neighbor.
Pkts	Number packet in the interface.
TX bytes	Size of the packets that transmitted to the neighbor.
Swapped pkts	Number of swapped packets in session.

Table 13: show mpls in-segment-table output field

Field	Description
Popped pkts	Number of popped packets in the interface.
LSP-Type	LSP type associated with each interface being protected.
CLASS	Creates a class map to be used for matching traffic to a specified class, and enters class-map configuration mode.
DSCP value	The value of the DSCP and DSCP classifier is used for routing Layer 3 packets.
EXP value	Sets the value of the MPLS EXP field on all imposed label entries.
Cross-connect ix	Displays the table index for the cross-connect.
Out-Label	Label received from downstream neighbor for route.
Out-Intf	Short name of the physical interface through which traffic goes to the protected link.
In label	Displays the ingress (incoming interface) label for this segment.
In intf	Installed as a result of configuring an interface.
Nexthop	Displays the IP address of the next hop.
Out-segment ix	Displays the outbound segment index.
Persistent	Displays whether the tunnel is persistent – Yes or No.
Admin Status	Indicates whether the user can administratively disable a peer while still preserving its configuration. Up = Yes, Down = No.
Oper Status	Displays the current status of the cross-connect segment – Up or Down.
Op code	PUSH = Replace the top label with another and then push one or more additional labels onto the label stack. SET = Set the next hop label.

show mpls l2-circuit

Use this command to view MPLS-TP L2 circuit parameters.

Command Syntax

```
show mpls l2-circuit (detail|)
show mpls l2-circuit NAME (detail|)
```

Parameters

`detail`	Show detailed information
`NAME`	The name of the virtual circuit

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show mpls l2-circuit detail
MPLS Layer-2 Virtual Circuit: vc1, id: 1 PW-INDEX: 1 service-tpid: 8100

Endpoint: 1.1.1.1
Control Word: 0
MPLS Layer-2 Virtual Circuit Group: none
Bound to interface: xe41
Virtual Circuit Type: Ethernet VLAN
Virtual Circuit is configured as Primary
Virtual Circuit is configured as Active
Virtual Circuit is active
Service-template : C1
Match criteria : 10-14, 16-20
```

Table 14 explains the show command output fields.

Table 14: show mpls l2-circuit output field

Field	Description
MPLS Layer-2 Virtual Circuit	The MPLS virtual circuit on the egress PE router or switch and the specified neighbor, testing the integrity of the Layer 2 circuit between the ingress and egress PE routers or switches.
Endpoint	Endpoint address.
Control Word	Number of control words.
MPLS Layer-2 Virtual Circuit Group	The MPLS virtual circuit group on the egress PE router or switch and the specified neighbor, testing the integrity of the Layer 2 circuit between the ingress and egress PE routers or switches.

Table 14: show mpls l2-circuit output field

Field	Description
Bound to interface	A bound service is the server in a client-server interface.
Virtual Circuit Type	Type of virtual circuit in the interface.
Service-template	Service Templates provides a powerful mechanism to configure advanced service-related options.
Match criteria	The match criteria under which redistribution is allowed for the current route-map.

show mpls l2-circuit statistics

Use this command to display MPLS traffic statistics for l2 circuit.

Command Syntax

```
show mpls l2-circuit NAME statistics (access-port|network-port|)
```

Parameters

`NAME`	Name of L2 circuit
`access-port`	Displays the access port statistics
`network-port`	Displays the network port statistics

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show mpls l2-circuit t1 statistics
MPLS Layer-2 Virtual Circuit: t1, id 100        # Virtual circuit name and ID
Access port statistics:
   RX: Input packets : 1000
       Input bytes : 120000
   TX: Output packets : 0
       Output bytes : 0
Network port statistics:
   RX: Input packets : 0
       Input bytes : 0
   TX: Output packets : 1000
       Output bytes : 120000
```

Table 15 explains the show command output fields.

Table 15: show mpls l2-circuit statistics output field

Field	Description
MPLS Layer-2 Virtual Circuit	The MPLS virtual circuit on the egress PE router or switch and the specified neighbor, testing the integrity of the Layer 2 circuit between the ingress and egress PE routers or switches.
Virtual circuit name and ID	The MPLS virtual circuit identifier on the egress PE router or switch and the specified neighbor, testing the integrity of the Layer 2 circuit between the ingress and egress PE routers or switches.
Access port statistics	Traffic statistics on Access port of VC/VPLS.
Network port statistics	Traffic statistics on Provider port of VC/VPLS.
RX	Number of received packets.

Table 15: show mpls l2-circuit statistics output field

Field	Description
Input packets	Number of hello packets received from the neighbor.
Input bytes	Size of hello packets received from the neighbor.
TX	Number of packets transmitted.
Output packets	Number of hello packets sent to the neighbor.
Output bytes	Size of hello packets sent to the neighbor.

show mpls mapped-routes

Use this command to view MPLS mapped routes.

Use the `no` parameter with this command to reset this configuration.

Command Syntax

```
show mpls mapped-routes
```

Parameters

None

Command Mode

Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show mpls mapped-routes

Mapped-route        IPv4 FEC            MPLS-TP Tunnel
14.1.2.3/32         N/A                 NH4
```

Table 16 explains the show command output fields.

Table 16: show mpls mapped-routes output field

Field	Description
Mapped-route	Map the route of the interface.
IPv4	IPv4 address of the neighbor interface.
FEC	Displays the Forward Equivalency Class (FEC) for this entry.
MPLS-TP Tunnel	MPLS-TP tunnel can be provisioned between two arbitrary nodes in an MPLS-TP enabled network.

show mpls out-segment-table

Use this command to display detailed information of out-segment entries (also known as NHLFE) table.

Command Syntax

```
show mpls out-segment-table
```

Parameters

None

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show mpls out-segment-table
       Out-segment with ix: 1, owner: RSVP, out intf: eth1, out label: 52480
        Nexthop addr: 20.30.0.3        cross connect ix: 1, op code: Swap
        TX bytes:0, pkts:0, error pkts:0, discard pkts:0

       Out-segment with ix: 2, owner: RSVP, out intf: eth2, out label: 52481
        Nexthop addr: 30.30.0.3        cross connect ix: 1, op code: Swap
        TX bytes:0, pkts:0, error pkts:0, discard pkts:0Zx
```

Table 17 explains the show command output fields.

Table 17: show mpls out-segment-table output field

Field	Description
Out-segment ix	Displays the outbound segment index.
Out-Label	Label received from downstream neighbor for route.
Out-Intf	Short name of the physical interface through which traffic goes to the protected link.
Nexthop addr	Displays the IP address of the next hop.
Cross-connect ix	Displays the table index for the cross-connect.
Op code	PUSH = Replace the top label with another and then push one or more additional labels onto the label stack. SET = Set the next hop label.
Pkts	Number packet in the interface.
TX bytes	Size of the packets that transmitted to the neighbor.

Table 17: show mpls out-segment-table output field

Field	Description
Error pkts	Number of error packets.
Discard pkts	Number of packets discarded in the interface.

show mpls qos-resource

Use this command to display detailed QoS resource information.

Command Syntax

```
show mpls qos-resource IFNAME
```

Parameters

`IFNAME`	Display the interface name for a QoS resource

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show mpls qos-resource eth1
<*************************************************>
               QOS RESERVED TABLE
<*************************************************>
HOLD PRIORITY : 0

HOLD PRIORITY : 1

HOLD PRIORITY : 2

HOLD PRIORITY : 3

HOLD PRIORITY : 4

HOLD PRIORITY : 5

HOLD PRIORITY : 6

HOLD PRIORITY : 7
<*************************************************>
   QOS AWAITING TABLE (static resources)
<*************************************************>
HOLD PRIORITY : 0

HOLD PRIORITY : 1

HOLD PRIORITY : 2

HOLD PRIORITY : 3

HOLD PRIORITY : 4

HOLD PRIORITY : 5

HOLD PRIORITY : 6
```

```
HOLD PRIORITY : 7
TSUP-173>
```

Table 18 explains the show command output fields.

Table 18: show mpls qos-resource output fields

Field	Description
QOS RESERVED TABLE	FTM/ILM entries for which QOS is reserved.
HOLD PRIORITY	Determines the degree to which an LSP holds onto its session reservation after the LSP has been set up successfully
QOS AWAITING TABLE (static resources)	FTN/ILM entries for which QOS reservation is pending.

show mpls vc-table

Use this command view configured virtual circuit (VC) components

Command Syntax

```
show mpls vc-table
```

Parameters

None

Command Mode

Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#show mpls vc-table

VC-ID Vlan-ID Inner-Vlan-ID Access-Intf Network-Intf Out Label  Tunnel-Label
Nexthop Status
500    N/A         N/A          eth2          eth1          544        57
N/A    Active
#
```

Table 19 explains the show command output fields.

Table 19: show mpls vc-table output fields

Field	Description
VC-ID	The virtual circuit ID for the Provider Edge (PE) MPLS.
Vlan-ID	Virtual LAN (VLAN) ID number.
Inner-Vlan-ID	Inner Virtual LAN (VLAN) ID number.
Access-Intf	The Interface Access page provides a method with which to control access to specific areas of the interface.
Network-Intf	A networking interface allows a computer or mobile device to connect to a local area network (LAN) using Ethernet as the transmission mechanism.
Out Label	Label received from downstream neighbor for route.
Tunnel-Label	Used to provide reachability between PE devices.
Nexthop Status	Displays the network status of the next hop.

show mpls vrf

Use this command to display detailed information of all the configured VRF entries. Specify the name of the VRF to display information about a specific VRF entry.

Command Syntax

```
show mpls vrf-table
show mpls vrf-table VRFNAME (count|)
```

Parameters

`VRFNAME`	Display the MPLS VRF table by its configured name
`count`	Display the MPLS VRF FTN's count

Command Mode

Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#show mpls vrf new_vrf count
---------------------------------------------
Num VRF-FTNs          : 1          [UP: 1, INSTALLED: 1]
---------------------------------------------
---------------------------------------------
Num  VRF-FTNs          : 0          [UP: 0]
---------------------------------------------
```

Table 20 explains the show command output fields.

Table 20: show vrf-table output fields

Field	Description
Num VRF-FTNs	Number of FEC-to-NHLFE map counters in VRF protocol.
Num VRF-FTNs	Number of VRF FEC-to-NHLFE map counters in protocol.

show mpls vrf-forwarding-table vrf

This CLI can be used to display a tabular output of the VRF forwarding entries received from the remote PE via MPBGP.

Command Syntax

```
show mpls vrf-forwarding-table vrf <VRFNAME>
```

Parameters

VRFNAME	Display the MPLS VRF table by its configured name

Command Mode

Exec mode

Applicability

This command was introduced in OcNOS-SP version 4.1.

Examples

```
OcNos#show mpls vrf-forwarding-table vrf BEVrf
Owner    FEC                          FTN-ID    Oper-Status    Out-Label    Tunnel-id    NHLFE-id    Out-Intf    Nexthop
BGP      10.143.73.1/32                 1         Up            24320        0            19          xe25        10.143.73.1
BGP      10.143.73.10/32                6         Up            25600        0            30          xe4        10.143.73.10
BGP      10.143.169.26/31               2         Up            24320        0            19          xe25        10.143.73.1
BGP      10.143.170.26/31               3         Up            24324        0            28          xe4         10.143.73.6
```

Table 21 explains the show command output fields.

Table 21: show mpls vrf-forwarding-table vrf output fileds

Field	Description
Owner	Displays the creator of this entry, typically a protocol such as BGP.
FEC	Displays the Forward Equivalency Class (FEC) for this entry.
FTN-ID	FEC-to-NHLFE identification.
Oper-Status	Displays the current status of the entry – Up or Down. It will be “UP” if the vrf entry is installed in the forwarder and it will be in “DOWN“ state if the vrf entry is not installed in the forwarder.
Out-Label	Displays the egress label for this FTN.
Tunnel-id	Tunnel identification to which packets of this FTN are going.
NHLFE-id	Next Hop Label Forwarding Entry identification (also known as out-segment entry identification).
Out-Intf	Name of the physical interface through which traffic goes.
Nexthop	Displays the IP address of the next hop.

show running-config interface mpls

Use this command to show the running system status and configuration for an MPLS interface.

Command Syntax

```
show running-config interface IFNAME mpls
```

Parameters

`IFNAME`	Display information for this interface name

Command Mode

Privileged Exec mode and Configure mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show running-config interface eth1 mpls

#
```


show running-config mpls

Use this command to show any Multi-Protocol Label Switching (MPLS) related running configuration.

Command Syntax

```
show running-config mpls
```

Parameters

None

Command Mode

Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
>enable
#show running-config mpls
!
mpls propagate-ttl
!
!
!
#
```

show running-config service-template

Use this command to show service-template related running configuration.

Command Syntax

```
show running-config service-template
```

Parameters

None

Command Mode

Privileged Exec mode

Applicability

This command was introduced in OcNOS-SP version 4.2.

Examples

```
OcNOS#sho running-config service-template
!
service-template s2
 match outer-vlan 200
!
service-template s1
 match outer-vlan 100
!
service-template s3
 match outer-vlan 300
!
service-template s4
 match outer-vlan 400
!
```


show running-config vc

Use this command to show any Virtual Private Wire Service (VPWS) related running configuration.

Command Syntax

```
show running-config vc
```

Parameters

None

Command Mode

Privileged Exec mode

Applicability

This command was introduced in OcNOS-SP version 4.2.

Examples

```
OcNOS#show running-config vc
!
mpls l2-circuit vc1 1 2.2.2.2
!
mpls l2-circuit vc2 3 2.2.2.2
 tunnel-select-policy p1
!
!
interface xe2
 mpls-l2-circuit vc1 service-template s1 primary
 mpls-l2-circuit vc2 service-template s3 primary
!
```

show running-config vpls

Use this command to show any Virtual Private LAN Service (VPLS) related running configuration.

Command Syntax

```
show running-config vpls
```

Parameters

None

Command Mode

Privileged Exec mode

Applicability

This command was introduced in OcNOS-SP version 4.2.

Examples

```
#show running-config vpls
!
mpls vpls vpls1 2
 signaling ldp
  vpls-type vlan
  vpls-peer 2.2.2.2
  exit-signaling
 exit-vpls
!
mpls vpls vpls2 4
 signaling ldp
  vpls-type vlan
  vpls-peer 2.2.2.2 tunnel-select-policy p1
  exit-signaling
 exit-vpls
!
!
interface xe2
 mpls-vpls vpls1 service-template s2
 mpls-vpls vpls2 service-template s4
!
```


show service-template

Use this command to display information of all or particular service templates.

Command Syntax

```
show service-template (detail|)
show service-template NAME
```

Parameters

detail	Show detailed information
NAME	Name of customer service template

Command Mode

Exec mode

Applicability

This command was introduced in OcNOS version 1.3.3.

Examples

```
#show service-template detail
 Service-template : C2
  Services mapped : -
  Match criteria : 9/8

 Service-template : C1
  Services mapped : -
  Match criteria : 100

 Service-template : C3
  Services mapped : -
  Match criteria : 2-5

#show service-template C1
 Service-template : C1
  Services mapped : -
  Match criteria : 100
```

Table 22 explains the show command output fields.

Table 22: show service template output fields

Field	Description
Service-template	Creates a service template and enters service template configuration mode.
Services mapped	Used to match the type of services.
Match criteria	Used to approve the identification result or dismiss it.

show vccv statistics

Use this command to display VCCV messages received prior to advertising capability.

Command Syntax

```
show vccv statistics
```

Parameters

None

Command Mode

Privileged mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

The following is the sample output for `show vccv statistics` command.

```
#show vccv statistics
  CC Mismatch Discards - 10
```

Table 23 explains the show command output fields.

Table 23: show vccv statistics output fields

Field	Description
CC Mismatch Discards	Number of CC mismatch packets received from neighbor discarded.

srlg-disjoint

Use this command to set how to avoid the SRLGs (Shared Risk Link Groups) of a protected primary.

A fast-reroute/secondary path for an LSP that is disjoint from the primary ensures that a single point of failure on a particular link does not bring down both the primary and secondary paths in the LSP.

Note: The SRLG option configured in RSVP-TRUNK mode (see the secondary-priority srlg-disjoint command) takes higher preference than the option configured in RSVP router mode (this command).

Use the `no` form of this command to not avoid the SRLGs of a protected interface.

Command Syntax

```
srlg-disjoint (forced|preferred)
```

```
no srlg-disjoint
```

Parameters

`forced`	The router does not create the secondary/backup tunnel unless it avoids SRLGs of the primary-path/protected-interface.
`preferred`	With two explicit paths, the first explicit path tries to avoid the SRLGs of the primary-path/protected interface. If that does not work, the secondary/backup tunnel uses the second path (which ignores SRLGs).

Command Mode

Router RSVP mode

Example

```
#configure terminal
(config)#router rsvp
(config-rsvp)# srlg-disjoint forced
```

trace mpls

Use this command to trace the route traversed by a specified echo request packet in an MPLS protocol. Trace requests can be configured for LDP, RSVP, L2 VC, VPLS, and L3 VPN label switched paths.

```
trace mpls (6pe default X:X::X:X/M|ldp A.B.C.D/M|rsvp (tunnel-name NAME|egress
  A.B.C.D)|l3vpn VRFNAME A.B.C.D/M|ipv4 A.B.C.D/M) ({reply-mode
  (2)|flags|destination A.B.C.D|source A.B.C.D|timeout <1-500>|force-explicit-
  null|detail}|)
```

Parameters

`6pe`	FEC type is 6pe
`default`	VPN Instance Name (default)
`X:X::X:X/M`	6pe prefix address
`ldp`	FEC type is LDP
`A.B.C.D/M`	LDP prefix address
`rsvp`	FEC type is RSVP
`tunnel-name`	RSVP tunnel name
`NAME`	Tunnel name string
`egress`	RSVP tunnel egress
`A.B.C.D`	RSVP tunnel egress address
`l3vpn`	FEC type is MPLS VPN (L3-VPN)
`VRFNAME`	VPN instance name
`A.B.C.D./M`	VPN prefix
`ipv4`	FEC type generic; use for static/SNMP label switched paths
`A.B.C.D/M`	IPv4 prefix address
`X:X::X:X/M`	VPNv6 prefix
`reply-mode`	Reply mode, one of
`2`	Reply via UDP/IP packet (default)
`flags`	Validate FEC stack
`destination`	Destination address
`A.B.C.D`	IPv4 address of the destination
`source`	Source address
`A.B.C.D`	IPv4 address of the source
`timeout`	Time to wait before rejecting the probe as a failure, in seconds
`<1-500>`	Timeout value
`force-explicit-null`	Force Explicit NULL label
`detail`	Print detailed output of the trace probe

Defaults

Default timeout value is 60 seconds.

Command Mode

Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#trace mpls ipv4 10.10.0.0/24 reply-mode 2 flags destination 127.1.2.3 source
10.10.0.1 timeout 65 detail force-explicit-null

#trace mpls l3vpn vrfa 10.10.0.0/24 reply-mode 2 flags destination 127.1.2.3
source 10.10.0.1 timeout 65 detail force-explicit-null

#trace mpls ldp 10.10.0.0/24 reply-mode 2 flags destination 127.1.2.3 source
10.10.0.1 timeout 65 detail force-explicit-null

#trace mpls rsvp egress 1.2.3.5 reply-mode 2 flags destination 127.1.2.3 source
10.10.0.1 timeout 65 detail force-explicit-null

#trace mpls rsvp tunnel-name tun1 reply-mode 2 flags destination 127.1.2.3 source
10.10.0.1 timeout 65 detail force-explicit-null
```

tunnel-id

Use this command to configure tunnel identifier for the MPLS transport tunnel to be used for the MPLS layer-2 virtual circuit.

Use the no parameter with this command to delete tunnel identifier from the MPLS layer-2 virtual circuit.

Command Syntax:

```
tunnel-id <1-5000>
no tunnel-id
```

Parameters

`<1-5000>`	Identifying value for Tunnel-id

Default

By default, tunnel-id is disabled

Command Mode

Configure Pseudowire mode

Applicability

This command was introduced before OcNOS version 1.X

Example

```
#configure terminal
(config)#mpls l2-circuit mycircuit 45678 1.2.3.4
(config-pseudowire)#tunnel-id 22
```


tunnel-name

Use this command to configure tunnel name for the MPLS transport tunnel to be used for the MPLS layer-2 virtual circuit.

Use the no parameter with this command to delete tunnel name from the MPLS layer-2 virtual circuit.

Command Syntax:

```
tunnel-name NAME
no tunnel-name
```

Parameters

`NAME`	Identifying name for MPLS Tunnel

Default

By default, tunnel-name is disabled

Command Mode

Configure Pseudowire mode

Applicability

This command was introduced before OcNOS version 1.X

Example

```
#configure terminal
(config)#mpls l2-circuit mycircuit 45678 1.2.3.4
(config-pseudowire)#tunnel-name pe1-to-pe2
```

tunnel-select-policy

Use this command to configure tunnel selection policy name for the MPLS transport tunnel to be used for the MPLS layer-2 virtual circuit.

Use the no parameter with this command to delete tunnel selection policy name from the MPLS layer-2 virtual circuit.

Command Syntax

```
tunnel-select-policy POLICYNAME
no tunnel-select-policy
```

Parameters

POLICYNAME	Selection policy name for MPLS Tunnel

Default

By default, tunnel-select-policy is disabled

Command Mode

Configure Pseudowire mode

Applicability

This command was introduced before OcNOS version 1.X

Example

```
#configure terminal
(config)#mpls l2-circuit mycircuit 45678 1.2.3.4
(config-pseudowire)#tunnel-select-policy policy1
```

vccv cv-type

Use this command to configure the VCCV control verification for MPLS layer-2 virtual circuit.

Use the no parameter with this command to disable control verification from MPLS layer-2 virtual circuit.

Command Syntax:

```
vccv cv-type (type-1|type-2|type-3|type-4)
no vccv cv-type (type-1|type-2|type-3|type-4)
```

Parameters

`type-1`	BFD IP/UDP-encapsulated for PW Fault Detection only
`type-2`	BFD IP/UDP-encapsulated for PW Fault Detection and AC/PW Fault Status Signalling
`type-3`	BFD PW-ACH-encapsulated for PW Fault Detection only
`type-4`	BFD PW-ACH-encapsulated for PW Fault Detection and AC/PW Fault Status Signalling

Default

By default, vccv is disabled

Command Mode

Configure Pseudowire mode

Applicability

This command was introduced before OcNOS version 1.X

Example

```
#configure terminal
(config)#mpls l2-circuit mycircuit 45678 1.2.3.4
(config-pseudowire)# vccv cv-type type-1
```

Label Distribution Protocol Command Reference

CHAPTER 1 LDP Commands

This chapter is a reference for the LDP commands:

- advertise-labels
- advertise-label-for-default-route
- advertisement-mode
- clear ldp adjacency
- clear ldp session
- clear ldp statistics
- clear ldp statistics advertise-labels
- control-mode
- debug ldp advertise-labels
- debug ldp all
- debug ldp dsm
- debug ldp events
- debug ldp fsm
- debug ldp hexdump
- debug ldp inter-area
- debug ldp nsm
- debug ldp packet
- debug ldp usm
- debug ldp vc usm
- disable-ldp
- enable-ldp
- explicit-null
- global-merge-capability
- graceful-restart
- hello-interval
- hold-time
- import-bgp-routes
- inter-area-lsp
- keepalive-interval
- label-retention-mode
- ldp advertisement-mode
- ldp hello-interval
- ldp hold-time
- ldp keepalive-interval
- ldp keepalive-timeout

advertise-labels

Use this command to prevent the distribution of any locally assigned labels.

Use the `no` parameter to enable the distribution of all locally assigned labels to all LDP neighbors.

Command Syntax

```
advertise-labels for any to none
 advertise-labels for PREFIX to (PEER|any)
no advertise-labels for any to none
no advertise-labels for PREFIX to (PEER|any
```

Parameters

`for`	Specify the permitted destinations
`any`	Specify to permit any locally assigned labels
`PREFIX`	Specify the destinations which have labels are advertised
`to`	Specify the given neighbor
`PEER`	Specify the LDP neighbors which receive these advertisements
`none`	Specify that there are no LDP neighbors

Default

The labels of all destinations are advertised to all LDP neighbors.

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#router ldp
(config-router)#advertise-labels for any to none

#configure terminal
(config)#router ldp
(config-router)#advertise-labels for PREFIX to any

#configure terminal
(config)#router ldp
(config-router)#advertise-labels for PREFIX to PEER
```

advertise-label-for-default-route

Use this command to enable label advertisement for default route.

Use no form to disable the label advertisement for default route.

Command Syntax

```
advertise-label-for-default-route
```

Parameters

None

Default

Disabled

Command Mode

Router mode

Applicability

This command was introduced before OcNOS-OTN version 4.2.

Examples

```
#configure terminal
(config)#router ldp
(config-router)#advertise-label-for-default-route
```

advertisement-mode

Use this command to set the label advertisement mode for all the interfaces for the current LSR. Specifying `downstream-on-demand` and `downstream-unsolicited` mode affects which LSR initiates mapping requests and mapping advertisements.

This command is a global command used to set the label advertisement mode for all interfaces for the current LSR. The advertisement mode set for a specific interface overrides the value set by this command (see ldp advertisement-mode). Use this command before starting the interface as it closes and restarts all sessions.

Use the `no` parameter to revert to the default advertisement mode value.

Command Syntax

```
advertisement-mode (downstream-on-demand|downstream-unsolicited)
no advertisement-mode (downstream-on-demand|downstream-unsolicited)
```

Parameters

`downstream-on-demand`

Sends label upon request. When a users uses this mode, a router distributes a label to a peer only if there is a pending label request from a peer. The reaction of the downstream router to this request depends on the label advertising mode supported on the next hop. This mode is typically used with the conservative label retention mode.

`downstream-unsolicited`

Sends label without waiting request. This mode distributes labels to peers without waiting for a label request, and is typically used with the liberal label retention mode.

Default

By default, advertisement mode is downstream-unsolicited

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

In the following example, the LSR will use the downstream-unsolicited advertisement mode for an LDP session on its interfaces.

```
#configure terminal
(config)#router ldp
(config-router)#advertisement-mode downstream-unsolicited
```

clear ldp adjacency

Use this command to clear an adjacency with a specified peer, or to clear all adjacencies for the current LSR.

Command Syntax

```
clear ldp adjacency (A.B.C.D|*)
```

Parameters

`*`	Specify to clear all adjacencies.
`A.B.C.D`	Specify to clear IPv4 address of the peer.

Command Mode

Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#clear ldp adjacency 123.123.123.33
```

clear ldp session

Use this command to clear a session established with a specified peer, or to clear all sessions for the current LSR.

Command Syntax

```
clear ldp session (A.B.C.D|*)
```

Parameters

`*`	Specify to clear all sessions.
`A.B.C.D`	Specify to clear IPv4 address of the peer.

Command Mode

Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#clear ldp session 123.123.123.33
```


clear ldp statistics

Use this command to clear LDP statistics. This command clears the count per each operation filtered by an advertisement list.

Command Syntax

```
clear ldp statistics
```

Parameters

None

Command Mode

Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#clear ldp statistics
```


clear ldp statistics advertise-labels

Use this command to clear LDP advertise-labels statistics. This command clears the count per each operation filtered by an advertisement list.

Command Syntax

```
clear ldp statistics advertise-labels
clear ldp statistics advertise-labels for PREFIX
clear ldp statistics advertise-labels for PREFIX to PEER
```

Parameters

`advertise-labels`	Specify the IP prefix list of advertise-labels.
`for`	Specify the permitted destinations.
`PREFIX`	Specify the destinations that have their labels advertised.
`to`	Specify the given neighbor.
`PEER`	Specify the LDP neighbors that receive these advertisements.

Command Mode

Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#clear ldp statistics advertise-labels
```

control-mode

Use this command to set the control mode for label processing. Ordered processing sets the mode to strict chain-of-command; an LSR replies to a request packet from an LSR higher in the chain only after it receives a label from an LSR lower in the chain. Independent processing sets the mode to instant replies.

In independent control mode, each LSR might advertise label mappings to its neighbors at any time. In independent downstream-on-demand mode, an LSR might answer requests for label mappings immediately, without waiting for a label mapping from the next hop. In independent downstream unsolicited mode, an LSR might advertise a label mapping for an Forwarding Equivalence Class (FEC) to its neighbors whenever it is prepared to label-switch that FEC. In independent mode, an upstream label can be advertised before a downstream label is received.

In ordered control mode, an LSR may initiate the transmission of label mapping only for an FEC for which it has a label mapping for the FEC next hop, or for which the LSR is the egress. For each FEC for which the LSR is not the egress and no mapping exists, the LSR must wait until a label from a downstream LSR is received. An LSR may be an egress for some FECs and a non-egress for others. Changes in control mode only affect labels that were sent or received after the change was made.

Use the `no` parameter to revert to default control mode.

Note: The support of control mode independent with advertisement mode is available in Downstream Unsolicited (DU) only not in Downstream on Demand (DOD).

The support of control mode ordered with advertisement mode is available in DOD only not with DU.

The control mode configuration is not allowed in DOD.

Command Syntax

```
control-mode (ordered|independent)
no control-mode
```

Parameters

`independent`	Sets control mode to independent processing. DU advertisement mode.
`ordered`	Sets control mode to ordered processing. DOD advertisement mode

Command Mode

Router mode

Default

By default, control mode is independent

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#router ldp
(config-router)#control-mode ordered
```


debug ldp advertise-labels

Use this command to enable the debugging of LDP advertise-label events.

On using the debug command, the router continues to generate an output until the `no` parameter is used with this command. The debug output and system error messages are written on the virtual terminal. Use the `log syslog` command in `configure` mode to redirect the debugging output to a file or the syslog.

Use the `no` parameter with this command to disable this function.

Command Syntax

```
debug ldp advertise-labels
no debug ldp advertise-labels
```

Parameters

None

Command Mode

Configure mode, Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#log syslog
(config)#debug ldp advertise-labels
```

debug ldp all

Use this command to enable the debugging of all LDP events.

On using the debug command, the router continues to generate an output until the `no` parameter is used with this command. The debug output and system error messages are written on the virtual terminal. Use the l`og syslog` command in `configure` mode to redirect the debugging output to a file or the syslog.

Use the `no` parameter with this command to disable this function.

Command Syntax

```
debug ldp all
no debug ldp all
no debug all
undebug all
```

Parameters

None

Command Mode

Configure mode, Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#log syslog
(config)#debug ldp all
```

debug ldp dsm

Use this command to enable the debugging of LDP DSM events.

On using the debug command, the router continues to generate an output until the `no` parameter is used with this command. The debug output and system error messages are written on the virtual terminal. Use the `log syslog` command in `configure` mode to redirect the debugging output to a file or the syslog.

Use the `no` parameter with this command to disable this function.

Command Syntax

```
debug ldp dsm

no debug ldp dsm
```

Parameters

None

Command Mode

Configure mode, Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#log syslog
(config)#debug ldp dsm
```

debug ldp events

Use this command to enable the debugging of all LDP events.

On using the debug command, the router continues to generate an output until the `no` parameter is used with this command. The debug output and system error messages are written on the virtual terminal. Use the `log syslog` command in `configure` mode to redirect the debugging output to a file or the syslog.

Use the `no` parameter with this command to disable this function.

Command Syntax

```
debug ldp events
no debug ldp events
```

Parameters

None

Command Mode

Configure mode, Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#log syslog
(config)#debug ldp advertise-labels
(config)#debug ldp all
(config)#debug ldp dsm
(config)#debug ldp events
```


debug ldp fsm

Use this command to enable the debugging of LDP FSM events.

On using the debug command, the router continues to generate an output until the `no` parameter is used with this command. The debug output and system error messages are written on the virtual terminal. Use the `log syslog` command in `configure` mode to redirect the debugging output to a file or the syslog.

Use the `no` parameter with this command to disable this function.

Command Syntax

```
debug ldp fsm
no debug ldp fsm
```

Parameters

None

Command Mode

Configure mode, Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#log syslog
(config)#debug ldp fsm
```

debug ldp hexdump

Use this command to enable the debugging of LDP hexdump events.

On using the debug command, the router continues to generate an output until the `no` parameter is used with this command. The debug output and system error messages are written on the virtual terminal. Use the `log syslog` command in `configure` mode to redirect the debugging output to a file or the syslog.

Use the `no` parameter with this command to disable this function.

Command Syntax

```
debug ldp hexdump
no debug ldp hexdump
```

Parameters

None

Command Mode

Configure mode, Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#log syslog
(config)#debug ldp hexdump
```


debug ldp inter-area

Use this command to enable the debugging of LDP inter-area events.

On using the debug command, the router continues to generate an output until the no parameter is used with this command. The debug output and system error messages are written on the virtual terminal. Use the log syslog command in configure mode to redirect the debugging output to a file or the syslog.

Use the `no` parameter with this command to disable this function.

Command Syntax

```
debug ldp inter-area
no debug ldp inter-area
```

Parameters

None

Command Mode

Configure mode, Privileged Exec mode

Applicability

This command was introduced before OcNOS-OTN version 4.2.

Example

```
#configure terminal
(config)#log syslog
(config)#debug ldp inter-area
```

debug ldp nsm

Use this command to enable the debugging of LDP NSM events.

On using the debug command, the router continues to generate an output until the `no` parameter is used with this command. The debug output and system error messages are written on the virtual terminal. Use the `log syslog` command to redirect the debugging output to a file or the syslog.

Use the `no` parameter with this command to disable this function.

Command Syntax

```
debug ldp nsm
no debug ldp nsm
```

Parameters

None

Command Mode

Configure mode, Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#log syslog
(config)#debug ldp nsm
```


debug ldp packet

Use this command to enable the debugging of LDP packet events.

On using the debug command, the router continues to generate an output until the `no` parameter is used with this command. The debug output and system error messages are written on the virtual terminal. Use the `log syslog` command in `configure` mode to redirect the debugging output to a file or the syslog.

Use the `no` parameter with this command to disable this function.

Command Syntax

```
debug ldp packet
debug ldp packet (notification|hello|initialization|keepalive|address|label)
no debug ldp packet
no debug ldp packet (notification|hello|initialization|keepalive|address|label)
```

Parameters

`notification`	Debug LDP notification packets.
`hello`	Debug LDP hello packets.
`initialization`	Debug LDP initialization packets.
`keepalive`	Debug LDP keepalive packets.
`address`	Debug LDP address (withdraw) packets.
`label`	Debug LDP address label packets.

Command Mode

Configure mode, Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#log syslog
(config)#debug ldp packet hello
```

debug ldp usm

Use this command to enable the debugging of LDP USM events.

On using the debug command, the router continues to generate an output until the `no` parameter is used with this command. The debug output and system error messages are written on the virtual terminal. Use the `log syslog` command in `configure` mode to redirect the debugging output to a file or the syslog.

Use the `no` parameter with this command to disable this function.

Command Syntax

```
debug ldp usm

no debug ldp usm
```

Parameters

None

Command Mode

Configure mode, Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#log syslog
(config)#debug ldp usm
```


debug ldp vc usm

Use this command to enable the debugging of LDP VC events.

On using the debug command, the router continues to generate an output until the `no` parameter is used with this command. The debug output and system error messages are written on the virtual terminal. Use the `log syslog` command in `configure` mode to redirect the debugging output to a file or the syslog.

Use the `no` parameter with this command to disable this function.

Command Syntax

```
debug ldp vc dsm
debug ldp vc usm
no debug ldp vc dsm
no debug ldp vc usm
```

Parameters

`dsm`	Debug LDP downstream SM.
`usm`	Debug LDP upstream SM.

Command Mode

Configure mode, Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#log syslog
(config)#debug ldp vc dsm
(config)#debug ldp vc usm
```

disable-ldp

Use this command to disable LDP IPv4 on a specified interface.

This command disables the transmission of Hello packets through the current interface, and clears all created sessions and adjacencies for this interface. Use `disable-ldp` alone to disable only LDP IPv4 on the interface.

Command Syntax

```
disable-ldp (ipv4|)
```

Parameters

`ipv4`	Disables IPv4 on the interface.

Default

By default, disable ldp is disabled

Command Mode

Interface mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

The following example disables LDP IPv4 on interface eth0.

```
#configure terminal
(config)#interface eth0
(config-if)#disable-ldp
```

The following example disables LDP IPv4 on interface eth0.

```
#configure terminal
(config)#interface eth0
(config-if)#disable-ldp ipv4
```


enable-ldp

Use this command to enable LDP IPv4 on a specified interface. This command enables the transmission of Hello packets through the current interface, so that LDP adjacencies and LDP sessions can be created.

Note: The corresponding interface must be enabled for label-switching using the label-switching command.

Command Syntax

```
enable-ldp ipv4
```

Parameters

None

Default

By default, enable ldp is disabled

Command Mode

Interface mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

The following example enables LDP IPv4 on interface eth0.

```
#configure terminal
(config)#interface eth0
(config-if)#enable-ldp ipv4
```

explicit-null

Use this command to configure the router to send explicit-null labels for directly connected FECs instead of implicit-null labels. Implicit-nulls are the default labels.

This command controls the label value advertised on the egress router of an LSP. By default, implicit null label (label 3) is advertised for directly connected FECs. LDP advertises an Implicit Null label that causes the previous hop router to perform penultimate hop popping. Use the `explicit null` command to avoid the penultimate router from penultimate hop popping, and to force it to replace the incoming label with the explicit null label.

Note: Do not use this command if the LDP is concurrently used for MPLS/BGP VPNs.

Use the `no` parameter to stop sending explicit-null labels for directly connected FECs and resume sending implicit-null labels for them.

Command Syntax

```
explicit-null

no explicit-null
```

Parameters

None

Default

By default, sends implicit-null labels.

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#router ldp
(config-router)#explicit-null
```


global-merge-capability

Use this command to override the default merge capability setting of all the interfaces for the current LSR.

The merge capability aggregates multiple incoming flows with the same destination address into a single outgoing flow. This reduces the label-space shortage by sharing labels for different flows with the same destination, or the same FEC (Forwarding Equivalence Class).

Use the `no` parameter to revert to the default merge capability settings of all the interfaces for this LSR.

Command Syntax

```
global-merge-capability (merge-capable|non-merge-capable)
no global-merge-capability
```

Parameters

`merge-capable` Maps all incoming labels that are destined for the same FEC to the same outgoing label (this is the Ethernet default.)

`non-merge-capable` Maps all incoming labels, regardless of destination FEC to unique outgoing labels (this is the non-Ethernet default.)

Default

By default, global merge capability is merge capable.

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#router ldp
(config-router)#global-merge-capability merge-capable
```

graceful-restart

Use this command to enable the Graceful-Restart capability for LDP.

Use the `no` parameter to disable the GR capability for LDP.

Command Syntax

```
graceful-restart full
graceful-restart helper-only
graceful-restart timers max-recovery <15-600>
graceful-restart timers neighbor-liveness <5-300>
no graceful-restart
no graceful-restart timers max-recovery
no graceful-restart timers neighbor-liveness
```

Parameters

`full`	Configuring with full enable the complete GR capability
`helper-only`	Configuring with helper-only enables only helper mode
`timers`	Used to configure the non-default recovery and reconnect timer values.
`max-recovery`	Maximum recovery time
`<15-600>`	Interval until which LDP preserves route after peer restart
`neighbor-liveness`	Neighbor Liveness Time
`<5-300>`	Set the hold timer for a targeted LDP peer

Default

GR capability is not enbabled.

Command Mode

Router mode

Applicability

This command was introduced before OcNOS-SP version 5.0.

Examples

```
OcNOS#configure terminal
OcNOS(config)#router ldp
OcNOS(config-router)#graceful-restart full
OcNOS(config-router)#graceful-restart helper-only
OcNOS(config-router)#graceful-restart timers max-recovery 100
OcNOS(config-router)#graceful-restart timers neighbor-liveness 200
```


hello-interval

Use this command to set the interval after which hello packets are sent out.

LDP defines a mechanism for discovering adjacent Label Switching Routers (LSRs) that participate in label switching (adjacencies). Hello messages are sent to the All Routers Multicast Group (224.0.0.2). Whenever a new router comes up, it sends out a hello packet to a specified, multicast address announcing itself to the network. Every router directly connected to the network receives the packet. Receipt of a hello packet from another LSR creates a hello adjacency with that LSR. Use this command to specify the interval after which the hello packets will be sent.

Used as a global command, the hello-interval value may be overridden by the hello-interval set on the interface (see ldp hello-interval). For optimum performance, set this value to no more than one-third the value of the hold-time specified.

Use the no parameter to revert to default hello interval.

Command Syntax

```
hello-interval <1-21845>
no hello-interval
```

Parameters

<1-21845>	Specify the interval in seconds. The default is 5 seconds.

Default

By default, hello interval is 5 seconds

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

This example shows how to set the hello-interval value for all interfaces of an LSR.

```
#configure terminal
(config)#router ldp
(config-router)#hello-interval 35

(config-router)#no hello-interval
```


hold-time

Use this command to set the global value for the hold-time after which the LSR rejects adjacencies.

An LSR maintains a record of `hellos` received from peers. `Hold-time` specifies the time an LSR maintains its record of hellos from a peer on not receiving another hello from that peer. A pair of LSRs negotiates the hold-time they use for hellos from each other. Each proposes a hold time value, and the LSR uses the lower of the two hold-time values. The hold-time value set on the interface overrides the hold-time value set by this command (see ldp hold-time). For optimum performance, set this value to no less than three times the value of the hello-interval specified.

Use the `no` parameter to revert to the default hold time.

Command Syntax

```
hold-time <3-65535>
no hold-time
```

Parameters

`<3-65535>`	Specify the hold-time value in seconds.

Default

By default, hold time is 15 seconds

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

This example shows how to set the hold-time value for all interfaces of an LSR.

```
#configure terminal
(config)#router ldp
(config-router)#hold-time 635

(config-router)#no hold-time
```


import-bgp-routes

Use this command to import BGP routes into LDP. BGP routes are not imported into LDP by default.

Use the `no` parameter to flush out all BGP routes currently being used by LDP, and to reject any further BGP specific routing updates from OcNOS.

Command Syntax

```
import-bgp-routes
no import-bgp-routes
```

Parameters

None

Default

By default, import bgp route is disabled

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#router ldp
(config-router)#import-bgp-routes
```

inter-area-lsp

Use this command to enable creation of inter-area LSPs.

Use the `no` form of the command to disable this configuration.

Command Syntax

```
inter-area-lsp (PREFIX_ACL|)(config-only|)
no inter-area-lsp
```

Parameters

PREFIX_ACL	Access-list name for Prefix Based inter-area lsp
config-only	Optional. When this option is used, existing LDP sessions are not torn down.

Command Mode

Router mode

Applicability

This command was introduced before OcNOS-OTN version 4.2.

Example

```
#configure terminal
(config)#router ldp
(config-router)#inter-area-lsp

#configure terminal
(config)#router ldp
(config-router)#inter-area-lsp config-only

#configure terminal
(config)#router ldp
(config-router)#inter-area-lsp acl1

#configure terminal
(config)#router ldp
(config-router)#inter-area-lsp acl1 config-only
```

keepalive-interval

Use this command to set the global value for the interval after which keep-alive packets are sent out.

Each LSR must send keep-alive messages at regular intervals to its LDP peers to keep the sessions active. The keep-alive interval determines the time interval between successive keep-alive messages. Use this command to set this interval. This value is overridden by the keep-alive interval set on the interface. For optimum performance, set this value to no more than one-third the value of the specified keep-alive time-out value.

Use the `no` parameter to revert to default keep-alive interval.

Command Syntax

```
keepalive-interval <1-21845>
no keepalive-interval
```

Parameters

`<1-21845>`	Specify the value of interval in seconds.

Default

By default, keepalive interval is 10 seconds

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

This example shows how to set the keep-alive timer for all interfaces of an LSR.

```
#configure terminal
(config)#router ldp
(config-router)#keepalive-interval 635

(config-router)#no keepalive-interval
```

keepalive-timeout

Use this command to set the global value for the time-out after which sessions are rejected.

Use this command to set the time period for which an LSR must wait for successive keep-alive messages from LDP peers. The keep-alive time-out value is overridden by the keep-alive time-out set on the interface (see ldp keepalive-timeout). For optimum performance, set this value to no less than three times the value of the specified keep-alive interval value.

Use the `no` parameter to revert to default keep-alive time-out.

Command Syntax

```
keepalive-timeout <3-65535>
```

```
no keepalive-timeout
```

Parameters

`<3-65535>`	Specify the time-out value in seconds.

Default

By default, keepalive timeout is 30 seconds.

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

This example shows how to set the keep-alive time-out value for all interfaces of an LSR.

```
#configure terminal
(config)#router ldp
(config-router)#keepalive-timeout 635

(config-router)#no keepalive-timeout
```


label-retention-mode

Use this command to set the retention mode to be used for all labels exchanged.

When an LSR receives a label binding for a particular FEC (Forwarding Equivalence Class) from another LSR that is not its next hop for that FEC, it might keep track of such bindings or discard them. Use the `liberal` parameter to retain all labels binding to FEC received from label distribution peers, even if the LSR is not the current next-hop. Use the `conservative` parameter to maintain only the label bindings for valid next-hops in a LSP. Liberal label retention mode allows for quicker adaptation to routing changes, whereas conservative label retention mode requires an LSR to maintain fewer labels.

Note: The retention mode value set on the interface (see ldp label-retention-mode) overrides the value set by this command.

Note: Any changes made to the retention mode for an interface (after a session is already operational) will only apply to labels received after the mode has been changed. All previously received labels will remain as they were.

Note: The label-retention-mode functions with advertisement-mode DU only.

The label-retention-mode conservative functions with advertisement-mode DU only.

The label-retention-mode configuration in advertisement-mode DOD is not allowed.

Use the `no` parameter to revert to default retention mode.

Command Syntax

```
label-retention-mode (conservative|liberal)
no label-retention-mode (conservative|liberal)
```

Parameters

`conservative`	Specify to delete all unused labels and FECs.
`liberal`	Specify to retain all labels, regardless of use.

Default

By default, label retention mode is liberal

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

This example shows how to set the retention mode for all interfaces of an LSR.

```
#configure terminal
(config)#router ldp
(config-router)#label-retention-mode liberal
```


ldp advertisement-mode

Use this command to set the label advertisement mode for an interface for the current LSR to either downstream-on-demand (label is sent only when requested) or downstream-unsolicited (label is sent unrequested). Specifying downstream-on-demand and downstream-unsolicited mode affects which LSR initiates mapping requests and mapping advertisements.

This is an interface-specific command; it overrides the advertisement mode set for an LSR using the advertisement-mode command (see advertisement-mode). Use this command after the advertisement-mode command sets all the interface advertisement modes. In addition, users should use this command before starting the interface, since all affected sessions will be closed and restarted.

Use the `no` parameter to revert to the advertisement mode value set for the main LDP process.

Command Syntax

```
ldp advertisement-mode (downstream-on-demand|downstream-unsolicited)
no ldp advertisement-mode (downstream-on-demand|downstream-unsolicited)
```

Parameters

`downstream-on-demand`

Indicates that the sent label was requested. When a user uses this parameter, a router distributes a label to a peer only if there is a pending label request from a peer. The reaction of the downstream router to this request depends on the label advertising mode supported on the next hop. The downstream-on-demand mode is typically used with the conservative label retention mode.

`downstream-unsolicited`

Indicates that the label was sent unrequested. This parameter distributes labels to peers without waiting for a label request. This mode is typically used with the liberal label retention mode.

Default

By default, ldp advertisement mode is downstream unsolicited mode

Command Mode

Interface mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#interface eth0
(config-if)#ldp advertisement-mode downstream-on-demand
```

ldp hello-interval

Use this command to set the interval for sending multicast Hello packets via an interface.

LDP defines a mechanism for discovering adjacent Label Switching Routers (LSR) that participate in label switching (adjacencies). Whenever a new router comes up, it sends out a hello packet to a specified, multicast address announcing itself to the network. Every router directly connected to the network receives the packet. Receipt of a hello packet from another LSR creates a hello adjacency with that LSR. Use this command to specify the interval after which the hello packets will be sent.

For optimum performance, set the hello-interval value to no more than one-third the hold-time value.

Note: This command is an interface-specific command and overrides the value set for an LSR using the global hello-interval command.

Use the `no` parameter with this command to revert to the hello-interval value set for the main LDP process.

Command Syntax

```
ldp hello-interval <1-21845>
no ldp hello-interval
```

Parameters

`<1-21845>`	Specify the interval in seconds.

Default

By default, ldp hello interval is 5 seconds

Command Mode

Interface mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

This example shows how to set the hello-interval for a specific interface.

```
#configure terminal
(config)#interface eth0
(config-if)#ldp hello-interval 635

(config-if)#no ldp hello-interval
```

ldp hold-time

Use this command to set the hold-time value after which the LSR rejects adjacencies.

The hold-time timer is reset every time a hello packet is received from the peer in question. For optimum performance, set this value to no less than three times the hello-interval value.

Note: This command is an interface-specific command, and overrides the value set for an LSR using the global hold-time command.

Use the `no` parameter to revert to the hold-time value set for the main LDP process.

Command Syntax

```
ldp hold-time <3-65535>
no ldp hold-time
```

Parameters

`<3-65535>`	Specify the hold-time value in seconds.

Default

By default, ldp hold time is 15 seconds

Command Mode

Interface mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

This example shows how to set the hold-time for a specific interface:

```
#configure terminal
(config)#interface eth0
(config-if)#ldp hold-time 635

(config-if)#no ldp hold-time
```

ldp keepalive-interval

Use this command to set the interval for sending keep-alive messages to the peer in order to maintain a session.

Each LSR must send keep-alive messages at regular intervals to its LDP peers to keep the sessions active. The keep-alive interval determines the time-interval between successive keep-alive messages. This command sets this interval.

Note: This command is an interface-specific command, and overrides the value set for an LSR using the global `keepalive-interval` command.

Use the `no` parameter to revert to the keep-alive interval set for the main LDP process.

Command Syntax

```
ldp keepalive-interval <1-21845>
no ldp keepalive-interval
```

Parameters

`<1-21845>`	Specify the interval in seconds.

Default

By default, ldp keepalive interval is 10 seconds

Command Mode

Interface mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

This example shows how to set the hello-interval for a specific interface:

```
#configure terminal
(config)#interface eth0
(config-if)#ldp keepalive-interval 635

(config-if)#no ldp keepalive-interval
```


ldp keepalive-timeout

Use this command to set the keep-alive time-out value for rejecting a session with a peer.

Use this command to set the time period for which an LSR must wait for successive keep-alive messages from LDP peers. The keep-alive timer is reset every time a keep-alive packet is received from the peer in question. For optimum performance, set this value to no more than three times the keep-alive interval value.

Note: This command is an interface-specific command and overrides the value set for an LSR using the global `keepalive-timeout` command.

Use the `no` parameter to revert to the keep-alive time-out set for the main LDP process.

Command Syntax

```
ldp keepalive-timeout <3-65535>
no ldp keepalive-timeout
```

Parameters

`<3-65535>`	Specify the value in seconds.

Default

By default, ldp keepalive timeout is 30 seconds

Command Mode

Interface mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

This example shows how to set the keep-alive time-out timer for a specific interface:

```
#configure terminal
(config)#interface eth0
(config-if)#ldp keepalive-timeout 635

(config-if)#no ldp keepalive-timeout
```


ldp label-retention-mode

Use this command to set the retention mode to be used for all labels exchanged via the given interface.

When an LSR receives a label binding for a particular FEC (Forwarding Equivalence Class) from another LSR that is not its next hop for that FEC, it might keep track of such bindings or discard them. Use the `liberal` parameter to retain all labels binding to FEC received from label distribution peers, even if the LSR is not the current next-hop. Use the `conservative` parameter to maintain only the label bindings for valid next-hops in a LSP. Liberal label retention mode allows for quicker adaptation to routing changes, whereas conservative label retention mode requires an LSR to maintain fewer labels.

Note: The retention mode value set on the interface (see label-retention-mode) overrides the value set by this command. This command is an interface-specific command, and overrides the setting for an LSR using the global `label-retention-mode` command.

Use the `no` parameter to revert to the retention mode set for the main LDP process.

Command Syntax

```
ldp label-retention-mode (conservative|liberal)
no ldp label-retention-mode (conservative|liberal)
```

Parameters

`conservative`	Specify to delete all unused labels and FECs.
`liberal`	Specify to retain all labels, regardless of use.

Default

By default, ldp label retention mode is liberal

Command Mode

Interface mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

This example shows how to set the label retention mode for a specific interface:

```
#configure terminal
(config)#interface eth0
(config-if)#ldp label-retention-mode liberal
```

ldp multicast-hellos

Use this command to enable multicast hello exchange on a specified interface.

Use the `no` parameter to disable multicast hello exchange. R

Command Syntax

```
ldp multicast-hellos
no ldp multicast-hellos
```

Parameters

None

Default

By default, ldp multicast hello is enabled

Command Mode

Interface mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#interface eth0
(config-if)#ldp multicast-hellos
```


ldp-optimization

This command helps optimize the resetting of an LDP session by enabling the following two scalability features for LDP:

- Resets the session keepalive timer on receipt of a hello message
- Resets the hold timer on receipt of any LDP control message

Use the `no` parameter to disable the two previously listed scalability features.

Command Syntax

```
ldp-optimization
no ldp-optimization
```

Parameters

None

Default

By default, ldp optimization is disabled

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#router ldp
(config-router)#ldp-optimization
```

loop-detection

Use this command to enable loop detection on the current LSR. This command detects looping LSPs, and prevent Label Request messages from looping because of non-merge capable LSRs. This loop detection mechanism is useful for networks of non time-to-live (non TTL) decrementing devices that can not allocate resources among traffic flows.

There are two methods supported for the loop detection mechanism: A Hop Count detection system, that is always enabled; and the Path Vector detection system, that can be toggled:

- Hop Count - During the setup of an LSP, the LSP passes a hop count with the LSP setup messages. This hop count is incremented by each node router participating in LSP establishment. If the hop count exceeds the maximum configured value, the LSP setup process is stopped, and a notification message is passed back to the message originator.
- Path Vector - A path vector contains a list of LSR identifiers. This is passed as a part of LSP setup messages. Each LSR participating in the LSP establishment adds its own LSR identifier to the path vector. If an LSR finds its own identifier in the path vector, it drops the message, and sends a message back to the originator.

The use of these messages ensures that a loop is detected while establishing a label switched path and before any data is passed over that LSP.

Use the `no` parameter to disable loop detection.

Command Syntax

```
loop-detection
no loop-detection
```

Parameters

None

Default

By default, loop detection is disabled

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#router ldp
(config-router)#loop-detection
```


loop-detection-hop-count

Use this command to set the loop detection hop count, which determines the maximum hop-count value.

This command sets the maximum hop count value, which specifies the permitted maximum permitted hop-count. An LSR that detects a maximum hop count behaves as if the containing message has traversed a loop. The use of this command ensures that a loop is detected while establishing a label switched path before any data is passed via LSP.

Use the `no` parameter to revert to the default loop detection count

Command Syntax

```
loop-detection-hop-count <1-255>
```

Parameters

`<1-255>`	Indicates the loop detection hop count.

Default

By default, loop detection hop is disabled

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#router ldp
(config-router)#loop-detection-hop-count 128
```

loop-detection-path-vec-count

Use this command to set the loop detection vec (vector) count, which determines the maximum supported path vectors.

This command sets the maximum supported path vectors for loop detection, which specifies the permitted path vector length. An LSR that detects a path vector has reached the maximum length behaves as if the containing message has traversed a loop. This command ensures that a loop is detected while establishing a label switched path before any data is passed over that LSP.

Use the `no` parameter to revert to the default loop detection count

Command Syntax

```
loop-detection-path-vec-count <1-255>
```

Parameters

`<1-255>`	Indicates the loop detection hop count.

Default

By default, loop detection path vec count is disabled

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#router ldp
(config-router)#loop-detection-path-vec-count 123
```


mpls ldp-igp sync isis

Use this command to enable LDP ISIS synchronization and to set the holddown timer for synchronization.

Use the `no` parameter to disable the LDP ISIS synchronization.

Note: Holddown timer value should be higher than LDP IGP sync timer.

Command Syntax

```
mpls ldp-igp sync isis (level-1|level-2|level-1-2) (holddown-timer <1-2147483>| )
```

Parameters

`level-1|level-2|level-1-2`
The ISIS level.

`holddown-timer` How long IGP should wait for LDP to converge in seconds.

Default

None

Command Mode

Interface configuration mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
#int eth 1
#mpls ldp-igp sync isis level-1-2 holddown-timer 500
```

mpls ldp-igp sync ospf

Use this command to enable LDP-OSPF synchronization. This command also provides option to configure the hold-down timer for which OSPF will wait for LDP to converge and advertises Max cost. When the configured time expires, OSPF starts advertising the actual cost in the Router-LSA.

Note: Holddown timer value should be higher than LDP IGP sync timer.

Command Syntax

```
mpls ldp-igp sync ospf (holddown-timer <1-2147483>|)
```

Parameters

`holddown-timer`	Set holddown timer for the OSPF Sync
`<1-2147483>`	Hold down timer in seconds

Default

OSPF waits infinite when no hold-down timer is configured.

Command Mode

Interface configuration mode

Applicability

This command was introduced before OcNOS-OTN version 4.2.

Example

Enabling OSPF-LDP sync in interface eth3

```
#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
(config)#int eth3
(config-if)#mpls ldp-igp sync ospf
(config-if)#end
```

Enabling OSPF-LDP sync with holdown-timer enabled

```
#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
(config)#int eth3
(config-if)#mpls ldp-igp sync ospf holddown-timer 200
(config-if)#no mpls ldp-igp sync ospf
(config-if)#end
#
```


mpls ldp-igp sync-delay

Use this command to set the time delay for LDP-IGP synchronization.

Use the `no` parameter to disable the time delay.

Command Syntax

```
mpls ldp-igp sync-delay <5-60>
no mpls ldp-igp sync-delay
```

Parameters

`sync-delay`	Time delay for LDP to converge in seconds.
`<5-60>`	Time delay for notification of LDP convergence to IGP, in seconds

Default

If not configured the delay will be 0 seconds.

Command Mode

Interface configuration mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config-if)# interface eth0
(config-if)# mpls ldp-igp sync-delay 15
(config-if)# no mpls ldp-igp sync-delay
```

multicast-hellos

Use this command to enable multicast hello exchange on all interfaces enabled for LDP. This is used for auto-discovery of LDP peers on directly connected networks. This option is enabled by default.

Use the `no` parameter with this command to disable multicast hello exchange.

Command Syntax

```
multicast-hellos
no multicast-hellos
```

Parameters

None

Default

By default, multicast hello is enabled

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#router ldp
(config-router)#multicast-hellos
```


neighbor

Use this command to configure neighbors of LDP.

Use the `no` parameter with this command to unconfigure the LDP neighbor.

Command Syntax

```
neighbor A.B.C.D auth AUTH-TYPE password (0|7) WORD
no neighbor A.B.C.D auth AUTH-TYPE password (0|7)
```

Parameters

A.B.C.D	Neighbor address
auth AUTH-TYPE	Authentication Type md5
password	Set password to the neighbor
(0|7)	Password Type
WORD	Password

Default

By default, neighbor is disabled.

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#router ldp
(config-router)#neighbor 1.1.1.1 auth md5 password 0 myPass

(config-router)#no neighbor 1.1.1.1 auth md5 password 0
```

neighbor tcp-mss

Use this command to set the TCP MSS for an LDP session. MSS is a TCP parameter that defines the maximum amount of data in a TCP segment that can be transmitted.

Use the no command to remove the TCP MSS from an LDP session.

For more information, refer to the command reference page for neighbor tcp-mss in the TCP MSS configuration for LDP sessions section of the *OcNOS Key Feature document*, Release 6.4.1.

propagate-release

Use this command to propagate the release of labels to downstream routers.

Use the `no` parameter to prevent the propagate-release of labels.

Command Syntax

```
propagate-release
no propagate-release
```

Parameters

None

Default

By default, propagate release is disabled

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#router ldp
(config-router)#propagate-release
```

pw-status-tlv

Use this command to enable the use of the PW Status TLV to signal the pseudowire status.

Use the `no` option with this command to disable the use of the PW Status TLV to signal the pseudowire status.

Command Syntax

```
pw-status-tlv
no pw-status-tlv
```

Parameters

None

Default

By default, pw status tlv is disabled

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#router ldp
(config-router)#pw-status-tlv
```


request-labels-for

Use this command to request labels for the prefixes in the given IP prefix list. LDP request labels for the prefixes only if the valid and exact route is present for that prefix.

Use the no form of this command to disable multicast hello exchange.

Command Syntax

```
request-labels-for prefix-list-ipv4 NAME
no request-labels-for prefix-list-ipv4
```

Parameters

NAME	IPv4 prefix list name

Command Mode

LDP router mode

Applicability

This command was introduced in OcNOS-OTN version 4.2.

Examples

```
#configure terminal
(config)#router ldp
(config-router)#request-labels-for prefix-list-ipv4 myPrefixList
```

request-retry

Use this command to enable the retry of requests once a request for a label has been rejected for a valid reason. This command enables the LSR to send a maximum of five label requests if a label request is rejected by an LDP peer.

Use the `no` parameter to disable the retry of requests.

Command Syntax

```
request-retry
no request-retry
```

Parameters

None

Default

By default, request retry is disabled

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#router ldp
(config-router)#request-retry
```

request-retry-timeout

Use this command to set the interval between retries. Before this time is over, a request is re-sent to a peer. This command changes the interval between request messages that are resent to a peer to account for routing changes.

Use the `no` parameter to revert to the default request-retry time-out set.

Command Syntax

```
request-retry-timeout <1-65535>
no request-retry-timeout
```

Parameter

`<1-65535>`	Specify the interval between retries in seconds.

Default

By default, timeout is 5 seconds.

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#router ldp
(config-router)#request-retry-timeout 512

(config-router)#no request-retry-timeout
```

restart ldp graceful

Use this command to restart ldp gracefully.

Command Syntax

```
restart ldp graceful
```

Parameter

None

Command Mode

Privileged Exec mode

Applicability

This command was introduced before OcNOS-SP version 5.0.

Example

```
OcNOS#restart ldp graceful
% Warning : You may loose ldp configuration, if not saved
 Proceed for graceful restart? (y/n):y
%% Managed module is down or crashed
```

router ldp

This command is used to enter the LDP specific command-line mode in which global attributes for the LDP process can be set. Without this command, the LSR does not perform any LDP operations, such as sending `hello` packets.

Use the `no` parameter with this command to disable this configuration.

Command Syntax

```
router ldp
no router ldp
```

Parameters

None

Default

By default, router ldp is disabled

Command Mode

Configure mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

The following example shows the change in the prompt after using this `router ldp` command to enter router mode.

```
#configure router
(config)#router ldp
(config-router)#
```

router-id

Use this command to set the router-id to the supplied IP address; the router uses this address to generate the LDP-ID.

OcNOS has three methods to choose the router-id of LDP. The first priority router-id is the configured router-id in router mode (local configured router-id). The second priority router-id is the configured router-id in configure mode (global configured router-id). The lowest priority router-id is chosen by OcNOS among interfaces (global computed router-id).

Use the `no` parameter with this command to revert to using the first IP address configured on the box as the router-id for LDP-ID generation purposes.

Command Syntax

```
router-id A.B.C.D
no router-id A.B.C.D
no router-id
```

Parameter

`A.B.C.D`	Indicates the LDP router ID value.

Default

By default, router id is disabled

Command Mode

Configure mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure router
(config)#router ldp
(config-router)#router-id 123.123.123.8
```


snmp restart ldp

Use this command to restart SNMP in Label Distribution Protocol (LDP)

Command Syntax

```
snmp restart ldp
```

Parameters

None

Default

By default, snmp restart ldp is disabled

Command Mode

Configure mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#snmp restart ldp
```

targeted-peer ipv4

Use this command to enter a targeted IPv4 LDP peer mode.

A targeted session is an LDP session between non-directly connected LSRs. Set this command to send a targeted hello messages to specific IP addresses. This command is specific to a targeted IPv4 LDP peer.

Command Syntax

```
targeted-peer ipv4 A.B.C.D
no targeted-peer ipv4 A.B.C.D
```

Parameter

`A.B.C.D`	Specify the IPv4 address of the targeted peer.

Default

By default, targeted peer IPv4 is disabled

Command Mode

Configure mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#router ldp
(config-router)#targeted-peer ipv4 10.10.10.10
(config-router-targeted-peer)#
```

targeted-peer-hello-interval

Use this command to set the interval for sending unicast `hello` packets to targeted peers.

Use the `no` parameter with this command to revert to the default targeted-peer hello-interval value.

Command Syntax

```
targeted-peer-hello-interval <1-21845>
no targeted-peer-hello-interval
```

Parameter

`<1-21845>`	Specify the interval in seconds.

Default

By default, targeted peer hello interval is 15 seconds.

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#router ldp
(config-router)#targeted-peer-hello-interval 1
```

targeted-peer-hold-time

Use this command to set the time-out value that is the time that the router waits before rejecting an adjacency with targeted peers.

Use the `no` parameter to revert to the default targeted-peer hold-time value.

Command Syntax

```
targeted-peer-hold-time <3-65535>
no targeted-peer-hold-time
```

Parameter

`<3-65535>`	Specify the interval in seconds.

Default

By default, hold time is 45 seconds.

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#router ldp
(config-router)#targeted-peer-hold-time 555

(config-router)#no targeted-peer-hold-time
```

transport-address ipv4

Use this command to configure the IPv4 transport address for a label space.

The transport address is the address used for the TCP session over which LDP is running. Use this command to manually configure the transport address. Transport addresses may either be bound to a loopback interface, or to a physical interface that is bound to the label space in question. A transport address can also be manually configured using the CLI with the loopback address as the transport address.

Note: The CLI accepts only the loopback address to be configured as the transport address.

Use the `no` parameter to stop using the transport address as the IPv4 transport address. If the label space is not specified for either form of this command, a label space of zero is assumed.

Command Syntax

```
transport-address ipv4 A.B.C.D
transport-address ipv4 A.B.C.D ((0)|)
no transport-address ipv4 A.B.C.D
no transport-address ipv4 A.B.C.D LABELSPACE
```

Parameters

`A.B.C.D`	Specify the IPv4 address to be used as the transport address. Only addresses bound to a loopback interface are valid for manual transport address configuration.
`0`	Platform-wide label space (0) is supported.

Default

Transport addresses are chosen for label spaces. By default, the loopback address is selected as the transport address. If a loopback address is not configured, the label space value is examined. The IP address of the interface is bound to the same label space is chosen as the transport address.

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure router
(config)#router ldp
(config-router)#transport-address ipv4 10.10.0.5 20
```

CHAPTER 2 LDP Show Commands

This chapter provides an alphabetized reference for each of the LDP commands. It includes the following commands:

show debugging ldp

Use this command to display the status of the debugging of the LDP system.

Command Syntax

```
show debugging ldp
```

Parameter

None

Command Mode

Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

The following is a sample output from the `show debugging ldp` command.

```
#show debugging ldp
LDP debugging status:
  LDP event debugging is on
  LDP packet debugging is on
  LDP finite state machine debugging is on
  LDP pdu hexdump debugging is on
  LDP downstream state machine debugging is on
  LDP upstream state machine debugging is on
  LDP trunk state machine debugging is on
  LDP QoS debugging is on
  LDP CSPF debugging is on
  LDP VC USM debugging is on
  LDP VC DSM debugging is on
  LDP NSM debugging is on
  LDP Advertise-labels debugging is on
#
```

Table 2-1 explains the show command output fields.

Table 2-1: show debugging ldp output fields details

Field	Description
LDP debugging status	Status of the LDP debugging protocol.

show ldp

Use this command to display basic LDP attributes defined for the current LSR.

Command Syntax

```
show ldp
```

Parameter

None

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

The following is a sample output from the `show ldp` command displaying basic LDP attributes.

```
#show ldp
Router ID                    : 20.1.1.1
LDP Version                  : 1
Global Merge Capability      : Merge Capable
Label Advertisement Mode     : Downstream Unsolicited
Label Retention Mode         : Liberal
Label Control Mode           : Independent
Instance Loop Detection      : On
Instance Hop Count Limit     : 255
Instance Path Vec Count      : 255
Request Retry                : Off
Propagate Release            : Disabled
Graceful Restart             : Disabled
Hello Interval               : 5
Targeted Hello Interval      : 15
Hold time                    : 15
Targeted Hold time           : 45
Keepalive Interval           : 10
Keepalive Timeout            : 30
Request retry Timeout        : 5
Transport Address data       :
  Labelspace 0               : 20.1.1.1 (in use)
Import BGP routes            : No
```

Table 2-2 explains the show command output fields.

Table 2-2: show ldp output fields details:

Field	Description
Router ID	Router identifier in IP address format for this system.
LDP Version	Details of Link Layer Discovery Protocol (LLDP) version.
Global Merge Capability	Used to override the default merge capability setting of all the interfaces for the current LSR.
Label Advertisement Mode	Used to set the label advertisement mode for an interface for the current LSR to either downstream-on-demand (label is sent only when requested) or downstream-unsolicited (label is sent unrequested).
Label Retention Mode	Used for all labels exchanged via the given interface.
Label Control Mode	LSR generates a local label for a FEC which the router learned from routing table independently from other LSRs.
Loop Detection	Used to enable loop detection on the current LSR.
Loop Detection Count	Indicates the loop detection hop count.
Request Retry	Enables the LSR to send a maximum of five label requests.
Propagate Release	Used to propagate the release of labels to downstream routers.
Hello Interval	Sets the interval for sending unicast hello packets to peers.
Targeted Hello Interval	Sets the interval for sending unicast hello packets to targeted peers.
Hold time	Sets the time-out value to peers.
Targeted Hold time	Sets the time-out value that is the time that the router waits before rejecting an adjacency with targeted peers.
Keepalive Interval	Used to set the interval for sending keep-alive messages to the peer in order to maintain a session.
Keepalive Timeout	Time-out value for rejecting a session with a peer.
Request retry Timeout	Used to set the interval between retries.
Targeted Hello Receipt	Status of the hello receipt.
Transport Address	The transport address is the address used for the TCP session over which LDP is running.
Transport Interface	Interface is used for the TCP session over which LDP is running.
Import BGP routes	Used to import BGP routes into LDP.

show ldp adjacency

Use this command to display all the adjacencies for the current LSR.

Command Syntax

```
show ldp adjacency
```

Parameter

None

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

The following is a sample output from the `show ldp adjacency` command displaying all the adjacencies for this LSR.

```
#show ldp adjacency
Remote-Address   Local-Address   Mode         Intf-Name  Holdtime   LDP-Identifier
11.11.11.11      12.0.1.20       Targeted     ge11       45         11.11.11.11:0
33.33.33.33      11.0.1.20       Targeted     ge9        45         33.33.33.33:0
44.44.44.44      20.0.1.20       Targeted     xe14       45         44.44.44.44:0
11.0.1.10        11.0.1.20       Interface    ge9        15         33.33.33.33:0
12.0.1.10        12.0.1.20       Interface    ge11       15         11.11.11.11:0
20.0.1.10        20.0.1.20       Interface    xe14       15         44.44.44.44:0
```

Table 2-3 explains the show command output fields.

Table 2-3: show ldp adjacency output fields details

Field	Description
Remote Address	IP address of the interface.
Local Address	Local address of the LDP adjacency.
Interface Name	Name of the interface.
Hold time	Sets the time-out value to peers.
LDP ID	LDP identifier for this protocol.

show ldp advertise-labels

Use this command to display the IP access list of LDP advertise-labels.

Command Syntax

```
show ldp advertise-labels
```

Parameter

None

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

The following is a sample output from the `show ldp advertise-labels` command.

```
#show ldp advertise-labels
Advertisement spec:
Prefix list = prefix1; Peer plist = peer1
Deny : Label Mapping = 1
Label Request = 0
```

Table 2-4 explains the show command output fields.

Table 2-4: show ldp advertise-labels output fields details

Field	Description
Advertisement spec	Details of the advertisement spec.
Prefix list	The label is advertised to all peers permitted by the peer plist..
Peer plist	The prefix list permits the prefix and there is a peer plist.

show ldp downstream

Use this command to display the status of all downstream sessions and the label information exchanged.

Command Syntax

```
show ldp downstream
```

Parameter

None

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

The following is an output from the `show ldp downstream` command showing the status of all downstream sessions.

```
#show ldp downstream
Session peer 1.1.1.1:
  FEC                           Nexthop Addr       State             Label
Req.ID   Attr
  20.0.0.0/24                    connected      Established       impl-null  0
  10.0.2.0/24                    connected      Established       impl-null  0
  1.1.1.1/32                      20.0.0.1      Established       impl-null  0
Session peer 3.3.3.3:
  FEC                           Nexthop Addr       State             Label
Req.ID   Attr
  60.0.0.0/24                    connected      Established           52481  0
  50.0.0.0/24                     30.0.0.2      Established       impl-null  0
  30.0.0.0/24                    connected      Established       impl-null  0
  10.0.2.0/24                    connected      Established       impl-null  0
  5.5.5.5/32                      30.0.0.2      Established           52480  0
  3.3.3.3/32                      30.0.0.2      Established       impl-null  0
Session peer 4.4.4.4:
  FEC                           Nexthop Addr       State             Label
Req.ID   Attr
  50.0.0.0/24                    connected      Established           52483  0
  40.0.0.0/24                    connected      Established       impl-null  0
  10.0.2.0/24                    connected      Established       impl-null  0
  5.5.5.5/32                      40.0.0.2      Established           52480  0
  60.0.0.0/24                     40.0.0.2      Established       impl-null  0
  4.4.4.4/32                      40.0.0.2      Established       impl-null  0
Session peer 1.1.1.1:
  FEC                           State              Label     Req.ID    Attr
  60.0.0.0/24                 Established            52486       0     None
  4.4.4.4/32                  Established            52484       0     None
  50.0.0.0/24                 Established            52483       0     None
  40.0.0.0/24                 Established        impl-null       0     None
  30.0.0.0/24                 Established        impl-null       0     None
  20.0.0.0/24                 Established        impl-null       0     None
```

```
     10.0.2.0/24              Established      impl-null       0     None
     5.5.5.5/32               Established          52482       0     None
     3.3.3.3/32               Established          52481       0     None
     2.2.2.2/32               Established      impl-null       0     None
   Session peer 3.3.3.3:
     FEC                        State              Label    Req.ID   Attr
     60.0.0.0/24              Established          52487       0     None
     4.4.4.4/32               Established          52485       0     None
     1.1.1.1/32               Established          52480       0     None
     40.0.0.0/24              Established      impl-null       0     None
     30.0.0.0/24              Established      impl-null       0     None
     20.0.0.0/24              Established      impl-null       0     None
     10.0.2.0/24              Established      impl-null       0     None
     2.2.2.2/32               Established      impl-null       0     None
   Session peer 4.4.4.4:
     FEC                        State              Label    Req.ID   Attr
     50.0.0.0/24              Established          52483       0     None
     40.0.0.0/24              Established      impl-null       0     None
     30.0.0.0/24              Established      impl-null       0     None
     20.0.0.0/24              Established      impl-null       0     None
     10.0.2.0/24              Established      impl-null       0     None
     3.3.3.3/32               Established          52481       0     None
     2.2.2.2/32               Established      impl-null       0     None
     1.1.1.1/32               Established          52480       0     None
```

Table 2-5 explains the show command output fields.

Table 2-5: show ldp downstream output fields details

Field	Description
Session peer	Used to group and apply the configuration of general session commands to groups of neighbors that share common session configuration elements.
FEC	Displays the Forward Equivalency Class (FEC) for this entry.
Nexthop addr	Displays the IP address of the next hop.
State	Displays the current status of the ldp.
Label	Details of the ldp downstream labels.
Req.ID	Request identifier for the protocol.
Attr	The attribute is used to sent to a customer router.

show ldp fec

Use the following command to display all FECs (Forwarding Equivalence Classes) known to this LSR.

Command Syntax

```
show ldp fec
show ldp fec (prefix)
show mpls ldp fec
show mpls ldp fec (prefix|)
```

Parameter

`prefix`	Display prefix FEC information.

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show ldp fec
LSR codes    : E/N - LSR is egress/non-egress for this FEC,
               L - LSR received a label for this FEC,
               > - LSR will use this route for the FEC
FEC                    Code    Session         Out Label       Nexthop Addr
1.1.1.1/32             NL>     1.1.1.1         impl-null       20.0.0.1
2.2.2.2/32             E >     non-existent    none            connected
3.3.3.3/32             NL>     3.3.3.3         impl-null       30.0.0.2
4.4.4.4/32             NL>     4.4.4.4         impl-null       40.0.0.2
5.5.5.5/32             NL>     4.4.4.4         impl-null       40.0.0.2
                       NL>     3.3.3.3         impl-null       30.0.0.2
20.0.0.0/24            NL      1.1.1.1         impl-null       invalid
                       E >     non-existent    none            connected
30.0.0.0/24            NL      3.3.3.3         impl-null       invalid
                       E >     non-existent    none            connected
40.0.0.0/24            NL      4.4.4.4         impl-null       invalid
                       E >     non-existent    none            connected
50.0.0.0/24            NL      4.4.4.4         impl-null       invalid
                       NL>     3.3.3.3         impl-null       30.0.0.2
60.0.0.0/24            NL>     4.4.4.4         impl-null       40.0.0.2
                       NL      3.3.3.3         impl-null       invalid
```

Table 2-6 shows the codes at the end of each route entry that indicate where the route originated.

Table 2-6: Origin Codes

Origin Code	Description	Comments
E/N	Egress/Non-egress	LSR is egress/non-egress for this FEC.
L	LSR	LSR received a label for this FEC.
>		LSR will use this route for the FEC.

Table 2-7 explains the show command output fields.

Table 2-7: show ldp fec output fields details

Field	Description
FEC	Displays the Forward Equivalency Class (FEC) for this entry.
Session	Reports the current session state.
Out Label	Label received from downstream neighbor for route.
Nexthop addr	Displays the IP address of the next hop.

show ldp igp sync

Use the following command to display the LDP synchronization status.

Command Syntax

```
show ldp igp sync
show mpls ldp igp sync
```

Parameter

None

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show ldp igp sync
eth1
LDP configured; LDP-IGP Synchronization enabled.
Sync status: sync achieved
Delay timer: Not Configured , Not Running
```

show ldp inter-area-fecs

Use this command to show all FECs using the LPM-based mapping procedure.

Command Syntax

```
show ldp inter-area-fecs
show ldp inter-area-fecs (ipv4|ipv6|) (count)
```

Parameter

ipv4	IPv4 FECs
ipv6	IPv6 FECs
count	Count of FECs

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS-SP version 4.0. and the command was updated in OcNOS-SP version 4.1.

Examples

```
#show ldp inter-area-fecs
LSR codes : E/N - LSR is egress/non-egress for this FEC,
L - LSR received a label for this FEC,
> - LSR will use this route for the FEC
Code FEC Session Out Label Nexthop Addr
Matching RIB prefix - 1.1.1.0
NL> 1.1.1.1/32 33.33.33.33 52485 11.11.11.1
NL> 1.1.1.2/32 33.33.33.33 52486 11.11.11.1

#show ldp inter-area-fecs count
------------------------
Num. IPv4 FEC(s) : 9
------------------------
------------------------
Num. IPv6 FEC(s) : 0
------------------------
------------------------
Total Num. FEC(s): 9
------------------------

#show ldp inter-area-fecs ipv4 count
------------------------
Num. IPv4 FEC(s) : 9
------------------------

#show ldp inter-area-fecs ipv6 count
```



```
------------------------
Num. IPv6 FEC(s) : 0
------------------------
```

show ldp inter-area-fecs prefix

Use this command to show all LDP inter-area FECs by prefix.

Use parameter count to show FEC count for each prefix.

Command Syntax

```
show ldp inter-area-fecs prefix (A.B.C.D/M|X:X::X:X/M) count
```

Parameter

A.B.C.D/M	IP prefix <network>/<length>, e.g., 35.0.0.0/8
X:X::X:X/M	IPv6 prefix <network>/<length>, e.g., 3ffe::/16
count	Count of FECs

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced in OcNOS-SP version 4.1.

Examples

```
#show ldp inter-area-fecs prefix 4.4.4.0/30
LSR codes     : E/N - LSR is egress/non-egress for this FEC,
                L - LSR received a label for this FEC,
                > - LSR will use this route for the FEC
FEC                    Code    Session        Out Label       ELC     Nexthop Addr
Matching RIB prefix - 4.4.4.0/30
4.4.4.1/32              NL>     1.1.1.1         24970           No      12.1.1.1
                        NL>     3.3.3.3         24329           No      23.1.1.2
4.4.4.2/32              NL>     1.1.1.1         24971           No      12.1.1.1
                        NL>     3.3.3.3         24330           No      23.1.1.2
4.4.4.3/32              NL>     1.1.1.1         24972           No      12.1.1.1
                        NL>     3.3.3.3         24331           No      23.1.1.2

#show ldp inter-area-fecs prefix 4.4.4.0/30 count
Matching RIB prefix - 4.4.4.0/30
------------------------
Num. IPv4 FEC(s): 3
------------------------

#show ldp inter-area-fecs prefix 3ffe::/16
LSR codes     : E/N - LSR is egress/non-egress for this FEC,
                L - LSR received a label for this FEC,
                > - LSR will use this route for the FEC
FEC                    Code    Session        Out Label       ELC     Nexthop Addr

#show ldp inter-area-fecs prefix 3ffe::/16 count
```


show ldp interface

Table 2-8: show ldp fec output fields details

Field	Description
FEC	Displays the Forward Equivalency Class (FEC) for this entry.
Session	Reports the current session state.
Out Label	Label received from downstream neighbor for route.
Nexthop addr	Displays the IP address of the next hop.

Use this command to display the list of all interfaces on the current LSR, and to indicate whether a given interface is label-switching or not.

Command Syntax

```
show ldp interface
show ldp interface IFNAME
```

Parameter

`IFNAME` Displays the name of the interface.

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

The following output displays a list of all interfaces on the LSR.

```
#show ldp interface
InterfaceLDP IdentifierLabel-switchingMerge Capability
eth010.10.0.11:0DisabledN/A
lo10.10.0.11:0DisabledN/A
eth110.10.0.11:0Enabled Merge capable
eth210.10.0.11:0Enabled Merge capable
vmnet1 10.10.0.11:0Disabled N/A
```

The following is a sample output from the `show ldp interface IFNAME` command displaying information about the specified interface `eth1`.

```
#show ldp interface eth1
Status                  : Enabled
Primary IP Address      : 192.168.3.4
Interface Type          : Ethernet
Label Merge Capability  : Merge Capable
Hello Interval          : 5
Targeted Hello Interval : 15
Hold Time               : 15
Targeted Hold Time      : 45
```

```
    Keepalive Interval       : 10
    Keepalive Timeout        : 30
    Advertisement Mode       : Downstream On Demand
    Label Retention Mode     : Liberal
    Administrative Groups    : myGroup
```

Table 2-9 explains the show command output fields.

Table 2-9: show ldp interface output fields details

Field	Description
Interface	Name of the interface.
LDP Identifier	LDP identifier for this protocol.
Label-switching	Status of the label-switching on interface..
Merge Capability	Used to override the default merge capability setting of all the interfaces.
Status	Status of the ldp interface.
Primary IP Address	Address of the primary Internet protocol in the interface.
Interface Type	Type of interface.
Label Merge Capability	Used to override the default merge capability setting of all the interfaces for the label.
Hello Interval	Sets the interval for sending unicast hello packets to peers.
Targeted Hello Interval	Sets the interval for sending unicast hello packets to targeted peers.
Hold time	Sets the time-out value to peers.
Targeted Hold time	Sets the time-out value that is the time that the router waits before rejecting an adjacency with targeted peers.
Keepalive Interval	Used to set the interval for sending keep-alive messages to the peer in order to maintain a session.
Keepalive Timeout	Time-out value for rejecting a session with a peer.
Label Advertisement Mode	Used to set the label advertisement mode for an interface for the current LSR to either downstream-on-demand (label is sent only when requested) or downstream-unsolicited (label is sent unrequested).
Label Retention Mode	Used for all labels exchanged via the given interface.
Administrative Groups	Administrative group to be used for links.

show ldp lsp

Use this command to display LDP LSP and, optionally, advertise-label information.

Command Syntax

```
show ldp lsp
show ldp lsp prefix detail
show ldp lsp (prefix|detail)
```

Parameter

`prefix`	Displays advertise-label information in addition to LDP LSP information.
`detail`	Displays advertise-label information in addition to LDP LSP information.

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

The following is a sample output from the `show ldp lsp prefix detail` command displaying LDP LSP prefix information with advertise-label information.

```
#show ldp lsp prefix detail
Advertisement spec:
    Prefix acl = pfx1; Peer acl = pfx1
    Prevent the distribution of any assigned labels

FEC IPV4:1.1.1.0/30 -> 0.0.0.0
  Downstream state: Established Label: impl-null RequestID: 0 Peer: 
50.50.50.50
Attr:
  Advert acl(s): Prevent the distribution of any assigned labels
FEC IPV4:3.3.3.0/30 -> 0.0.0.0
  Advert acl(s): Prevent the distribution of any assigned labels
FEC IPV4:10.30.0.0/24 -> 0.0.0.0
  Downstream state: Established Label: impl-null RequestID: 0 Peer: 
50.50.50.50
Attr:
  Advert acl(s): Prevent the distribution of any assigned labels
FEC IPV4:50.50.50.50/32 -> 1.1.1.1
  Advert acl(s): Prefix acl = pfx1; Peer acl = pfx1
FEC IPV4:55.55.55.55/32 -> 3.3.3.2
  Advert acl(s): Prevent the distribution of any assigned labels
FEC IPV4:169.254.0.0/16 -> 0.0.0.0
  Downstream state: Established Label: impl-null RequestID: 0 Peer: 
50.50.50.50
Attr:
  Advert acl(s): Prevent the distribution of any assigned labels
```

Table 2-10 explains the show command output fields.

Table 2-10: show ldp lsp output fields details

Field	Description
Advertisement spec	Details of the advertisement spec.
Prefix acl	The label is advertised to all peers permitted by the peer acl.
Peer acl	The prefix acl permits the prefix and there is a peer acl.
Downstream state	Details of the downstream state.
Established Label	LSP established by the Downstream on Demand method of label distribution.
Req.ID	Request identifier for the protocol.
Peer	Details of the peer.
Attr	The attribute is used to sent packets to a customer router.

show ldp mpls-l2-circuit

Use this command to display summarized Layer-2 Virtual Circuit information about all MPLS virtual circuits configured on the current LSR. When the Virtual Circuit ID is specified, this command displays summarized information for the Virtual Circuit matching the specified ID only.

Command Syntax

```
show ldp mpls-l2-circuit
show ldp mpls-l2-circuit <1-4294967295>
show ldp mpls-l2-circuit detail
show ldp mpls-l2-circuit count
show ldp mpls-l2-circuit <1-4294967295> detail
```

Parameter

`<1-4294967295>`	Indicates the virtual circuit ID.
`detail`	Displays detailed LDP information.
`count`	Count of PWs from LDP standpoint.

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

The following is a sample output of this command displaying summarized information of VID 1000:

```
#show ldp mpls-l2-circuit 1000
Transport Client     VC     Trans    Local       Remote      Destination
VC ID     Binding    State  Type     VC Label    VC Label    Address
1000      eth2       UP     ethernet 640         640         192.168.0.80

#show ldp mpls-l2-circuit
Transport Client     VC     Trans    Local       Remote      Destination
VC ID     Binding    State  Type     VC Label    VC Label    Address
1000      eth2       UP     ethernet 640         640         192.168.0.80
2000      eth3       UP     ethernet 641         648         192.168.0.80
3000      eth4       UP     ethernet 642         645         192.168.0.90
```

The following is a sample output of this command when using the `detail` parameter:

```
#show ldp mpls-l2-circuit detail
vcid: 100, type: ethernet, local groupid: 4, remote groupid: 4 (vc is up)
destination: 10.0.0.2, Peer LDP Ident: 10.0.0.2
Local label: 53120, remote label: 53120
Access IF: eth3, Network IF: eth4
Local MTU: 1500, Remote MTU: 1500
Local Control Word: 0, Remote Control Word: 0
Local PW Status Capability : enabled
```

```
Remote PW Status Capability : enabled
Current PW Status TLV : enabled
Local PW Status :
Not Forwarding
Remote PW Status :
Not Forwarding
Standby
```

Table 2-11 explains the show command output fields.

Table 2-11: show ldp mpls-l2-circuit output fields details

Field	Description
Transport VC ID	Transport VC identifier for the protocol.
Client Binding	Show whether the interface is client bound and (if bound) with which client.
VC State	State of the VC.
Trans Type	Type of transmit.
Local VC Label	Incoming VC label details.
Remote VC Label	Outgoing VC label details.
Destination Address	Destination IP address for the protocol.
VCid	Address for the VC.
Type	Type of Ethernet interface.
local groupid	Address for the local group.
remote groupid	Address for the remote group.
destination	Destination IP address.
Peer LDP Ident	Identification for the peer LDP.
Local label	Number of Local label
remote label	Number remote label.
Access IF	Map the access port.
Network IF	Map the network port in the interface.
Local MTU	Number of local MTU., Remote MTU - Number of local MTU.
Local Control Word	Number of local control word.
Remote Control Word	Number of local control word.
Local PW Status Capability	PW Status capability of Local end of PW.

Table 2-11: show ldp mpls-l2-circuit output fields details (Continued)

Field	Description
Remote PW Status Capability	PW Status capability of Remote end of PW.
Current PW Status TLV	A data structure used to encode optional information in a data communications protocol.
Local PW Status	PW Status of Local end of PW.
Remote PW Status	PW Status of Remote end of PW.

show ldp routes

Use this command to display LDP routes.

Command Syntax

```
show ldp routes
```

Parameter

None

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show ldp routes
Prefix: 0.0.0.0/0   Nexthop: 10.0.2.2   IFINDEX: 2
Prefix: 1.1.1.1/32   Nexthop: 20.0.0.1   IFINDEX: 3
Prefix: 2.2.2.2/32   Nexthop: 0.0.0.0   IFINDEX: 1
Prefix: 3.3.3.3/32   Nexthop: 30.0.0.2   IFINDEX: 4
Prefix: 4.4.4.4/32   Nexthop: 40.0.0.2   IFINDEX: 5
Prefix: 5.5.5.5/32   Nexthop: 30.0.0.2   IFINDEX: 4
                     Nexthop: 40.0.0.2   IFINDEX: 5
Prefix: 20.0.0.0/24   Nexthop: 0.0.0.0   IFINDEX: 3
Prefix: 30.0.0.0/24   Nexthop: 0.0.0.0   IFINDEX: 4
Prefix: 40.0.0.0/24   Nexthop: 0.0.0.0   IFINDEX: 5
Prefix: 50.0.0.0/24   Nexthop: 30.0.0.2   IFINDEX: 4
Prefix: 60.0.0.0/24   Nexthop: 40.0.0.2   IFINDEX: 5
```

Table 2-12 explains the show command output fields.

Table 2-12: show ldp routes output fields details

Field	Description
Prefix	Details of the network address prefix.
Nexthop	Displays the IP address of the next hop.
IFINDEX	Displays an interface index.

show ldp session

Use this command to display sessions established between this LSR and other LSRs.

Command Syntax

```
show ldp session
show ldp session A.B.C.D
show ldp session X:X::X:X
show mpls ldp session
show mpls ldp session A.B.C.D
show mpls ldp session X:X::X:X
```

Parameter

`A.B.C.D`	IPv4 address of the peer.
`X:X::X:X`	IPv6 address of the peer.

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show ldp session 192.168.3.5
Session state          : OPERATIONAL
Session role           : Passive
TCP Connection         : Established
IP Address for TCP     : 192.168.3.5
Interface being used   : eth1
Peer LDP ID            : 10.10.0.18:0
Peer Password : mypwd
Authentication type: MD5
Adjacencies            : 192.168.3.5
                         192.168.4.5
Advertisement mode     : Downstream Unsolicited
Label retention mode   : Liberal
Graceful Restart               : Capable
Reconnect Timeout              : 120
Recovery Timeout (max)         : 120
Recovery Timeout [negotiated] : 0 [120]
Keepalive Timeout      : 30
Reconnect Interval     : 15
Address List received : 192.168.3.5
                         192.168.4.5
Received Labels :FecLabelMaps To
IPV4:10.10.0.0/24   impl-null none
IPV4:192.168.3.0/24 impl-null none
IPV4:192.168.4.0/24 impl-null none
IPV4:192.168.5.0/24 impl-null none
```

```
Sent Labels :FecLabelMaps To
IPV4:10.10.0.0/24   impl-null none
IPV4:192.168.3.0/24 impl-null none
IPV4:192.168.4.0/24 impl-null  none
```

Table 2-13 explains the show command output fields.

Table 2-13: show ldp session output fields details

Field	Description
Session state	Reports the current session state.
Session role	Displays the status of the session role.
TCP Connection	Details of the TCP connection.
IP Address for TCP	Transmission control protocol IP address for the network.
Interface	Name of interface used in the network.
Peer LDP ID	Identifier for the peer LDP.
Peer Password	Credential details for the neighbor.
Authentication type	Type of authentication.
Adjacencies	IP address for the neighbor adjacencies.
Advertisement mode	Details of the advertisement mode.
Label retention mode	Details of the label retention mode.
Graceful Restart	Indicates if the peer session is “Capable” or “Not Capable”.
Reconnect Timeout	The amount of time the router keeps the labels until session re-connection, the value is the lower value between local and remote neighbor-liveness timer. It appears when the session is GR capable.
Recovery Timeout (max)	Indicates the amount of time for the recovery session to send the initialization message to the peer, according to the local max-recovery timer. It appears when the session is GR capable.
Recovery Timeout [negotiated]	Indicates the actual timer value and the initial amount of time to recovery session (between brackets) that is negotiated with the peer to the lower value between local and remote values. Negotiated value 0 indicates the labels are not preserved after session disconnection. It appears when the session is GR capable.
Keepalive Interval	Used to set the interval for sending keep-alive messages to the peer in order to maintain a session.
Keepalive Timeout	Time-out value for rejecting a session with a peer.
Address List received	List of address that is received from neighbor.
Received Labels	Number of labels received from neighbor session.
Sent Labels	Number of labels transmitted to neighbor session.

show ldp statistics

Use this command to display LDP statistics.

Command Syntax

```
show ldp statistics
```

Parameter

None

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

The following is a sample output from the `show ldp statistics` command.

```
#show ldp statistics

=======================================================
 LSR ID = 0.0.0.0:0 : TARGETED PEER: 10.10.10.10
=======================================================
  PacketType                     Total
                            Sent        Received
  Notification                0            0
  Hello                       0            0
  Initialization              0            0
  Keepalive                   0            0
  Address                     0            0
  Address Withdraw            0            0
  Label Mapping               0            0
  Label Request               0            0
  Label Withdraw              0            0
  Label Release               0            0
  Request Abort               0            0
=======================================================
#
```

Table 2-14 explains the show command output fields.

Table 2-14: show ldp statistics output fields details

Field	Description
LSR ID	Identifier of the LSR.
Targeted Peer	Targeted LDP neighbor can improve the label convergence time compared to the convergence time with directly connected LDP peers when there are flapping links.

Table 2-14: show ldp statistics output fields details (Continued)

Field	Description
Packet Type	Type of packet in the interface that has been received or transmitted to the neighbors.
Total	Number of total packets that has been received and transmitted.

show ldp statistics advertise-labels

Use this command to display the count per each operation filtered by an advertisement list.

Command Syntax

```
show ldp statistics advertise-labels
```

Parameter

None

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

The following is a sample output from the `show ldp statistics advertise-labels` command.

```
#show ldp statistics advertise-labels
Advertisement spec:
    Prefix acl = pfx1; Peer acl = pfx1
      Deny : Label Mapping = 2
             Label Request = 0
    Prevent the distribution of any assigned labels
      Deny : Label Mapping = 9
             Label Request = 3
#
```

Table 2-15 explains the show command output fields.

Table 2-15: show ldp statistics advertise-labels output fields details

Field	Description
Advertisement spec	Details of the advertisement spec.
Prefix acl	It is an ordered list and entries are evaluated in order of increasing sequence number.
Peer acl	The peer keyword enables the device to receive time requests and used to synchronize itself to the servers specified in the access list.
Label Mapping	Number of label mapping that is denied.
Label Request	Number of label request that is denied.

show ldp targeted-peers

Use this command to display the list of targeted peers configured on the current LSR.

Command Syntax

```
show ldp targeted-peers
```

Parameter

None

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

The following is a sample output from the `show ldp targeted-peers` command.

```
#show ldp targeted-peers
IP Address          Interface

192.168.201.2       eth1
```

Table 2-16 explains the show command output fields.

Table 2-16: show ldp targeted-peers output fields details

Field	Description
IP Address	Internet protocol address for the interface.
Interface	Name of the interface.

show ldp upstream

Use this command to display the status of all upstream sessions and label information exchanged.

Command Syntax

```
show ldp upstream
```

Parameter

None

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

The following is a sample output of the `show ldp upstream` command showing the status of all upstream sessions.

```
#show ldp upstream
Session peer 1.1.1.1:
  FEC                         State              Label     Req.ID    Attr
  60.0.0.0/24               Established          52486       0       None
  4.4.4.4/32                Established          52484       0       None
  50.0.0.0/24               Established          52483       0       None
  40.0.0.0/24               Established      impl-null       0       None
  30.0.0.0/24               Established      impl-null       0       None
  20.0.0.0/24               Established      impl-null       0       None
  10.0.2.0/24               Established      impl-null       0       None
  5.5.5.5/32                Established          52482       0       None
  3.3.3.3/32                Established          52481       0       None
  2.2.2.2/32                Established      impl-null       0       None
Session peer 3.3.3.3:
  FEC                         State              Label     Req.ID    Attr
  60.0.0.0/24               Established          52487       0       None
  4.4.4.4/32                Established          52485       0       None
  1.1.1.1/32                Established          52480       0       None
  40.0.0.0/24               Established      impl-null       0       None
  30.0.0.0/24               Established      impl-null       0       None
  20.0.0.0/24               Established      impl-null       0       None
  10.0.2.0/24               Established      impl-null       0       None
  2.2.2.2/32                Established      impl-null       0       None
Session peer 4.4.4.4:
  FEC                         State              Label     Req.ID    Attr
  50.0.0.0/24               Established          52483       0       None
  40.0.0.0/24               Established      impl-null       0       None
  30.0.0.0/24               Established      impl-null       0       None
  20.0.0.0/24               Established      impl-null       0       None
  10.0.2.0/24               Established      impl-null       0       None
  3.3.3.3/32                Established          52481       0       None
  2.2.2.2/32                Established      impl-null       0       None
  1.1.1.1/32                Established          52480       0       None
```

Table 2-17 explains the show command output fields.

Table 2-17: show ldp upstream output fields details

Field	Description
Session peer	Details of the session peers.
FEC	Displays the Forward Equivalency Class (FEC) for this entry.
State	Reports the current session state.
Label	Number of Label received from upstream neighbor for route.
Req.ID	Requested session identifier for the protocol.
Attr	The attribute is used to sent packets to a customer router.

show ldp vpls

Use this command to display information about all VPLS instances. Specify the VPLS ID to display information about a specific VPLS instance.

Command Syntax

```
show ldp vpls <1-4294967295> (count|)

show ldp vpls count

show ldp vpls detail

show ldp vpls (no-vc|)
```

Parameter

`<1-4294967295>`	Display the VPLS identifier.
`count`	Display VPLS count from LDP standpoint.
`detail`	Display detailed LDP VPLS information.
`no-vc`	Specify not display L2VC information.

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

The following is a sample output of the `show ldp vpls` command displaying information about all VPLS instances.

```
#show ldp vpls
VPLS-ID      Peer Address      State  Type       Label-Sent   Label-Rcvd
1            192.168.0.80      Up     vpls       16           640
1            192.168.0.90      Up     vpls       18           642
2            192.168.0.80      Up     vpls       19           641
2            192.168.0.90      Up     vpls       17           643
```

The following is an output of the `show ldp vpls detail` command:

```
#show ldp vpls detail
 VPLS Identifier    : 1
 Peer IP            : 192.168.0.80
 VC State           : UP
 VC Type            : vpls
 VC Label Sent      : 16
 VC Label Received  : 640

 VPLS Identifier    : 1
 Peer IP            : 192.168.0.90
 VC State           : UP
 VC Type            : vpls
 VC Label Sent      : 18
 VC Label Received  : 642
```

```
VPLS Identifier     : 2
Peer IP             : 192.168.0.80
VC State            : UP
VC Type             : vpls
VC Label Sent       : 19
VC Label Received   : 641
```

The following is a sample output of `show ldp vpls count` displaying information about total, active and inactive VPLS instances from LDP.

```
#show ldp vpls count
-------------------------------
Total VPLS instances    : 2
Active VPLS instances   : 2
Inactive VPLS instances : 0
-------------------------------
```

Table 2-18 explains the show command output fields.

Table 2-18: show ldp vpls output fields details

Field	Description
VPLS-ID	Identification details of the VPLS.
Peer Addr	IP address of the peer device.
State	Reports the current session state.
Type	Type of protocol in network.
Label-Sent	Number of packets transmitted to neighbor.
Label-Rcvd	Number of packets received from neighbor.
Total VPLS instances	Number of total VPLS instance in the protocol.
Active VPLS instances	Number of active VPLS instance.
Inactive VPLS instances	Number of inactive VPLS instance.

show mpls ldp discovery

Use this command to display the sources for locally generated LDP Discovery Hello PDUs, and to indicate whether an interface is label-switching.

Command Syntax

```
show mpls ldp discovery
show mpls ldp discovery IFNAME
```

Parameter

IFNAME	Interface name.

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show mpls ldp discovery
InterfaceLDP IdentifierLabel-switchingMerge Capability
eth010.10.0.11:0DisabledN/A
lo10.10.0.11:0DisabledN/A
eth110.10.0.11:0Enabled Merge capable
eth210.10.0.11:0Enabled Merge capable
vmnet110.10.0.11:0  Disabled N/A
```

Table 2-19 explains the show command output fields.

Table 2-19: show ldp discovery output fields details

Field	Description
Interface	Name of the interface.
LDP Identifier	LDP identifier for this protocol.
Label-switching	Status of the label-switching on interface.
Merge Capability	Used to override the default merge capability setting of all the interfaces.

show mpls ldp neighbor

Use this command to display LDP neighbor information.

Command Syntax

```
show mpls ldp neighbor
show mpls ldp neighbor detail
```

Parameter

`detail`	Details for adjacencies.

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show mpls ldp neighbor detail
IP AddressInterface NameHoldtimeLDP ID
192.168.3.5eth11510.10.0.18:0
192.168.4.5eth21510.10.0.18:0
```

Table 2-20 explains the show command output fields.

Table 2-20: show mpls ldp neighbor output fields

Field	Description
IP Address	Address of the interface.
Interface Name	Name of the interface.
Holdtime	The amount of time this device waits between SPFs.
LDP ID	Local label space ID. The first four bytes of an LDP ID is a platform IP address called the LDP router ID. The last two bytes are called the local label space ID.

show mpls ldp parameter

Use this command to display LDP configuration parameters.

Command Syntax

```
show mpls ldp parameter
```

Parameter

None

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show mpls ldp parameter
Router ID                    : 0.0.0.0
LDP Version                  : 1
Global Merge Capability      : Merge Capable
Label Advertisement Mode     : Downstream Unsolicited
Label Retention Mode         : Liberal
Label Control Mode           : Independent
Instance Loop Detection      : Off
Request Retry                : Off
Propagate Release            : Disabled
Graceful Restart             : Disabled
Hello Interval               : 5
Targeted Hello Interval      : 15
Hold time                    : 15
Targeted Hold time           : 45
Keepalive Interval           : 10
Keepalive Timeout            : 30
Request retry Timeout        : 5
Transport Address data       :
  Labelspace 0               : 192.168.201.2 (not in use)
Import BGP routes            : No
```

Table 2-21 explains the show command output fields.

Table 2-21: show mpls ldp parameters output fields

Field	Description
Router ID	A preferred interface address for LDP router.
LDP Version	Latest LDP version details.

Table 2-21: show mpls ldp parameters output fields

Field	Description
Global Merge Capability	Override the default merge capability setting of all the interfaces.
Label Advertisement mode	Label advertisement mode details in the interface.
Label retention mode	Label retention mode details in the interface.
Label Control Mode	Controls the mode used for handling label binding requests on interfaces.
Instance Loop Detection	Disables the LDP optional loop detection mechanism.
Request Retry	Request causes the target peer to respond with targeted Hello messages.
Propagate Release	Propagate release is disabled in the interface.
Graceful Restart	Graceful Restart (GR) is a mechanisms to prevent routing protocol re-convergence during a processor switchover. Hello Interval - Hello interval sets the interval for sending unicast hello packets to peers.
Targeted Hello Interval	Targeted hello interval sets the interval for sending unicast hello packets to targeted peers.
Hold time	Hold time sets the time-out value to peers.
Targeted Hold time	Time-out value is the time that the router waits before rejecting an adjacency with targeted peers.
Keepalive Interval	Keepalive interval sets the interval for sending keep-alive messages to the peer in order to maintain a session.
Keepalive Timeout	Time-out value for rejecting a session with a peer.
Request retry Timeout	Request for the maximum retry duration (the number of retries times the length of the timeout).
Transport Address data	Transport address advertised in LDP Discovery Hello messages sent on an interface.
Label space	Label used in a label binding is allocated from a set of possible labels called a label space.
Import BGP routes	The BGP Support for IP Prefix Import from Global Table into a VRF Table feature introduces the capability to import IPv4 unicast prefixes from the global routing table into a Virtual Private Network (VPN) routing/forwarding (VRF) instance table using an import route map.

RSVP-TE Command Reference

CHAPTER 1 RSVP-TE Commands

This chapter describes the RSVP-TE commands.

- A.B.C.D
- clear rsvp session
- clear rsvp trunk
- cspf
- debug rsvp all
- debug rsvp cspf
- debug rsvp events
- debug rsvp fsm
- debug rsvp hexdump
- debug rsvp nsm
- debug rsvp packet
- description (rsvp-bypass)
- description (rsvp-path)
- description (rsvp-trunk)
- disable-rsvp
- enable-rsvp
- entropy-label-capability
- explicit-null
- ext-tunnel-id A.B.C.D
- from A.B.C.D
- graceful-restart
- graceful-restart recovery-time
- graceful-restart restart-time
- hello-interval
- hello-receipt
- hello-timeout
- keep-multiplier
- loop-detection
- lsp-metric
- lsp-reoptimization-timer
- map-route A.B.C.D

- router rsvp
- rsvp hello-interval
- rsvp hello-receipt
- rsvp hello-timeout
- rsvp keep-multiplier
- rsvp refresh-time
- rsvp-path
- rsvp-trunk
- rsvp-trunk force-reoptimize
- rsvp-trunk force-switchover-secondary
- rsvp-trunk-restart
- secondary ADMIN-GROUP-NAME
- secondary bandwidth
- secondary cspf
- secondary cspf-retry-limit
- secondary cspf-retry-timer
- secondary filter
- secondary hold-priority
- secondary hop-limit
- secondary label-record
- secondary local-protection
- no secondary affinity
- no secondary cspf
- no secondary record
- secondary path
- secondary-priority path
- secondary-priority hold-priority
- secondary-priority setup-priority
- secondary-priority label-record
- secondary-priority hop-limit
- secondary-priority bandwidth
- secondary record
- secondary retry-limit
- secondary retry-timer
- secondary reuse-route-record
- secondary setup-priority

A.B.C.D

Use this command to configure an explicit IPv4 route sub-object as either loose or strict. A list of sub-objects specifies an explicit route to the egress router for an LSP.

- For the strict type of route addresses, the route taken from the previous router to the current router must be a directly connected path and a message exchanged between the two routers should not pass any intermediate routers. This ensures that routing is enforced on the basis of each link.
- For the loose type of route addresses, the route taken form the previous router to the current router need not be a direct path and a message exchanged between the two routers can pass other routers.

Use the `no` parameter with this command to disable the configuration.

Command Syntax

```
A.B.C.D
A.B.C.D (loose|strict)
no A.B.C.D
no A.B.C.D (loose|strict)
```

Parameters

`loose`	Make this node loose
`strict`	Make this node strict

Default

By default, A.B.C.D is disabled

Command Mode

Path mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-path mypath
(config-path)#10.10.0.5 strict
```

clear rsvp session

Use this command to reset either all or specified sessions originating from a specific ingress and terminating on the specific egress.

Note: If the affected session originates from the router where the command is issued, it is stopped and started. If the affected session does not originate from the router where the command is issued, it is stopped and deleted.

Command Syntax

```
clear rsvp session TUNNEL-ID LSP-ID INGRESS EGRESS
```

Parameters

TUNNELID	Clear tunnel ID sessions
LSP-ID	Clear LSP ID sessions
INGRESS	Clear ingress sessions
EGRESS	Clear egress sessions

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#clear rsvp session 1 1 1.2.3.4 192.168.1.1
```


clear rsvp trunk

Use this command to clear an RSVP trunk or to clear all RSVP trunks.

Clearing a trunk also kills any session associated with the trunk. This command is useful when a trunk is missing required data such as routing information. When data is missing, the trunk is in an incomplete state, and clearing it correctly re-initializes the session.

Note: If this command is given in the session on the ingress router, the session stops and restarts. If this command is given in the session on the egress router, the session is not cleared.

Command Syntax

Note: Use the following commands to clear standard RSVP Trunks:

```
clear rsvp trunk *
clear rsvp trunk ingress (TRUNKNAME|*)
clear rsvp trunk non-ingress (TRUNKNAME|*)
clear rsvp trunk (TRUNKNAME|*)
clear rsvp trunk (TRUNKNAME|*) primary
clear rsvp trunk (TRUNKNAME|*) secondary
```

Parameters

`*`	Clear all RSVP trunks configured
`TRUNKNAME`	Name of a specific trunk to be cleared
`ingress`	Clear an RSVP ingress trunk
`non-ingress`	Clear an RSVP non-Ingress trunk
`primary`	Clear all primary sessions configured for this trunk
`secondary`	Clear all secondary sessions configured for this trunk

Command Mode

Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#clear rsvp trunk mytrunk
#clear rsvp trunk *
#clear rsvp trunk ingress mytrunk
#clear rsvp trunk ingress *
#clear rsvp trunk non-ingress mytrunk
#clear rsvp trunk non-ingress *
#clear rsvp trunk mytrunk primary
#clear rsvp trunk * primary
#clear rsvp trunk mytrunk secondary
#clear rsvp trunk * secondary
```

cspf

Use this command to enable the use of Constrained Shortest Path First (CSPF) server for all RSVP sessions. If CSPF is turned off globally, it cannot be enabled for any LSP.

The CSPF server computes paths for LSPs that are subject to various constraints such as bandwidth, hop count, administrative groups, priority, and explicit routes. When computing paths for LSPs, CSPF considers not only the topology of the network and the attributes defined for the LSP but also the links. It attempts to minimize congestion by intelligently balancing the network load.

Use the no cspf command to disable this configuration.

Note: CSPF server information is not signaled across session and hence sessions in transit and egress nodes will not be aware of the CSPF server. So, in multi CSPF scenarios, neighbor down event from a CSPF server restart all sessions irrespective of which CSPF server sessions were using.

Command Syntax

```
cspf
```

Parameters

None

Default

By default, CSPF server is enabled

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

This example shows using the `no cspf` command in Router mode to disable CSPF for all RSVP sessions.

```
#configure terminal
(config)#router rsvp
(config-router)#cspf
```


debug rsvp all

Use this command to enable all debugging options for an RSVP daemon.

Use the `no` parameter with this command to stop logging all debugging information.

Command Syntax

```
debug rsvp (all|)
no debug rsvp (all|)
```

Parameters

None

Command Mode

Privileged Exec mode and Configure mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#debug rsvp all
```

debug rsvp cspf

Use this command to enable the exchange of debugging messages between the RSVP module and the CSPF module.

Use the `no` parameter with this command to stop logging CSPF debugging information.

Command Syntax

```
debug rsvp cspf
no debug rsvp cspf
```

Parameters

None

Command Mode

Privileged Exec mode and Configure mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#debug rsvp cspf
```


debug rsvp events

Use this command to enable debugging of events that were generated from an RSVP daemon.

Use the `no` parameter with this command to stop logging RSVP debugging information.

Command Syntax

```
debug rsvp events
no debug rsvp events
```

Parameters

None

Command Mode

Privileged Exec and Configure modes

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#debug rsvp events
```

debug rsvp fsm

Use these commands to enable debugging of events related to RSVP finite state machines (FSM). Commands are available to log debugging information for the egress FSM, the ingress FSM, the transit FSM, the transit upstream FSM, or the transit downstream FSM.

Use the `no` parameter with these commands to stop logging FSM debugging information.

Command Syntax

```
debug rsvp fsm
debug rsvp fsm egress
debug rsvp fsm ingress
debug rsvp fsm transit
debug rsvp fsm transit upstream
debug rsvp fsm transit downstream
no debug rsvp fsm
no debug rsvp fsm egress
no debug rsvp fsm ingress
no debug rsvp fsm transit
no debug rsvp fsm transit upstream
no debug rsvp fsm transit downstream
```

Parameters

None

Command Mode

Privileged Exec and Configure modes

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
(config)#debug rsvp fsm transit upstream
```

debug rsvp hexdump

Use this command to enable the hexdump debugging option for an RSVP daemon.

Use the `no` parameter with this command to stop logging hexdump debugging information.

Command Syntax

```
debug rsvp hexdump
no debug rsvp hexdump
```

Parameters

None

Command Mode

Privileged Exec and Configure modes

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#debug rsvp hexdump
```

debug rsvp nsm

Use this command to enable the NSM debugging option for an RSVP daemon.

Use the `no` parameter with this command to stop logging NSM debugging information.

Command Syntax

```
debug rsvp nsm
no debug rsvp nsm
```

Parameters

None

Command Mode

Privileged Exec and Configure modes

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#debug rsvp nsm
```


debug rsvp packet

Use this command to enable packet debugging options for an RSVP daemon. Using the `in` option command enables debugging for incoming packets. Using the `out` option command enables debugging for outgoing packets.

Use the `no` parameter with these commands to stop logging debugging information.

Command Syntax

```
debug rsvp packet
debug rsvp packet in
debug rsvp packet out
no debug rsvp packet
no debug rsvp packet in
no debug rsvp packet out
```

Parameters

None

Command Mode

Privileged Exec and Configure modes

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#debug rsvp packet in
#debug rsvp packet out
```


description (rsvp-bypass)

Use this command to add a description to the rsvp-bypass or update an existing description.

Use the `no` parameter with this command to disable the configuration.

Command Syntax

```
description LINE
no description
```

Parameters

`LINE`	Line describing the RSVP tunnel

Default

By default, rsvp bypass description is empty.

Command Mode

Rsvp-bypass mode

Applicability

This command was introduced in OcNOS version 6.4.1.

Examples

```
#configure terminal
(config)#rsvp-bypass bp1
(config-bypass)#description this_is_the_description
(config-bypass)#no description
```


description (rsvp-path)

Use this command to add a description to the rsvp-path or update an existing description.

Use the `no` parameter with this command to disable the configuration.

Command Syntax

```
description LINE
no description
```

Parameters

`LINE`	Line describing the RSVP path

Default

By default, rsvp path description is empty.

Command Mode

Rsvp-path mode

Applicability

This command was introduced in OcNOS version 6.4.1.

Examples

```
#configure terminal
(config)#rsvp-path mypath
(config-path)#description this_is_the_description
(config-path)#no description
```

description (rsvp-trunk)

Use this command to add a description to the rsvp-trunk or update an existing description.

Use the `no` parameter with this command to disable the configuration.

Command Syntax

```
description LINE
no description
```

Parameters

LINE	Line describing the RSVP tunnel

Default

By default, rsvp trunk description is empty.

Command Mode

Rsvp-trunk mode.

Applicability

This command was introduced in OcNOS version 6.4.1.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#description this_is_the_description
(config-trunk)#no description
```


disable-rsvp

Use this command to disable RSVP message exchange on an interface.

RSVP can be enabled using the enable-rsvp command.

Command Syntax

```
disable-rsvp
```

Parameters

None

Default

By default, RSVP message exchange is disabled on an interface.

Command Mode

Interface mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#interface eth0
(config-if)#disable-rsvp
```

enable-rsvp

Use this command to enable RSVP message exchange on an interface.

Note: To use this command, the corresponding interface needs to be enabled for label-switching using the label-switching command.

See disable-rsvp to undo the effects of this command.

Command Syntax

```
enable-rsvp
```

Parameters

None

Default

By default, RSVP message exchange is disabled.

Command Mode

Interface mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#interface eth1
(config-if)#enable-rsvp
```

entropy-label-capability

Use this command to share the load across multiple members of a LAG port in the core of an MPLS network by using entropy labels.

Use the `no` form of the command to disable the use of entropy labels

Note: Load balancing is enabled by default for all the parameters. If you enable load balancing manually, then all the parameters enabled by default are reset and you need to enable the parameters based on which traffic should be load balanced.

Command Syntax

```
entropy-label-capability
no entropy-label-capability
```

Parameters

None

Default

By default, entropy labels are not used.

Command Mode

Router mode

Applicability

This command was introduced before OcNOS-SP version 1.0.

Examples

```
#configure terminal
(config)router rsvp
(config-router)#entropy-label-capability
```

explicit-null

Use this command to send explicit-null labels to upstream router, instead of implicit-null labels.

If php is enabled then implicit-null label is advertised, then the penultimate hop removes the label and sends the packet as a plain IP packet to the egress router. The explicit-null command advertises label 0 and retains the label so the egress router can pop it. For details about usage of explicit-null, please refer to *RFC 3032*.

Use the `no` parameter with this command to stop sending explicit-null labels for directly-connected FECs to upstream router and resume sending non reserved labels.

Command Syntax

```
explicit-null

no explicit-null
```

Parameters

None

Default

By default, no-php is enabled.

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#router rsvp
(config-router)#explicit-null
```


ext-tunnel-id A.B.C.D

Use this command to configure an extended-tunnel identifier as an IPv4 address. These identifiers are used in RSVP messages. If no extended-tunnel ID is specified, the LSR-ID for the router is used as the extended-tunnel ID for all LSPs. The extended-tunnel ID is a simple way of identifying all LSPs belonging to the same trunk.

Use the `no` parameter with this command to remove a configured extended-tunnel ID.

Command Syntax

```
ext-tunnel-id A.B.C.D
no ext-tunnel-id
no ext-tunnel-id
```

Parameters

`A.B.C.D`	Extended tunnel identifier for this trunk in IPv4 address format

Default

By default, the LSR-ID of the router is used as the extended-tunnel ID for all sessions.

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk t1
(config-trunk)#ext-tunnel-id 10.10.10.30

(config)#rsvp-trunk t1
(config-trunk)#no ext-tunnel-id
```

from A.B.C.D

Use this command to specify a “from” IPv4 address for the RSVP daemon. This command can be invoked from either the router rsvp mode or from the rsvp-trunk mode. In the RSVP router mode, this command defines the source address as an IPv4 packet sent out by the RSVP daemon. In the RSVP trunk mode, this command indicates a sender’s address in the sender template object that is used in path messages.

Use the `no` parameter with this command to revert to the default settings.

Command Syntax

```
from A.B.C.D
no from
```

Parameters

`A.B.C.D`	When in trunk mode, this is the IPv4 address of a tunnel ingress node
`A.B.C.D`	When in router mode, this is the loopback IPv4 address

Default

By default, from A.B.C.D is enabled

Command Mode

Router or Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#from 10.10.0.5

#configure terminal
(config)#router rsvp
(config-router)#from 10.10.0.5
```


graceful-restart

Use this command to enable RSVP-TE Graceful Restart capability on a router. This is a global parameter. RSVP-TE determines whether or not to send the graceful restart capability object in its hello message. However, this capability also depends on support for graceful restart on the neighbor router.

The following conditions must be met in order to activate RSVP-TE Graceful Restart:

- This command is used on the local router.
- The neighbor router is explicitly set with a neighbor command (refer to either the neighbor A.B.C.Dor neighborX:X::X:X command for details).
- The neighbor router supports Graceful Restart, and it is activated.

Command Syntax

```
graceful-restart
no graceful-restart
```

Parameters

None

Default

Graceful restart is disabled by default

Command Mode

Router mode

Applicability

This command was introduced before OcNOS-SP version 5.0.

Examples

```
#configure terminal
(config)#router rsvp
(config-router)#graceful-restart
(config-router)#no graceful-restart
```

graceful-restart recovery-time

Use this command to set a recovery time for an RSVP-TE graceful restart configuration.

Use the `no` parameter with this command to reset the recovery time.

Command Syntax

```
graceful-restart recovery-time <60000-3600000>
no graceful-restart recovery-time
```

Parameters

`<60000-3600000>`Recovery time value in milliseconds

Default

Default value is 360000 ms.

Command Mode

Router mode

Applicability

This command was introduced before OcNOS-SP version 5.0.

Examples

```
#configure terminal
(config)#router rsvp
(config-router)#graceful-restart recovery-time 600000
```

graceful-restart restart-time

Use this command to set a restart time for an RSVP-TE graceful restart configuration.

Use the `no` parameter with this command to reset the restart time.

Command Syntax

```
graceful-restart restart-time <10000-600000>
no graceful-restart restart-time
```

Parameters

`<10000-600000>` Restart time value in milliseconds

Default

Default value is 180000 ms.

Command Mode

Router mode

Applicability

This command was introduced before OcNOS-SP version 5.0.

Examples

```
#configure terminal
(config)#router rsvp
(config-router)#graceful-restart restart-time 100000
```


hello-interval

Use this command to set an interval between Hello packets.

Used as a global command, this value is over-ridden by the hello-interval set on the interface (see rsvp hello-interval). For optimum performance, set this value no more than one-third of the hello-timeout value.

Use the `no` parameter with this command to return to the default hello interval value.

Command Syntax

```
hello-interval <1-65535>
no hello-interval
```

Parameter

`<1-65535>`	The time in seconds after which hello packets are sent

Default

By default, hello interval is 2 seconds

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#router rsvp
(config-router)#hello-interval 5

(config)#router rsvp
(config-router)#no hello-interval
```

hello-receipt

Use this command to enable the receipt of Hello messages from peers.

Use the `no` parameter with this command to disable the exchange of Hello messages.

Command Syntax

```
hello-receipt
no hello-receipt
```

Parameters

None

Default

By default, hello receipt is disabled

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#router rsvp
(config-router)#hello-receipt
```

hello-timeout

Use this command to set the RSVP hello timeout. If an LSR has not received a hello message from a peer within the number of seconds set with this command, all sessions shared with this peer are reset. The hello-timeout determines how long an RSVP node waits for a hello message before declaring a neighbor to be down.

Use the `no` parameter with this command to set the default hello timeout value.

Command Syntax

```
hello-timeout <1-65535>
no hello-timeout
```

Parameter

`<1-65535>`	Time in seconds to receive a hello message.

Default

By default, hello-timeout value is 7 seconds.

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#router rsvp
(config-router)#hello-timeout 12

(config)#router rsvp
(config-router)#no hello-timeout
```

keep-multiplier

Use this command to configure the constant to be used to calculate a valid reservation lifetime for a Labeled Switched Path (LSP).

The refresh time and keep multiplier are two interrelated timing parameters used to calculate the valid reservation lifetime for an LSP. Use the following formula to calculate the reservation lifetime for an LSP:

```
L >= (K + 0.5)* 1.5 * R
```

`K` = keep-multiplier

`R` = refresh timer

The router sends refresh messages periodically so that the neighbors do not timeout.

Use the `no` parameter with this command to return to the default keep-multiplier setting.

Command Syntax

```
keep-multiplier <1-255>
no keep-multiplier <1-255>
```

Parameters

`<1-255>`	The keep-multiplier value

Default

By default, keep-multiplier value is 3

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#router rsvp
(config-router)#keep-multiplier 2
```

loop-detection

Use this command to turn on loop detection for Path and Reservation messages exchanged between LSRs.

Use the no loop-detection command to return to default settings.

Command Syntax

```
loop-detection
```

Parameters

None

Default

By default, loop detection is enabled

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#router rsvp
(config-router)#loop-detection
```


lsp-metric

Use this command to set LSP absolute metric or relative metric for IGP Shortcut use

Use the `no` parameter along with this command to unset the LSP metirc for IGP shortcut.

Command Syntax

```
lsp-metric absolute <1-65535>
lsp-metric relative (<-65535-0>|<1-65535>)
no lsp-metric absolute-metric (<1-65535>|)
no lsp-metric relative (<-65535-0>|<1-65535>|)
```

Parameters

`absolute`	Absolute metric
`relative`	Relative metric
`<1-65535>`	Metric value
`<-65535-0>`	The keep-multiplier value

Command Mode

RSVP Trunk mode

Examples

```
#configure terminal
(config)#router rsvp
(config-router)#exit
(config)#rsvp trunk T1
(config-trunk)#lsp-metric absolute 10
(config-trunk)#lsp-metric relative 10
```

lsp-reoptimization-timer

Use this command to set the re-optimization interval timer.

Use the no parameter with this command to set the default re-optimization interval (5 minutes).

Command Syntax

```
lsp-reoptimization-timer <1-240>
```

Parameter

`<1-240>`	The interval in minutes after which LSP re-optimization will take place.

Default

By default, the re-optimization timer interval is 5 minutes.

Command Mode

RSVP router mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
(config)#router rsvp
(config-router)#lsp-reoptimization-timer 10
(config)#router rsvp
(config-router)#no lsp-reoptimization-timer
```

map-route A.B.C.D

Use this command to map a route using an IPv4 to an RSVP trunk. If the primary LSP for a trunk goes down, all mapped routes are sent automatically to a secondary LSP configured as backup for a primary LSP.

Use the `no` parameter with this command to unmap routes from specified trunks.

Command Syntax

```
map-route A.B.C.D/M
map-route A.B.C.D/M CLASS
map-route A.B.C.D A.B.C.D
map-route A.B.C.D A.B.C.D CLASS
no map-route A.B.C.D/M
no map-route A.B.C.D/M CLASS
no map-route A.B.C.D A.B.C.D
no map-route A.B.C.D A.B.C.D CLASS
```

Parameters

`A.B.C.D/M`	Prefix to map, plus mask
`A.B.C.D`	Prefix to be mapped
`A.B.C.D`	Prefix mask
`CLASS`	Incoming DiffServ Class (for example, be, ef, etc.) to map to the RSVP trunk

Default

By default, map route A.B.C.D/M is disabled

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#rsvp-trunk T1
(config-trunk)#map-route 2.2.2.2/16
```

neighbor A.B.C.D

Use this command to designate a neighbor IPv4 address to use when exchanging hello messages. Any neighbor hello message that is not explicitly identified is rejected.

Use the `no` parameter with this command to remove an IP neighbor from the system.

Command Syntax

```
neighbor A.B.C.D
no neighbor A.B.C.D
```

Parameters

None

Default

By default, neighbor A.B.C.D is disabled

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#router rsvp
(config-router)#neighbor 10.10.0.5
```

neighbor X:X::X:X

Use this command to designate a neighbor IPv6 address to use when exchanging hello messages. Any neighbor hello message that is not explicitly identified is rejected.

Use the `no` parameter with this command to remove an IP neighbor from the system.

Command Syntax

```
neighbor X:X::X:X
no neighbor X:X::X:X
```

Parameters

None

Default

By default, neighbor X:X::X:X is disabled

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#router rsvp
(config-router)#neighbor 3ffe::3:34
```

no cspf

Use this command to disable the use of the Constrained Shortest Path First (CSPF) server for all RSVP sessions. Disable CSPF when no nodes support the required traffic engineering extensions.

When this command is executed in Router mode, CSPF is disabled for all configured RSVP sessions, and all RSVP sessions configured from this point forward. If the default CSPF per RSVP session is enabled, it will be disabled. The CSPF status for RSVP sessions can be verified using the show rsvp session command with the detail option.

Use the cspf command to revert to the default settings.

Note: When CSPF is disabled, path is not calculated taking constraints into consideration. Path message is sent to the next hop based on IGP best route. In this case, ERO is not included in path message and all constraints are included.

Command Syntax

```
no cspf
```

Parameters

None

Default

By default, no cspf is disabled

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

This example shows using the `no cspf` command in Router mode to disable CSPF for all RSVP sessions.

```
#configure terminal
(config)#router rsvp
(config-router)#no cspf
```

no igp-shortcut

Use this command to disable Interior Gateway Protocol (IGP) shortcut.

Command Syntax

```
no igp-shortcut
```

Parameters

None

Command Mode

Trunk mode

Example

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#no igp-shortcut
```

no loop-detection

Use this command to turn off loop detection for Path and Reservation messages exchanged between LSRs. When a Path or Resv message is received, the primary IP address of the incoming interface is compared with the received route record list.

Use the loop-detection command to revert to default settings.

Command Syntax

```
no loop-detection
```

Parameters

None

Default

By default, no loop detection is disabled

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#router rsvp
(config-router)#no loop-detection
```


no php

Use this command to disable Penultimate-Hop-Popping (PHP) for the router. An egress router sends neither implicit null label nor explicit null for LSPs. When `no-php` command is used, the egress router sends non-reserved labels (those labels in the label pool range allotted to RSVP) to the upstream router and retains the labels till the egress router.

Note: Use the show rsvp command to display the status of Penultimate-Hop-Popping.

Command Syntax

```
no php
```

Parameters

None

Default

By default, no php is enabled.

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#router rsvp
(config-router)#no php
```

no record

Use this command to disable recording of the route taken by Path and Reservation Request (Resv) messages that confirm establishment of reservations and are used to identify errors. The routes are recorded by means of the Route Record Object (RRO) in RSVP messages.

Command Syntax

```
no record
```

Parameters

None

Default

Routes are recorded by default.

Command Mode

RSVP Bypass mode

Examples

```
#configure terminal
(config)#rsvp-bypass bypassname
```

(config-bypass)#no record

no refresh-path-parsing

Use this command to disable parsing of Refresh PATH messages received from upstream nodes. Enable this command to minimize message processing by RSVP, if you are sure that a particular router does not need to parse Refresh-PATH messages to check for changes because LSPs passing through this router are not required to be updated, simultaneously.

Use the refresh-path-parsing command to revert to the default settings.

Command Syntax

```
no refresh-path-parsing
```

Parameters

None

Default

By default, refresh-path-parsing is enabled.

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
Router#configure terminal
Router(config)#router rsvp
Router(config-router)#no refresh-path-parsing
```

no refresh-resv-parsing

Use this command to disable parsing of Refresh RESV messages received from upstream nodes. Enable this command to minimize message processing by RSVP, if you are sure that a particular router does not need to parse Refresh RESV messages to check for changes because LSPs passing through this router are not required to be updated simultaneously.

Command Syntax

```
no refresh-resv-parsing
```

Parameters

None

Default

By default, refresh reservation parsing is enabled.

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
Router#configure terminal
Router(config)#router rsvp
Router(config-router)#no refresh-resv-parsing
```


php

Use this command to enable Penultimate-Hop-Popping for the router. An egress router send an implicit-null label (3) to the upstream router.

Note: Use the show rsvp command to display the status of Penultimate-Hop-Popping.

Use the no php command to revert to the default setting.

Note: When a primary session has non-implicit-null out label and a backup session has implicit-null out label, then services do not work when the session is at backup state.

Command Syntax

```
php
```

Parameters

None

Default

By default, no-php is enabled.

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#router rsvp
(config-router)#php
```

primary ADMIN-GROUP-NAME

Use this command to configure primary administrative groups. Administrative groups are manually assigned attributes that describe the color of links, so that links with the same color are in one class. These groups are used to implement different policy-based LSP setups. Administrative group attributes can be included or excluded for an LSP or for a path's primary and secondary paths.

Note: A link can be added to a specific Administrative Group via the Network Services Module. Refer to the *Network Services Module Command Reference* for details.

Use the `no` parameter to remove a previously configured group from an administrative group list.

Command Syntax

```
primary (include-any|include-all|exclude-any) ADMIN-GROUP-NAME
primary (include-any|exclude-any) ADMIN-GROUP-NAME
primary (include-any|include-all|exclude-any) ADMIN-GROUP-NAME
primary (include-any|exclude-any) ADMIN-GROUP-NAME
```

Parameters

`include-any`	Include any attributes
`include-all`	Include all attributes
`exclude-any`	Exclude any attribute
`ADMIN-GROUP-NAME`	Administrative group name

Default

By default, primary admin group name is disabled

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#primary exclude-any myadmingroup

#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#primary include-all admingrp2

#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#primary include-any admingrp2
```


primary affinity

Use this command to enable sending of session attribute objects with resource affinity data.

Use the no primary affinity command to disable sending of session attribute objects.

Command Syntax

```
primary affinity
```

Parameters

None

Default

By default, primary affinity is disabled

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#primary affinity
```

primary bandwidth

Use this command to reserve the primary bandwidth in bits per second for the current trunk.

Each LSP has an associated bandwidth attribute. The bandwidth value is included in the sender's RSVP Path message and specifies the bandwidth to be reserved for the LSP. It is specified in bits per second, with a higher value indicating a greater user traffic volume. A zero bandwidth reserves no resources, although exchanges labels.

Use the `no` parameter to remove configured bandwidth information.

Command Syntax

```
primary bandwidth BANDWIDTH
no primary bandwidth BANDWIDTH
```

Parameter

`BANDWIDTH`	<1-999>k for 1 to 999 kilobits/s
	<1-999>m for 1 to 999 megabits/s
	<1-100>g for 1 to 100 gigabits/s

Default

The default bandwidth is 0 bits per second, which allows data to flow through but does not reserve bandwidth.

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#primary bandwidth 100m
```

primary cspf

Use this command to enable the use of Constrained Shortest Path First (CSPF) server for an explicit route to the egress, or all RSVP sessions. When CSPF is turned off globally, it cannot be enabled for any LSP.

The CSPF server computes paths for LSPs that are subject to constraints such as bandwidth, hop count, administrative groups, priority, and explicit routes. When computing paths for LSPs, CSPF considers not only the topology of the network and the attributes defined for the LSP, but also the links. It attempts to minimize congestion by intelligently balancing the network load.

Use the no primary affinity command to revert to the default settings.

Note: CSPF server information is not signaled across session and hence sessions in transit and egress nodes will not be aware of the CSPF server. So, in multi CSPF scenarios, neighbor down event from a CSPF server restart all sessions irrespective of which CSPF server sessions were using.

Command Syntax

```
primary cspf
```

Parameters

None

Default

By default, primary cspf is enabled

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#primary cspf
```

primary cspf-retry-limit

Use this command to specify the number of retries that CSPF should carry out for a request received from RSVP.

Use the `no` parameter with this command to disable this configuration.

Command Syntax

```
primary cspf-retry-limit <1-65535>
no primary cspf-retry-limit
```

Parameter

`<1-65535>`	Set the number of times CSPF should retry for this LSP

Default

By default, retry-limit is 0.

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk T1
(config-trunk)#primary cspf-retry-limit 535

(config)#rsvp-trunk T1
(config-trunk)#no primary cspf-retry-limit
```


primary cspf-retry-timer

Use this command to specify the time between each retry that CSPF might carry out for a request received from RSVP.

Use the `no` parameter with this command to disable this configuration.

Command Syntax

```
primary cspf-retry-timer <1-600>
hno primary cspf-retry-timer
```

Parameter

`<1-600>`	Timeout between successive retries, in seconds

Default

By default, retry-timer is 0

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk T1
(config-trunk)#primary cspf-retry-timer 45

(config)#rsvp-trunk T1
(config-trunk)#no primary cspf-retry-timer
```

primary filter

Use this command to set the filter to the fixed or shared style for an LSP.

- The shared filter style identifies a shared reservation environment. It creates a single reservation into which flows from all senders are mixed.
- The fixed filter style designates a distinct reservation. A distinct reservation request is created for data packets from a particular sender. The fixed filter style is also used style to prevent rerouting of an LSP and to prevent another LSP from using this bandwidth.

Use the `no` parameter to reset the configured filter to the default.

Command Syntax

```
primary filter (fixed|shared-explicit)
no primary filter (fixed|shared-explicit)
```

Parameters

`fixed`	Use a fixed filter for this LSP
`shared-explicit`	Use a shared-explicit filter for this LSP

Default

By default, primary filter is shared-explicit.

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#primary filter shared-explicit
```


primary hold-priority

Use this command to configure the hold priority value for the selected trunk. In case of insufficient bandwidth, remove less important existing LSPs to free up a portion of the bandwidth. This can be done by preempting one or more of the signaled LSPs. Hold priority determines the degree to which an LSP holds onto its reservation for a session after the LSP has been configured successfully. When the hold priority is high, the existing LSP is less likely to give up its reservation.

Use the `no` parameter to reset the trunk to the default hold-priority value.

Command Syntax

```
primary hold-priority <0-7>
no primary hold-priority
```

Parameter

`<0-7>`	Set a hold priority for the LSP

Default

The default hold-priority value is 0, which is the highest. Once a session is configured with a hold priority of 0, no other session can preempt it.

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#primary hold-priority 2
```

primary hop-limit

Use this command to specify a limit of hops for an RSVP trunk. Hop-limit data is sent to the CSPF server if CSPF is used.

Upon configuration of an arbitrary hop-limit, the hop-limit is compared with the number of hops configured in the primary path, if a primary path has been configured. If the number of hops in the primary path exceeds the hop-limit configured, no `Path` messages are sent, and any existing session is torn down. If no primary path is configured, the trunk is processed normally and Path messages are sent.

Use the `no` parameter to reset the trunk to the default hop-limit value.

Command Syntax

```
primary hop-limit <1-255>
no primary hop-limit <1-255>
no primary hop-limit
```

Parameters

`<1-255>`	Set the number of acceptable hops for the LSP

Default

By default, primary hop limit is 255

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#primary hop-limit 23
```


primary label-record

Use this command to record all labels exchanged between RSVP-enabled routers during the reservation setup process.

Use the `no` parameter with this command to turn off recording.

Command Syntax

```
primary label-record
no primary label-record
```

Parameters

None

Default

By default, primary label record is disabled

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#primary label-record
```

primary local-protection

Use this command to enable the local repair of explicit routes for which this router is a transit node.

Use the `no` parameter with this command to disable local repair of explicit routes.

Command Syntax

```
primary local-protection
no primary local-protection
```

Parameters

None

Default

By default, primary local protection is disabled

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#rsvp-trunk T1
(config-trunk)#primary local-protection
```


no primary affinity

Use this command to disable the use of sending out session attribute objects with resource affinity data.

Use the primary affinity command to return to the default settings.

Command Syntax

```
no primary affinity
```

Parameters

None

Default

By default, primary no affinity is disabled

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#no primary affinity
```

no primary cspf

Use this command to disable the use of Constrained Shortest Path First (CSPF) server for an explicit route to the egress, or all RSVP sessions. When CSPF is turned off globally it cannot be enabled for any LSP. If used per LSP, it can be used to turn off CSPF computation for a specific LSP.

Disable CSPF when all nodes do not support the required traffic engineering extensions, and configure LSPs manually to use an explicit path. The LSP is then established only along the path specified by the operator.

Use the primary cspf command to enable this setting.

Command Syntax

```
no primary cspf
```

Parameters

None

Default

By default, no primary cspf is disabled

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

This example shows using the `no cspf` command in Trunk mode to disable CSPF for the primary LSP.

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#no primary cspf
```


no primary record

Use this command to disable recording of the route taken by Path and Reservation Request (Resv) messages to confirm establishment of reservations and identify errors. Routes are recorded by means of the Route Record Object (RRO) in RSVP messages.

Use the primary record command to return to the default settings.

Command Syntax

```
no primary record
```

Parameters

None

Default

By default, routes are recorded

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#no primary record
```

primary path

Use this command to specify an RSVP path to be used. The `PATHNAME` in this command is the string (name) used to identify an RSVP path defined for the node (refer to `rsvp-path` command).

Use the `no` parameter with this command to remove a configured RSVP path.

Command Syntax

```
primary path PATHNAME
no primary path
```

Parameters

PATHNAME	The name of the path to use

Default

By default, primary path is disabled

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#primary path mypath
```


primary record

Use this command to enable recording of the route taken by Path and Reservation Request (Resv) messages to confirm establishment of reservations and identify errors. Routes are recorded by means or the Route Record Object (RRO) in RSVP messages.

Use the no primary record command to disable recording of routes.

Command Syntax

```
primary record
```

Parameters

None

Default

By default, routes are recorded

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#primary record
```

primary retry-limit

Use this command to specify a retry count this RSVP Trunk.

If a session is in a `nonexistent` state due to a path error message, the system tries to recreate the LSP for the number of times specified by the `retry-limit` command.

Although the same retry command controls both the trunk and the session, the retry-limit value affects only the session and not the trunk. If the trunk is in an `incomplete` state, the code keeps trying forever to bring it to a `complete` state regardless of the retry-limit value.

Use the `no` parameter with this command to revert to the default retry-limit value.

Command Syntax

```
primary retry-limit <1-65535>

no primary retry-limit
```

Parameter

<1-65535>	The set number of times the system should try setting up the LSP

Default

By default, the retry-limit value is 0, and the trunk and session try to create the LSP indefinitely.

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#primary retry-limit 256
```


primary retry-timer

Use this command to specify a retry interval for an RSVP Trunk. When an ingress node tries to configure an LSP and the setup fails due to the receipt of a Path Error message, the system waits for the time configured with this command, before retrying the LSP setup process.

Use the `no` parameter with this command to revert to the default retry-time value.

Command Syntax

```
primary retry-timer <1-600>
no primary retry-timer <1-600>
no primary retry-timer
```

Parameter

<1-600>	Time in seconds after which the system should retry setting up the LSP

Default

By default, retry-timer value is 30 seconds.

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#primary retry-timer 12
```

primary reuse-route-record

Use this command to use the updated Route Record List as an Explicit Route (with all strict nodes) when a path message is sent out at the next refresh.

The ERO list contains the hops to be taken to reach the egress from the current LSR. If CSPF is not available, to place an ERO with all strict routes, use this command to modify the ERO after receiving the Resv message. The future Path messages have the ERO with all strict nodes, identifying each and every node to be traversed.

Use the `no` parameter with this command to disable the use of the Route Record List as the explicit route.

Command Syntax

```
primary reuse-route-record
no primary reuse-route-record
```

Parameters

None

Default

By default, primary reuse route record is disabled

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#primary reuse-route-record
```

primary setup-priority

Use this command to configure a setup priority value for a trunk. In case of insufficient bandwidth, users must remove less important LSPs to free up the bandwidth. This can be done by preempting one or more of the existing LSPs. The primary setup priority determines if a new LSP can preempt an existing LSP.

The setup priority of the new LSP must be higher than the hold priority of an existing LSP for the existing LSP to be preempted. Note that for a trunk, the setup priority should not be higher than the hold priority.

Use the `no` parameter with this command to revert to the default primary setup priority value.

Command Syntax

```
primary setup-priority <0-7>
no primary setup-priority
```

Parameters

`<0-7>`	Set the priority value

Default

By default, setup priority is 7, which is the lowest.

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#primary setup-priority 2
```


primary traffic

Use this command to specify the traffic type for this RSVP Trunk.

Use the `no` parameter with this command to reset the configured traffic type.

Command Syntax

```
primary traffic (guaranteed|controlled-load)
no primary traffic
```

Parameters

`controlled-load`	Controlled loaded traffic
`guaranteed`	Guaranteed traffic

Default

By default, primary traffic type is controlled-load

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#primary traffic guaranteed
```


refresh-time

Use this command to configure RSVP refresh interval timer. The timer specifies the interval after which Path and/ or Reservation Request (Resv) messages will be sent out.

The refresh time and keep multiplier are two interrelated timing parameters used to calculate the valid Reservation Lifetime for an LSP. Refresh time regulates the interval between Refresh messages which include Path and Reservation Request (Resv) messages. Refresh messages are sent periodically so that reservation does not timeout in the neighboring nodes. Each sender and receiver host sends Path and Resv messages, downstream and upstream respectively, along the paths.

Use the `no` parameter with this command to return to the default refresh-time interval.

Command Syntax

```
refresh-time <1-65535>
no refresh-time <1-65535>
no refresh-time
```

Parameter

`<1-65535>`	The duration for which messages are sent, in seconds

Default

By default, refresh-time interval is 30 seconds

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#router rsvp
(config-router)#refresh-time 20
```

refresh-path-parsing

Use this command to disable parsing of Refresh PATH messages received from upstream nodes. Use this command to minimize message processing by RSVP when you are sure that a particular router does not need to parse Refresh-PATH messages to check for changes, because LSPs passing through this router are not required to be updated simultaneously.

Use the no refresh-path-parsing command to disable this setting.

Command Syntax

```
refresh-path-parsing
```

Parameters

None

Default

By default, refresh-path-parsing is enabled.

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
Router#configure terminal
Router(config)#router rsvp
Router(config-router)#refresh-path-parsing
```


refresh-resv-parsing

Use this command to disable parsing of Refresh RESV messages received from upstream nodes. Use this command to minimize message processing by RSVP when you are sure that a particular router does not need to parse Refresh RESV messages to check for changes because LSPs passing through this router are not required to be updated simultaneously.

Use the no refresh-resv-parsing command to disable this setting.

Command Syntax

```
refresh-resv-parsing
```

Parameters

None

Default

By default, refresh reservation parsing is enabled.

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
Router#configure terminal
Router(config)#router rsvp
Router(config-router)#refresh-resv-parsing
```

reoptimize

Use this command to enable re-optimization of the RSVP primary LSP with the rsvp-trunk force-reoptimize command.

Use the no parameter with this command to disable re-optimization of the RSVP primary LSP.

Command Syntax

```
reoptimize
```

Parameters

None

Command Mode

Trunk mode

Applicability

This command was introduced in OcNOS version 1.3.4.

Examples

```
(config)#rsvp-trunk t1
(config-trunk)#reoptimize
(config)#rsvp-trunk t1
(config-trunk)#no reoptimize
```


restart rsvp graceful

Use this command to restart RSVP gracefully.

To restart RSVP gracefully, you must give the graceful-restart command to enable graceful restart capability on the device in RSVP router mode.

Command Syntax

```
restart rsvp graceful
```

Parameter

None

Command Mode

Privileged Exec mode

Applicability

This command was introduced before OcNOS-SP version 5.0.

Example

```
#restart rsvp graceful
% Warning : You may loose rsvp configuration, if not saved
Proceed for graceful restart? (y/n):y
%% Managed module is down or crashed
```

router rsvp

Use this command to enter router mode from configure mode and to enable the RSVP daemon, if it is not already enabled.

Use the `no` parameter with this command to disable RSVP on the node.

Command Syntax

```
router rsvp
```

```
no router rsvp
```

Parameters

None

Default

RSVP is started only if this command is executed.

Command Mode

Configure mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

The command prompt changes from config to config-router, as illustrated below:

```
#configure terminal
(config)#router rsvp
(config-router)#

(config-router)#exit
(config)#no router rsvp
```

rsvp hello-interval

Use this command to enable the sending of Hello packets on the interface and to set the interval value between successive Hello packets to neighbor. For optimum performance, set this value to less than one-third the value of the configured RSVP hello-timeout. See the rsvp hello-timeout command for more information.

Note: This is an interface-specific command and when not used, the global hello-interval state applies.

Use the `no` parameter with this command to return to the default hello interval value.

Command Syntax

```
rsvp hello-interval <1-65535>
no rsvp hello-interval
```

Parameter

`<1-65535>`	RSVP hello interval in seconds

Default

By default, RSVP hello interval is 2 seconds

Command Mode

Interface mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#interface eth0
(config-if)#rsvp hello-interval 110

(config)#interface eth0
(config-if)#no rsvp hello-interval
```

rsvp hello-receipt

Use this command to enable the receipt of hello messages from peers connected through this interface. This is an interface-specific command and when not used, the global hello-receipt command applies.

Use the `no` parameter with this command to disable the exchange of hello messages for this interface.

Command Syntax

```
rsvp hello-receipt
no rsvp hello-receipt
```

Parameters

None

Default

By default, rsvp hello receipt is disabled

Command Mode

Interface mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#interface eth0
(config-if)#rsvp hello-receipt
```


rsvp hello-timeout

This command determines how long an RSVP node should wait for a hello message before declaring a neighbor to be down. If an LSR does not received a hello message from a peer connected to an interface within the specified duration, the LSR resets all sessions that are shared with this particular peer. This is an interface-specific command and when not used, the global hello-timeout command applies.

Use the `no` parameter to revert to the default hello timeout value.

Command Syntax

```
rsvp hello-timeout <1-65535>
no rsvp hello-timeout
```

Parameters

`<1-65535>`	Time to receive a hello message, in seconds

Default

By default, hello-timeout value is 7 seconds

Command Mode

Interface mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#interface eth0
(config-if)#rsvp hello-timeout 550

(config)#interface eth0
(config-if)#no rsvp hello-timeout
```

rsvp keep-multiplier

This command sets the constant for calculating a valid reservation lifetime for an LSP, which allows messages to be exchanged through this interface. This is an interface-specific command and when not specified, the global keep-multiplier command applies.

Reservation lifetime is the duration of bandwidth reservation for the LSP. The refresh time and keep multiplier are two interrelated timing parameters used to calculate the valid reservation lifetime for an LSP. Use the following formula to calculate the reservation lifetime for an LSP:

```
L >= (K + 0.5)* 1.5 * R
```

K = keep-multiplier

R = refresh timer

Refresh messages are sent periodically so that neighbors do not timeout.

Use the `no` parameter with this command to return to the global keep-multiplier value.

Command Syntax

```
rsvp keep-multiplier <1-255>
no rsvp keep-multiplier <1-255>
```

Parameter

<1-255>	Set a value for the lifetime constant

Default

By default RSVP keep-multiplier value is 3

Command Mode

Interface mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#interface eth0
(config-if)#rsvp keep-multiplier 3

(config)#interface eth0
(config-if)#no rsvp keep-multiplier 3
```


rsvp refresh-time

Use this command to configure RSVP refresh interval timer for the current interface. This is an interface-specific command and when not used, the global refresh-time command applies.

The refresh time and keep multiplier are two interrelated timing parameters used to calculate the valid reservation lifetime for an LSP. Refresh time regulates the interval between refresh messages that include path and reservation request (Resv) messages. Refresh messages are sent periodically so that the reservation does not timeout in the neighboring nodes. Each sender and receiver host sends path and resv messages, downstream and upstream respectively, along the paths.

Use the `no` parameter with this command to revert to the refresh-time value set in RSVP mode.

Command Syntax

```
rsvp refresh-time <1-65535>
no rsvp refresh-time <1-65535>
```

Parameter

`<1-65535>`	The duration for which messages are sent, in seconds

Default

By default, refresh interval is 30 seconds

Command Mode

Interface mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#interface eth0
(config-if)#rsvp refresh-time 5055

(config)#interface eth0
(config-if)#no rsvp refresh-time 5055
```

rsvp-path

Use this command to create a new RSVP path or to enter the `Path` command mode. In this mode, you can add or delete paths and also specify the path to be loose or strict.

Use the `no` parameter with this command to delete the path and its specified hops.

Command Syntax

```
rsvp-path PATHNAME
no rsvp-path PATHNAME
```

Parameter

PATHNAME	Name of the path

Default

By default, rsvp path is disabled

Command Mode

Configure mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#rsvp-path mypath
(config-path)#
```


rsvp-trunk

Use this command to create a new RSVP trunk. When the trunk is created, the attributes required to configure an explicitly-routed or traditionally-routed LSP are set. Once a trunk is configured with the required attributes, an RSVP session (and PSB) is created for this trunk, which enables the exchange of messages and completes the LSP setup.

This command also modifies an existing RSVP path to configure an explicitly-routed or traditionally-routed LSP. In addition, this command can be used to set the address family (IPv4) of an RSVP trunk. If no address family is assigned, the default value is used. If the address family is already set, a check is made to see whether the address family configured and the one already in the database are the same. An error message is returned if the two do not match.

Use the `no` parameter with this command to remove an RSVP trunk and all configured attributes, except the primary path.

Note: The RSVP trunk's name (`TRUNKNAME`) is limited to 32 characters.

Command Syntax

```
rsvp-trunk TRUNKNAME (ipv4|gmpls)
no rsvp-trunk TRUNKNAME
```

Parameters

`TRUNKNAME`	Name to use for the trunk
`ipv4`	IPv4 address family trunk
`gmpls`	GMPLS enabled trunk

Default

By default, rsvp trunk is disabled

Command Mode

Configure mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

The command prompt changes from `config` to `config-trunk` as illustrated below:

```
#configure terminal
(config)#rsvp-trunk mytrunk ipv4
(config-trunk)#
```

rsvp-trunk force-reoptimize

Use this command to force re-optimize a particular primary LSP. Re-optimization of the LSP must have been enabled with the reoptimize command.

Command Syntax

```
rsvp-trunk TRUNKNAME force-reoptimize
```

Parameters

TRUNKNAME	Name of the trunk

Default

NA.

Command Mode

Execute mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#rsvp-trunk t1 force-reoptimize
```


rsvp-trunk force-switchover-secondary

Use this command to force switchover a secondary LSP. This command is recommended for limited use on a stable system when there is a need for software upgrade without traffic impact.

Note: This command is supported on secondary configured tunnels and not on multiple secondary configured tunnels.

Command Syntax

```
rsvp-trunk TRUNKNAME force-switchover-secondary
```

Parameters

`TRUNKNAME` Name of the trunk

`force-switchover-secondary`
Force switchover to secondary

Default

NA.

Command Mode

Execute mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#rsvp-trunk <Trunk-Name> force-switchover-secondary
```

rsvp-trunk-restart

Use this command to restart the RSVP trunk. This command “kills” an existing LSP and restarts the LSP setup process.

Command Syntax

```
rsvp-trunk-restart
```

Parameters

None

Default

By default, rsvp trunk restart is disabled

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#rsvp-trunk-restart
```

secondary ADMIN-GROUP-NAME

Use this command to configure secondary administrative groups. Administrative groups are manually assigned attributes that describe the color of links, so that links with the same color are in one class. These groups are used to implement different policy-based LSP setups. Administrative group attributes can be included or excluded for an LSP or for a path's primary and secondary paths.

Note: A link can be added to a specific Administrative Group via NSM. Refer to the *Network Services Module Command Reference* for details.

Use the `no` parameter to remove a previously set group from an administrative group list.

Command Syntax

```
secondary (include-any|include-all|exclude-any) ADMIN-GROUP-NAME
secondary (include-any|exclude-any) ADMIN-GROUP-NAME
no secondary (include-any|include-all|exclude-any) ADMIN-GROUP-NAME
no secondary (include-any|exclude-any) ADMIN-GROUP-NAME
```

Parameters

`include-any` Include any attribute

`include-all` Include all attribute

`exclude-any` Exclude any attribute

`ADMIN-GROUP-NAME`
Administrative group name

Default

By default, secondary admin group name is disabled

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#secondary exclude-any myadmingroup

#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#secondary include-any myadmingroup

#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#secondary include-all myadmingroup
```

secondary bandwidth

Use this command to reserve the bandwidth in bits per second for the current trunk.

Each LSP has an associated bandwidth attribute. The bandwidth value is included in the sender's RSVP Path message and specifies the bandwidth to be reserved for the LSP. It is set in bits per second, with a higher value indicating a greater user traffic volume. A zero bandwidth reserves no resources, although label exchanges are possible.

Use the `no` parameter with this command to unset the configured bandwidth information.

Command Syntax

```
secondary bandwidth BANDWIDTH
no secondary bandwidth BANDWIDTH
no secondary bandwidth
```

Parameter

BANDWIDTH	<1-999>k for 1 to 999 kilobits/s
	<1-999>m for 1 to 999 megabits/s
	<1-100>g for 1 to 100 gigabits/s

Default

By default, bandwidth is 0 bits per second, which allows data to flow through but does not reserve bandwidth.

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#secondary bandwidth 100m
```


secondary cspf

Use this command to enable the use of Constrained Shortest Path First (CSPF) server for an explicit route to the egress, or all RSVP sessions.

The CSPF server computes paths for LSPs that are subject to constraints such as bandwidth, hop count, administrative groups, priority, and explicit routes. When computing paths for LSPs, CSPF considers not only the topology of the network and the attributes defined for the LSP, but also the links. It attempts to minimize congestion by intelligently balancing the network load.

Use the no secondary cspf command to revert to the default settings.

Note: CSPF server information is not signaled across session and hence sessions in transit and egress nodes will not be aware of the CSPF server. So, in multi CSPF scenarios, neighbor down event from a CSPF server restart all sessions irrespective of which CSPF server sessions were using.

Command Syntax

```
secondary cspf
```

Parameters

None

Default

By default, secondary cspf is enabled

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

This example shows using the `no cspf` command in Trunk mode to disable CSPF for the primary LSP.

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#secondary cspf
```

secondary cspf-retry-limit

Use this command to specify the number of retries that CSPF should carry out for a request received from RSVP.

Use the `no` parameter with this command to remove this configuration.

Command Syntax

```
secondary cspf-retry-limit <1-65535>
no secondary cspf-retry-limit
```

Parameter

`<1-65535>`	The number of times CSPF should retry for this LSP

Default

By default, no retry limit for CSPF route calculations is configured, so the value is 0.

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk T1
(config-trunk)#secondary cspf-retry-limit 535
```

secondary cspf-retry-timer

Use this command to specify the time between each retry that CSPF might carry out for a request received from RSVP.

Use the `no` parameter with this command to remove this configuration.

Command Syntax

```
secondary cspf-retry-timer <1-600>
no secondary cspf-retry-timer
```

Parameters

`<1-600>`	Timeout between successive retries, in seconds

Default

By default, no retry-timer configuration is defined for CSPF calculations, so the value is set to 0.

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk T1
(config-trunk)#secondary cspf-retry-timer 45
```

secondary filter

Use this command to set the filter to fixed or shared filter style for RSVP trunk.

- The shared filter style identifies a shared reservation environment. It creates a single reservation into which flows from all senders are mixed.
- The fixed filter style designates a distinct reservation. A distinct reservation request is created for data packets from a particular sender. The fixed filter style is also used style to prevent rerouting of an LSP and to prevent another LSP from using this bandwidth.

Use the `no` parameter to reset the configured filter to the default style.

Command Syntax

```
secondary filter (fixed|shared-explicit)
no secondary filter
```

Parameters

`fixed`	Use a Fixed Filter for this RSVP Trunk.
`shared-explicit`	Use a Shared Explicit Filter for this RSVP Trunk.

Default

By default, secondary filter is shared-explicit.

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Usage

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#secondary filter shared-explicit
```


secondary hold-priority

Use this command to configure the hold priority value for the selected trunk.

In case of insufficient bandwidth, the user must remove any less important existing LSP to free up the bandwidth. This can be done by preempting one or more of the signaled LSPs. Hold priority determines the degree to which an LSP holds onto its reservation for a session after the LSP has been configured successfully. When the hold priority is high, the existing LSP is less likely to give up its reservation.

Use the `no` parameter to revert to the default hold-priority value.

Command Syntax

```
secondary hold-priority <0-7>
no secondary hold-priority
```

Parameter

`<0-7>`	Specify a value for hold priority

Default

The default hold-priority is 0, the highest value. Once a session is configured with a 0 hold priority value, no other session can preempt it.

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#secondary hold-priority 2
```

secondary hop-limit

Use this command to specify a limit of hops for an RSVP trunk.

Upon configuration of an arbitrary hop-limit, the hop-limit is compared with the number of hops configured in the primary path, if a primary path has been configured. If the number of hops in the primary path exceed the hop-limit configured, no path messages are sent out and any existing session is torn down. If no primary path is configured, the trunk is processed normally and the path messages are sent out. The hop-limit data is sent to the CSPF server, if CSPF is being used.

Use the `no` parameter to revert to the default hop-limit value.

Command Syntax

```
secondary hop-limit <1-255>
no secondary hop-limit <1-255>
no secondary hop-limit
```

Parameter

`<1-255>`	The number of acceptable hops

Default

By default, secondary hop limit is 255

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#secondary hop-limit 23
```

secondary label-record

Use this command to record all labels exchanged between RSVP enabled routers during the reservation setup process. This command records all labels exchanged for an LSP from the ingress to the egress, and helps with debugging.

Use the `no` parameter to turn off recording.

Command Syntax

```
secondary label-record
no secondary label-record
```

Default

By default, secondary label record is disabled

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#secondary label-record
```

secondary local-protection

Use this command to enable the local repair of explicit routes for which this router is a transit node.

Use the `no` parameter with this command to disable local repair of explicit routes.

Command Syntax

```
secondary local-protection
no secondary local-protection
```

Parameters

None

Default

By default, secondary local protection is disabled

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#rsvp-trunk T1
(config-trunk)#secondary local-protection
```

no secondary affinity

Use this command to disable the use of sending out session attribute objects with resource affinity data.

Use the secondary bandwidth command to revert to the default settings.

Command Syntax

```
no secondary affinity
```

Parameters

None

Default

By default, no secondary affinity is disabled.

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#no secondary affinity
```

no secondary cspf

Use this command to disable the use of Constrained Shortest Path First (CSPF) server for an explicit route to the egress, or all RSVP sessions.

If CSPF is turned off globally, it cannot be enabled for any LSP. If used per LSP, it can be used to turn off CSPF computation for a specific LSP. The CSPF server computes paths for LSPs that are subject to various constraints such as bandwidth, hop count, administrative groups, priority, and explicit routes. When computing paths for LSPs, CSPF considers not only the topology of the network and the attributes defined for the LSP, but, also the links. It attempts to minimize congestion by intelligently balancing the network load.

Disable CSPF when all nodes do not support the required traffic engineering extensions and configure LSPs manually to use an explicit path. The LSP is then established only along the path specified by the operator.

Use the secondary cspf command to revert to the default settings.

Command Syntax

```
no secondary cspf
```

Parameters

None

Default

By default, secondary no cspf is disabled

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

This example shows using the `no cspf` command in Trunk mode to disable CSPF for the primary LSP.

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#no secondary cspf
```

no secondary record

This command is used to disable recording of the route taken by path and resv messages and confirms the establishment of reservations and to identify errors. Routes are recorded by means of the route record object (RRO) in an RSVP message.

Use the secondary record command to revert to the default settings.

Command Syntax

```
no secondary record
```

Parameters

None

Default

By default, routes are recorded

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#no secondary record
```

secondary path

Use this command to specify an RSVP path to be used.

Use the `no` parameter with this command to remove a configured RSVP path.

Command Syntax

```
secondary path PATHNAME
no secondary path
```

Parameters

PATHNAME	The name of the path to be used. PATHNAME is a string (name) used to identify an RSVP path defined for the node (refer to the rsvp-path command).

Default

By default, secondary path is disabled

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#secondary path mypath
```


secondary-priority path

Use this command to specify a RSVP path to be used for a specific priority secondary.

Use the no parameter with this command to remove a configured secondary-priority.

Command Syntax

```
secondary-priority <1-5> path PATHNAME
no secondary-priority <1-5>
```

Parameters

`<1-5>`	Secondary Priority value.
`PATHNAME`	The name of the path to be used. `PATHNAME` is a string (name) used to identify an RSVP path defined for the node (refer to the rsvp-path command).

Default

Secondary-priority can only be configured along with a path. Other attributes can only be associated post this command.

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk t1
(config-trunk)#secondary-priority 1 path sp1
(config)# rsvp-trunk t1
(config-trunk)#no secondary-priority 1
```

secondary-priority hold-priority

Use this command to configure the hold priority value for the secondary-priority lsp.

In case of insufficient bandwidth, the user must remove any less important existing LSP to free up the bandwidth. This can be done by preempting one or more of the signaled LSPs. Hold priority determines the degree to which an LSP holds onto its reservation for a session after the LSP has been configured successfully. When the hold priority is high, the existing LSP is less likely to give up its reservation.

Use the no parameter to revert to the default hold-priority value.

Command Syntax

```
secondary-priority <1-5> hold-priority <0-7>
no secondary-priority <1-5> hold-priority <0-7>
no secondary-priority <1-5> hold-priority
```

Parameters

<1-5>	Secondary Priority value.
<0-7>	Specify a value for hold priority.

Default

The default hold-priority is 0, the highest value. Once a session is configured with a 0 hold priority value, no other session can preempt it.

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
(config)# rsvp-trunk t1
(config-trunk)#secondary-priority 1 hold-priority 4
(config)# rsvp-trunk t1
(config-trunk)# no secondary-priority 1 hold-priority
```


secondary-priority setup-priority

Use this command to configure a setup priority value for the secondary-priority lsp.

In case of insufficient bandwidth, the user must remove any less important LSPs to free up bandwidth. This can be done by preempting one or more of the existing LSPs. The setup priority determines whether a new LSP that preempts an existing LSP may be established. The setup priority of the new LSP must be higher than the hold priority of an existing LSP for the existing LSP to be preempted. Note that for a trunk, the setup priority should not be higher than the hold priority.

Use the no parameter with this command to revert to the default setup priority value.

Command Syntax

```
secondary-priority <1-5> setup-priority <0-7>
no secondary-priority <1-5> setup-priority <0-7>
```

Parameters

`<1-5>`	Secondary Priority value.
`<0-7>`	Specify a value for hold priority.

Default

By default, setup value is 7 (the lowest).

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
(config)# rsvp-trunk t1
(config-trunk)#secondary-priority 1 setup-priority 4
(config)# rsvp-trunk t1
(config-trunk)# no secondary-priority 1 setup-priority 4
```

secondary-priority label-record

Use this command to record all labels exchanged between RSVP enabled routers during the reservation setup process. This command records all labels exchanged for an LSP from the ingress to the egress, and helps with debugging.

Use the no parameter to turn off recording.

Command Syntax

```
secondary-priority <1-5> label-record
no secondary-priority <1-5> label-record
```

Parameters

`<1-5>`	Secondary Priority value.

Default

By default, label record is disabled for secondary-priority.

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
(config)# rsvp-trunk t1
(config-trunk)#secondary-priority 1 label-record
(config)# rsvp-trunk t1
(config-trunk)# no secondary-priority 1 label-record
```


secondary-priority hop-limit

Use this command to specify a limit of hops for a secondary-priority lsp.

Upon configuration of an arbitrary hop-limit, the hop-limit is compared with the number of hops configured in the path, if a path has been configured. If the number of hops in the path exceed the hop-limit configured, no path messages are sent out and any existing session is torn down.

Use the no parameter to revert to the default hop-limit value.

Command Syntax

```
secondary-priority <1-5> hop-limit <1-255>
no secondary-priority <1-5> hop-limit <1-255>
```

Parameters

`<1-5>`	Secondary Priority value.
`<1-255>`	The number of acceptable hops.

Default

By default, hop limit is 255.

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
(config)# rsvp-trunk t1
(config-trunk)#secondary-priority 1 hop-limit 123
(config)# rsvp-trunk t1
(config-trunk)# no secondary-priority 1 hop-limit 123
```

secondary-priority bandwidth

Use this command to reserve the bandwidth in bits per second for the current trunk.

Each LSP has an associated bandwidth attribute. The bandwidth value is included in the sender's RSVP Path message and specifies the bandwidth to be reserved for the LSP. It is set in bits per second, with a higher value indicating a greater user traffic volume. A zero bandwidth reserves no resources, although label exchanges are possible.

Use the no parameter with this command to unset the configured bandwidth information.

Command Syntax

```
secondary-priority <1-5> bandwidth BANDWIDTH
no secondary-priority <1-5> bandwidth BANDWIDTH
```

Parameters

`<1-5>`	Secondary Priority value.
`BANDWIDTH`	<1-999>k for 1 to 999 kilobits/s
	<1-999>m for 1 to 999 megabits/s
	<1-100>g for 1 to 100 gigabits/s

Default

By default, bandwidth is 0 bits per second, which allows data to flow through but does not reserve bandwidth.

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
(config)# rsvp-trunk t1
(config-trunk)#secondary-priority 1 bandwidth 100m
(config)# rsvp-trunk t1
(config-trunk)# no secondary-priority 1 bandwidth 100m
```

secondary record

This command is used to enable recording of the route taken by path and resv messages to confirm the establishment of reservations and to identify errors. Routes are recorded by means of the route record object (RRO) in RSVP messages.

Use the no secondary record command to revert to the default settings.

Command Syntax

```
secondary record
```

Parameters

None

Default

By default, routes are recorded

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#secondary record
```

secondary retry-limit

Use this command to specify a retry count this RSVP Trunk.

If a session is in a nonexistent state due to the receipt of a path error message, it tries to recreate the LSP for the number of times specified by primary retry-limit. Although the same retry command controls both the trunk and the session, the retry-limit value affects only the session and not the trunk. If the trunk is in an incomplete state, the code keeps trying to bring it to a complete state, irrespective of the retry-limit value.

Use the `no` parameter to revert to the default retry-limit value.

Command Syntax

```
secondary retry-limit <1-65535>
no secondary retry-limit
```

Parameter

<1-65535>	The set number of times the system should try setting up the LSP

Default

By default, the retry-limit value is 0 so the trunk and session try to create the LSP indefinitely.

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#secondary retry-limit 256
```


secondary retry-timer

Use this command to specify a retry interval for an RSVP Trunk. When the ingress tries to configure an LSP and the setup fails due to the receipt of a path error message, the system waits for the time configure by this command before retrying the LSP setup process.

Use the `no` parameter to revert to the default.

Command Syntax

```
secondary retry-timer <1-600>
no secondary retry-timer
```

Parameter

`<1-600>`	Interval after which the system should retry setting up the LSP, in seconds

Default

By default, retry time is 30 seconds

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#secondary retry-timer 12
```

secondary reuse-route-record

Use this command to use the updated route record list as an explicit route (with all strict nodes) when a path message is sent out at the next refresh.

An explicit route object (ERO) list contains the hops to be taken to reach the egress from the current LSR. If CSPF can not place an ERO with all strict routes, then this command helps modify the ERO after receiving resv messages. Future path messages have the ERO with all strict nodes, which identify each and every node to be traversed.

Use the `no` parameter to disable the use of the route record list as the explicit route.

Command Syntax

```
secondary reuse-route-record
no secondary reuse-route-record
```

Parameters

None

Default

By default, secondary reuse route record is disabled

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#secondary reuse-route-record
```


secondary setup-priority

Use this command to configure a setup priority value for this trunk.

In case of insufficient bandwidth, the user must remove any less important LSPs to free up bandwidth. This can be done by preempting one or more of the existing LSPs. The setup priority determines whether a new LSP that preempts an existing LSP may be established. The setup priority of the new LSP must be higher than the hold priority of an existing LSP for the existing LSP to be preempted. Note that for a trunk, the setup priority should not be higher than the hold priority.

Use the `no` parameter with this command to revert to the default setup priority value.

Command Syntax

```
secondary setup-priority <0-7>
no secondary setup-priority
```

Parameters

`<0-7>`	The priority value

Default

By default, setup value is 7 (the lowest).

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#secondary setup-priority 2
```

secondary traffic

Use this command to identify the traffic type for this RSVP Trunk.

Use the `no` parameter with this command to unset the configured traffic type.

Command Syntax

```
secondary traffic (guaranteed|controlled-load)
no secondary traffic
```

Parameters

`guaranteed` Guaranteed traffic

`controlled-load` Controlled load traffic

Default

Controlled load is the default traffic type.

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#secondary traffic guaranteed
```

snmp restart rsvp

Use this command to restart SNMP in Resource Reservation Protocol -Traffic Engineering (RSVP-TE)

Command Syntax

```
snmp restart rsvp
```

Parameters

None

Default

By default, snmp restart rsvp is disabled

Command Mode

Configure mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#snmp restart rsvp
```

to A.B.C.D

Use this command to specify an IPv4 egress for an LSP. When configuring an LSP, you must specify the address of the egress router by using this command in the trunk node. An egress definition is a mandatory attribute; no RSVP session is created when an egress is not defined.

Use the `no` parameter with this command to unset the configured egress address.

Command Syntax

```
to A.B.C.D
no to
```

Parameters

None

Default

The operator must specify an egress for LSP initialization to begin.

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#to 10.10.0.5
```

update-type

Use this command to change the method of updating attributes for sessions (primary/ secondary) for this trunk.

- If make-before-break is configured (default type), a new LSP is created for each attribute update. When the new LSP becomes operational, the original LSP is torn down.
- If break-before-make is configured, the existing LSP is torn down and restarted for each attribute update.

Use the `no` parameter with this command to remove an update type.

Command Syntax

```
update-type (make-before-break|break-before-make)
no update-type
```

Parameters

`make-before-break`
: Make before break update

`break-before-make`
: Break before make update

Default

By default, make-before-break types of updates are carried out.

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk T1
(config-trunk)#update-type break-before-make

#configure terminal
(config)#rsvp-trunk T1
(config-trunk)#update-type make-before-break
```

CHAPTER 2 Show Commands

This chapter describes the RSVP-TE show commands.

- show debugging rsvp
- show rsvp
- show rsvp admin-groups
- show rsvp bypass
- show rsvp bypass detail
- show rsvp bypass lsp-address-list
- show rsvp bypass protected-lsp-list
- show rsvp control-adjacency
- show rsvp data-link
- show rsvp graceful-restart
- show rsvp interface
- show rsvp l2-info
- show rsvp local-addresses
- show rsvp neighbor
-
- show rsvp path
- show rsvp protected-lsp-reop-list
- show rsvp session
- show rsvp session count
- show rsvp session egress
- show rsvp session ingress
- show rsvp session LSP-NAME
- show rsvp session transit
- show rsvp statistics
- show rsvp summary-refresh
- show rsvp trunk
- show rsvp trunk multi-sec-detail
- show rsvp version

show debugging rsvp

This command displays the status of the options selected by the `debug RSVP` command.

Command Syntax

```
show debugging rsvp
```

Parameters

None

Command Mode

Exec and Privileged Exec modes

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show debugging rsvp
NSM debugging status:
  RSVP event debugging is on
  RSVP packet debugging is on
  RSVP incoming packet debugging is on
  RSVP outgoing packet debugging is on
  RSVP hexadecimal dump debugging is on
#
```

Table 2-1 explains the show command output fields.

Table 2-1: show debugging rsvp output fields

Field	Description
NSM debugging status	Debugging is enabled or disabled on a per-interface basis, using the commands.

show rsvp

Use this command to display data about the RSVP daemon.

Command Syntax

```
show rsvp
```

Parameters

None

Command Mode

Exec and Privileged Exec modes

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show rsvp
RSVP Version                      : 1
Process uptime                    : 8 minutes
RSVP Refresh Reduction            : Enabled
RSVP Message Acknowledgement      : Disabled
Bundle Send                       : Disabled
NSM Connection                    : Up
CSPF Connection                   : Up
CSPF usage                        : Enabled
RSVP Refresh Timer                : 5
Keep Multiplier                   : 3
Acknowledgement Await Timeout     : 10
Explicit-Null For Direct Conn     : Disabled
Local Protection                  : Disabled
Hello Receipt                     : Disabled
Hello Interval                    : 2
Hello Timeout                     : 10
Loop detection                    : Enabled (all interface)
Override Diffserv                 : Disabled
Ingress                           : 1.1.1.1
Penultimate Hop Popping           : Enabled
Refresh PATH msg parsing          : Enabled
Refresh RESV msg parsing          : Enabled
Detour identification             : Sender-Template

#
```

Table 2-2 explains the show command output fields.

Table 2-2: show rsvp output fields

Field	Description
RSVP Version	Version number associated with the RSVP ingress route.
Process uptime	Duration of the process running time.
RSVP Refresh Reduction	Measure of processing over head requests of refresh messages. Refresh reduction detail extensions improve routing device performance by reducing the process overhead, thus increasing the number of LSPs a routing device can support.
RSVP Message Acknowledgement	Acknowledge message for refresh reductions.
Bundle Send	Disables sending of Bundle Messages for a system.
NSM Connection	The Network Services Module (NSM) sends unsolicited messages to, or receives unsolicited messages from, the QoS (quality of service) module.
CSPF Connection	NSM passes the information to CSPF.
CSPF usage	CSPF finds the shortest path toward the LSP’s egress router, taking into account explicit-path constraints.
RSVP Refresh Timer	Time interval used to generate periodic RSVP messages.
Keep Multiplier	Number of RSVP messages that can be lost before an RSVP state is declared stale.
Acknowledgment Await Timeout	The router that initiates the acknowledgment messages for an RSVP session waits for the timeout.
Explicit-Null For Direct Conn	Advertise label 0 to the egress routing device of an LSP. Explicit null: enabled or disabled.
Local Protection	A local repair mechanism is in use to maintain this tunnel.
Hello Receipt	To exchange Hello messages among neighbors.
Hello Interval	Frequency at which RSVP hellos are sent on this interface (in seconds).
Hello Timeout	RSVP Hello State Timer feature detects when a neighbor is down and triggers faster state timeout.
Loop detection	Loop back Detection (LBD) provides protection against loops by transmitting loop protocol packets out of ports where loop protection has been enabled.
Override Diffserv	Diffserv helps to carry the EXP-to-PHB mapping for signaled E-LSP or the PSC value for L-LSP.
Ingress	Information about ingress RSVP sessions.
Penultimate Hop Popping	Removes the label one hop before its destination.
Refresh PATH msg parsing	Refresh message supports the refreshing of RSVP state without the transmission of conventional Path messages.
Refresh RESV msg parsing	Refresh message supports the refreshing of RSVP state without the transmission of conventional Resv messages.
Detour identification	Detours are calculated to avoid the immediate downstream link and node.

show rsvp admin-groups

Use this command to display all known administrative groups configured through the NSM for the system.

Command Syntax

```
show rsvp admin-groups
```

Parameters

None

Command Mode

Exec and Privileged Exec modes

Applicability

This command was introduced before OcNOS version 1.3.

Example

This is a sample output showing four administrative groups configured through NSM.

```
#show rsvp admin-groups
 Admin group detail:
  Value of 0 associated with admin group 'a'
  Value of 1 associated with admin group 'b'
  Value of 2 associated with admin group 'c'
  Value of 3 associated with admin group 'd'
#
```

Table 2-3 explains the show command output fields.

Table 2-3: show rsvp admin-groups output field

Field	Description
Admin group detail	Administrative groups details which implements the link coloring of resource classes.

show rsvp bypass

Use this command to display bypass session related information for configured bypass LSPs.

Command Syntax

```
show rsvp bypass
```

Parameters

None

Command Mode

Exec and Privileged Exec modes

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show rsvp bypass
Ingress RSVP:
To              From            Tun-ID   LSP-ID   LSPName                         State Uptime    Rt  Style  Labelin  Labelout
172.31.54.4     172.31.54.1     5001     2201     BYPASS2-172.31.222.19-Bypass    UP    02d15h11m 1 1 SE     -        52516
172.31.54.2     172.31.54.1     5002     2202     BYPASS3-172.31.222.9-Bypass     UP    02d15h11m 1 1 SE     -        0
172.31.54.2     172.31.54.1     5003     2203     BYPASS4-172.31.222.7-Bypass     UP    02d15h11m 1 1 SE     -        0
172.31.53.18   172.31.54.1      5004     2204     BYPASS5-172.31.189.179-Bypass  UP    02d15h11m 1 1 SE     -        52501
```

show rsvp bypass detail

Use this command to display bypass session related information in detail for all configured bypass LSPs or the bypass session with specified bypass tunnel name.

Command Syntax

```
show rsvp bypass (BYPASSNAME | detail)
```

Parameters

BYPASSNAME	Bypass tunnel name
detail	Detailed information of all configured bypass sessions

Command Mode

Exec and Privileged Exec modes

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show rsvp bypass BYPASS2-172.31.222.19
Ingress (Bypass)
172.31.54.4
  From: 172.31.54.1, LSPstate: Up, LSPname: BYPASS2-172.31.222.19-Bypass
  Ingress FSM state: Operational
  Establishment Time: 0s 324ms
  Setup priority: 7, Hold priority: 0
  CSPF usage: Enabled, CSPF Retry Count: 0, CSPF Retry Interval: 30 seconds
  LSP Re-Optimization: Disabled, Re-Optimization Timer: NA, Cspf Client: OSPF
  IGP-Shortcut: Disabled, LSP metric: 1
  LSP Protection: None
  Bypass trunk bandwidth type: Best-effort
   Label in: -,  Label out:    52516,
  Tspec rate: 0, Fspec rate: 0
  Policer: Not Configured
  Tunnel Id: 5001, LSP Id: 2201, Ext-Tunnel Id: 172.31.54.1
  Bind value: 0, Oper state: NA, Alloc mode: NA
  Downstream: 172.31.222.25, po22
  Path refresh: 30 seconds (RR enabled) (due in 12409 seconds)
  Resv lifetime: 157 seconds (due in 130 seconds)
  Retry count: 0, intrvl: 30 seconds
  RRO re-use as ERO: Disabled
  Label Recording: Disabled
  Admin Groups: none
  Configured Path: none
  Exclude Link: 172.31.222.19
  Session Explicit Route Detail :
   172.31.222.25/32 strict
   172.31.180.3/32 strict
   172.31.180.4/32 strict
  Record route:
   ------------------------------------------------------------
```



```
 IP Address        Label
 -------------------------------------------------------------
 <self>
 172.31.222.25
 172.31.180.3
 172.31.180.4
Style: Shared Explicit Filter
Traffic type: controlled-load
Minimum Path MTU: 9174
Current Error:
  Code : None, Value : None
  Originated Node : None, Recorded Time : N/A
Last Signaled Error:
  Code : None, Value : None
  Originated Node : None, Recorded Time : N/A
Trunk Type: mpls
Total LSP protected : 0, Bandwidth in use : 0
```

show rsvp bypass lsp-address-list

Use this command to display address details of every node of a bypass session shown as merge node detail for egress node of bypass session and transit node detail for transit node details of bypass session.

Command Syntax

```
show rsvp bypass BYPASSNAME lsp-address-list
```

Parameters

BYPASSNAME	Bypass tunnel name

Command Mode

Exec and Privileged Exec modes

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show rsvp bypass BYPASS2-172.31.222.19 lsp-address-list
Bypass trunk: BYPASS2-172.31.222.19

Merge Point Router ID: 172.31.54.4

Number of Merge Point IP addresses: 6
IP address:
  172.31.222.22    172.31.180.4     172.31.222.19    172.31.222.27
  172.31.222.31    172.31.186.4

Number of Transit Point IP addresses: 9
IP address:
  172.31.54.3      172.31.222.23    172.31.222.30    172.31.180.2
  172.31.222.25    172.31.186.20    172.31.33.120    172.31.180.3
  172.31.180.5

LSP address query interval: 60 seconds, next retry in: 27 seconds
```

show rsvp bypass protected-lsp-list

Use this command to display the list of sessions protected by a bypass session and match code provides the details bypass is a perfect match or any constraint compromised.

Note: Match code 0 is an indication of perfect match i.e. all constraint of protected session matched. i.e. If protected session asked for node protection, then bypass provides perfect node protection by merging exactly at next to next hop node. If protected session asked for bandwidth protection, bypass provides bandwidth protection. In case of PHP node, even when node protection is requested by protected session, it is not applicable and node protection request is not applicable on PHP node. Thus, a bypass providing link protection with other criteria matching is considered as perfect match.

Note: If a bypass protected session requested for link protection but it is mapped to a bypass node protection, then it is not a perfect match. Match code will be 4 in that case.

Note: When bandwidth protection is requested, highest importance of bypass mapping given to bandwidth protection. When bandwidth protection cannot be provided, then the remaining constraints given importance.

Command Syntax

```
show rsvp bypass (BYPASSNAME|) protected-lsp-list
```

Parameters

BYPASSNAME	Bypass tunnel name

Command Mode

Exec and Privileged Exec modes

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show rsvp bypass protected-lsp-list
Match Code: 0 - Perfect match (all criteria matching), 1 - Bandwidth protection miss, 2 - Node protection miss,
            3 - SRLG protection miss, 4 - Merge point not ideal, 255 - Invalid

Bypass trunk: BYPASS2-172.31.222.19
Bypass trunk bandwidth type: best-effort
Total LSP protected : 0
 Bandwidth in use : 0

Bypass trunk: BYPASS3-172.31.222.9
Bypass trunk bandwidth type: best-effort
List of LSP's Protected:
Tunnel-id  Lsp-Id     Lsp-Name                       Role       Ext_tnl_id      Ingress         Egress          Match-Code
61976      3         to_OKL_STRICT                    Transit    172.31.2.52      172.31.2.52      172.31.54.2      0
61975      4         to_OKL_2ND_LOOSE                 Transit    172.31.2.52      172.31.2.52      172.31.54.2      0
20         23884      to_OKL_1ST_LOOSE::to_OKL_1ST_LOOSE
                                                     Transit    172.31.33.120    172.31.33.120    172.31.54.2      0
22         5478       to_OKL_2ND_LOOSE::to_OKL_2ND_LOOSE
                                                     Transit    172.31.33.120    172.31.33.120    172.31.54.2      0
61974      3          to_OKL_1ST_LOOSE                Transit    172.31.2.52      172.31.2.52      172.31.54.2      0
21         36172      to_OKL_STRICT::to_OKL_STRICT   Transit    172.31.33.120    172.31.33.120    172.31.54.2      0
Total LSP protected : 6
 Bandwidth in use : 0
```

show rsvp control-adjacency

Use this command to display RSVP specific information for control adjacency.

Command Syntax

```
show rsvp control-adjacency
show rsvp control-adjacency CANAME
```

Parameters

CANAME	Use this parameter to display the name of a control-adjacency

Command Mode

Exec and Privileged Exec modes

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#"show rsvp control-adjacency" without parameters:
Control Adj    Admin status   Oper Status    Peer-address   Gifindex
Control Channel

#"show rsvp control-adjacency" with parameters:
Admin Status"Enabled" : "Disabled"
Oper Status"Up" : "Down"
Peer-address
Gifindex
Control-Channel in usecc->name : "N/A"
Control-Channel Gifindex
Control-Channel Local-address
Control-Channel Peer-address
Control-Channel ID
Control-Channel Binding Ifindex
Refresh Reduction usage"Disabled" : "Enabled"
Message Acknowledgement"Enabled" : "Disabled"
Bundle Buffer size
Current Epoch Value
Primary IPv4 addressIPv4_address : "N/A"
Primary IPv6 addressIPv6_address : "N/A"
Configured refresh time
Configured keep multiplier
Acknowledgement Await Timeout
Hello Receipt"Enabled" : "Disabled"
Hello Interval
Hello Timeout
Non IANA Hello exchange"Enabled" : "Disabled"
```

Table 2-4 explains the show command output fields.

Table 2-4: show rsvp control-adjacency output field

Field	Description
Control Adj	Control Adjacency status and configuration.
Admin status	Indicates whether the user can administratively disable a peer while still preserving its configuration. Up = Yes, Down = No.
Oper Status	Displays the current status of the cross-connect segment – Up or Down.
Peer-address	Peer address in aa IPv4 and IPv6 format.
Gifindex	Number of gif index on which RSVP is active.
Control Channel	Control Channel status and configuration.
Refresh Reduction usage	Measure of processing over head requests of refresh messages.
Message Acknowledgment	The router that initiates the acknowledgment messages for an RSVP session.
Bundle Buffer size	Number of bundle buffer size.
Current Epoch Value	Value of the database epoch and number of entries in the epoch.
Primary IPv4 address	Primary IPv4 address of the neighbor interface.
Primary IPv6 address	Primary IPv6 address of the neighbor interface.
Configured Refresh Time	Time refresher which takes to generate periodic RSVP messages.
Configured Keep Multiplier	Number of RSVP messages that can be lost before an RSVP state is declared stale.
Acknowledgment Await Timeout	The router that initiates the acknowledgment messages for an RSVP session waits for the timeout.
Hello Receipt	To exchange Hello messages among neighbors.
Hello Interval	Frequency at which RSVP hellos are sent on this interface (in seconds).
Hello Timeout	RSVP Hello State Timer feature detects when a neighbor is down and triggers faster state timeout.
Non IANA Hello exchange	Hello exchange state in the interface.

show rsvp data-link

Use this command to display RSVP specific information for data links.

Command Syntax

```
show rsvp data-link
show rsvp data-link DLNAME
```

Parameters

DLNAME	Data link name

Command Mode

Exec and Privileged Exec modes

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#sh rsvp data-link
```


show rsvp graceful-restart

To modify the lines displayed, use the | (output modifier token); to save the output to a file, use the > output redirection token.

Command Syntax

```
show rsvp graceful-restart
show rsvp graceful-restart A.B.C.D
```

Parameters

A.B.C.D	IPv4 address of a specific neighbor (optional).

Command Mode

Exec and Privileged Exec modes

Applicability

This command was introduced before OcNOS-SP version 5.0.

Example

```
#show rsvp graceful-restart
Graceful Restart: Enabled
Advertised Restart Time: 180000 msec
Advertised Recovery Time: 360000 msec
Sending Recovery Time: Yes
Remote addr: 172.16.10.2 Local addr: 172.16.10.1
Nbr State: Normal Type: Reroute
Nbr Hello State: Up
LSPs protecting: 0
Restart Time: 0 msec, Recovery Time: 0 msec
Rest of Restart Time: 0 msec, Rest of Recovery Time: 0 msec
```

show rsvp interface

Use this command to display data about RSVP-specific information for interfaces, or about a specific interface.

Command Syntax

```
show rsvp interface
show rsvp interface IFNAME
```

Parameter

IFNAME	The name of the interface to display data.

Command Mode

Exec and Privileged Exec modes

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show rsvp interface eth0
Status                         : Enabled
Interface Index                : 2
Refresh Reduction usage        : Enabled
Message Acknowledgement        : Disabled
Bundle Buffer size             : 65535
Current Epoch Value            : 208043005
Primary IPv4 address           : 10.10.23.1
Primary IPv6 address           : N/A
Interface Type                 : Ethernet
Administrative Group           : a
                               : d
Configured refresh time        : 5
Configured keep multiplier     : 3
Acknowledgement Await Timeout  : 10
Hello Receipt                  : Disabled
Hello Interval                 : 2
Hello Timeout                  : 10
Non IANA Hello exchange        : Disabled
#
```

Table 2-5 explains the show command output fields.

Table 2-5: show rsvp interface output field

Field	Description
Status	Display the status of Resource Reservation Protocol (RSVP).
Interface Index	Number of interface index on which RSVP is active.
Refresh Reduction usage	Measure of processing over head requests of refresh messages.

Table 2-5: show rsvp interface output field

Field	Description
Message Acknowledgement	The router that initiates the acknowledgment messages for an RSVP session.
Bundle Buffer size	Number of bundle buffer size.
Current Epoch Value	Value of the database epoch and number of entries in the epoch.
Primary IPv4 address	Primary IPv4 address of the neighbor interface.
Primary IPv6 address	Primary IPv6 address of the neighbor interface.
Interface Type	Type of interface.
Administrative Group	The administrators who belong to the same administrative group.
Configured Refresh Time	Time refresher which takes to generate periodic RSVP messages.
Configured Keep Multiplier	Number of RSVP messages that can be lost before an RSVP state is declared stale.
Acknowledgment Await Timeout	The router that initiates the acknowledgment messages for an RSVP session waits for the timeout.
Hello Receipt	To exchange Hello messages among neighbors.
Hello Interval	Frequency at which RSVP hellos are sent on this interface (in seconds).
Hello Timeout	RSVP Hello State Timer feature detects when a neighbor is down and triggers faster state timeout.
Non IANA Hello exchange	Hello exchange state in the interface.

show rsvp l2-info

Use this command to display MAC and out interface details of a bypass tunnel which is used to send control messages of protected sessions over bypass tunnel when protected session is using backup.

Command Syntax

```
show rsvp l2-info
```

Parameters

None

Command Mode

Exec and Privileged Exec modes

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show rsvp l2-info
==============================================================
## Bypass ftn l2 info ##
Ftn IX: 1
Out label: 52521 Out if 100022
src addr:(34ef.b63d.57a9)
Dst addr:(34ef.b694.3e08)
==============================================================
==============================================================
## Bypass ftn l2 info ##
Ftn IX: 2
Out label: 3 Out if 100022
src addr:(34ef.b63d.57a9)
Dst addr:(34ef.b694.3e08)
==============================================================
```


show rsvp local-addresses

Use this command to display data about any configured RSVP local address, including either IPv4 or IPv6 addresses.

Command Syntax

```
show rsvp local-addresses
show rsvp local-addresses ipv4
show rsvp local-addresses ipv6
```

Parameters

`ipv4`	Use this parameter to display IPv4 local addresses.
`ipv6`	Use this parameter to display IPv6 local addresses.

Command Mode

Exec and Privileged Exec modes

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show rsvp local-addresses
IPv4 Addresses:
 Address                      Interface
 4.4.4.40                     lo
 10.1.2.40                    eth0
 14.14.14.8                   eth4
 34.0.0.40                    eth2
 80.0.0.40                    eth2
 127.0.0.1                    lo
IPv6 Addresses:
 Address                      Interface
 ::1                          lo
 fe80::202:b3ff:fed5:8dbb     eth4
 fe80::202:b3ff:fed5:9842     eth2
 fe80::20e:cff:fe83:3727      eth0
#
```

Table 2-6 explains the show command output fields.

Table 2-6: show rsvp local-addresses output field

Field	Description
IPv4 Addresses	IPv4 address for the interface.
IPv6 Addresses	IPv6 address for the interface.

Table 2-6: show rsvp local-addresses output field

Field	Description
Address	Address for the interface.
Interface	Name of the interface.

show rsvp neighbor

Use this command to display a list of IPv4 RSVP neighbors or just a single IPv4 RSVP neighbor.

Command Syntax

```
show rsvp neighbor
show rsvp neighbor A.B.C.D
```

Parameters

`A.B.C.D`	Use this parameter to display the IP address of the IPv4 RSVP neighbor.

Command Mode

Exec and Privileged Exec modes

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show rsvp neighbor
IP Address          UpStrm LSP DnStrm LSP RefreshReduc Srefresh In  Type
10.10.20.4          0          1          Enabled      5s           Implicit
10.10.23.2          0          1          Enabled      8s           Implicit
#
```

Table 2-7 explains the show command output fields.

Table 2-7: show rsvp neighbor output field

Field	Description
IP Address	Address for the interface.
UpStrm LSP	Specify the upstream label for the bidirectional label-switched path (LSP).
DnStrm LSP	Specify the dnstream label for the bidirectional label-switched path (LSP).
Refresh Reduc	Refresh reduction improves the scalability, latency, and reliability of Resource Reservation Protocol (RSVP) signaling to enhance network performance and message delivery.
Srefresh In	Remaining seconds for srefresh timer expiry.
Type	Type of neighbor interface.

show rsvp nexthop-cache

Use this command to display the current nexthops being cached by RSVP.

Command Syntax

```
show rsvp nexthop-cache
```

Parameters

None

Command Mode

Exec and Privileged Exec modes

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show rsvp nexthop-cache
Prefix              Nexthop          Outgoing Intf  Valid For   Num Sessions
10.10.20.80/32      0.0.0.0          eth1           12 seconds  1
10.10.23.60/32      0.0.0.0          eth0           17 seconds  1
#
```

Table 2-8 explains the show command output fields.

Table 2-8: show rsvp nexthop-cache output field

Field	Description
Prefix	It is an ordered list and entries are evaluated in order of increasing sequence number.
Nexthop	IP address of the next hop.
Outgoing Intf	Short name of the physical interface through which traffic goes to the protected link.
Valid For	Frequency at which RSVP hellos are sent next hop on this interface (in seconds).
Num Sessions	Number of session in the interface.

show rsvp path

Use this command to display the configured rsvp paths and their configured hops. Specify the pathname to show hops related to a specific path. If no pathname is specified all the rsvp paths are displayed.

Command Syntax

```
show rsvp path
show rsvp path PATHNAME
```

Parameter

PATHNAME	The name of a specific path.

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

Following are sample outputs from this command, with and without a PATHNAME (PRI) specified.

```
#show rsvp path
Path name: PRI, id: 1
 10.10.11.51 strict
 10.10.12.50 strict
 10.10.13.51 strict

Path name: SEC, id: 2
 10.10.10.51 strict

Path name: loop, id: 3
 10.10.11.51 strict
 10.10.12.50 strict
 10.10.13.51 strict
 10.10.14.50 strict
#

#show rsvp path PRI
Path name: PRI, id: 1
 10.10.11.51 strict
 10.10.12.50 strict
 10.10.13.51 strict
#
```

Table 2-9 explains the show command output fields.

Table 2-9: show rsvp path output field

Field	Description
Path name	Name of the path.
id	Address of the rsvp path.

show rsvp protected-lsp-reop-list

Use this command to display list of facility protected sessions which didn't get any bypass protection or didn't get a perfect bypass protection. These sessions are checked for better protection whenever a new bypass session comes up.

Command Syntax

```
show rsvp protected-lst-reop-list
```

Parameters

```
None
```

Command Mode

Exec and Privileged Exec modes

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show rsvp protected-lsp-reop-list
Tunnel-id  Lsp-Id     Lsp-Name                        Role       Ext_tnl_id       Ingress          Egress           Protected
222       169       LHR_t222                         Transit    172.31.53.18     172.31.53.18     172.31.2.52      Yes
204       1522      LHR_t204                         Transit    172.31.53.18     172.31.53.18     172.31.33.120    Yes
17         52608      GGN_NDLS_2ND_LOOSE::to_CISCO_2ND_LOOSE
                                                       Transit    172.31.33.120    172.31.33.120    172.31.53.18     Yes
```

show rsvp session

Use this command to display session-related information for configured LSPs.

Command Syntax

```
show rsvp session
show rsvp session up
show rsvp session up detail
show rsvp session down
show rsvp session down detail
```

Parameters

`up`	Use this parameter to display sessions that are currently operational.
`down`	Use this parameter to display sessions that are currently not operational.
`detail`	Use this parameter to display detailed session-related information.

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

Following is a sample output from the command using the detail parameter.

```
#show rsvp session detail
Ingress (Primary)
10.10.21.3
  From: 1.1.1.1, LSPstate: Up, LSPname: t1
  Setup priority: 5, Hold priority: 5
  CSPF usage: Disabled
  LSP Protection: None
  Label in: -,  Label out: 16,
  Tspec rate: 10m, Fspec rate: 10m
  Tunnel Id: 1, LSP Id: 2, Ext-Tunnel Id: 1.1.1.1
  Downstream: 10.10.23.2, eth0
  Path refresh: 5 seconds (due in 6772 seconds)
  Resv lifetime: 26 seconds (due in 25 seconds)
  Retry count: 0, intrvl: 30 seconds
  RRO re-use as ERO: Disabled
  Label Recording: Disabled
  Admin Groups: none
  Configured Path: p1 (in use)
  Configured Explicit Route Detail :
   10.10.23.2/32 strict
  Session Explicit Route Detail :
   10.10.23.2/32 strict
  Record route: <self> 10.10.23.2 10.10.21.3
  Style: Shared Explicit Filter
```

```
      Traffic type: controlled-load
      Minimum Path MTU: 1500
      LSP Type:  ELSP_SIGNAL
      CLASS    DSCP_value     EXP_value
    #
```

Table 2-10 explains the show command output fields.

Table 2-10: show rsvp session output field

Field	Description
Ingress (Primary)	Information about ingress RSVP sessions. Each session has one line of output.
From	Source (ingress switch) of the session.
LSP state	State of the LSP that is being handled by this RSVP session. It can be either Up, Dn (down), or Admin Dn. Admin Dn indicates that the LSP is being taken down gracefully.
LSPname	Name of the LSP.
Setup priority	Value of the setup priority.
Hold priority	Determines the degree to which an LSP holds onto its session reservation after the LSP has been set up successfully.
CSPF usage	CSPF usage state in the rsvp session.
LSP Protection	Protects the traffic failures.
Label in	Incoming label for this LSP.
Label out	Outgoing label for this LSP.
Tspec rate	Sender's traffic specification, which describes the sender's traffic parameters.
Fspec rate	Fspec peak rate values.
Tunnel id	Tunnel address (destination port) for the session.
LSP id	Address of the LSP in the interface.
Ext-Tunnel Id	Session address for the ext-tunnel.
Down stream	Specify the dnstream label for the bidirectional label-switched path (LSP).
Path refresh	Path messages are sent periodically to refresh path states. The refresh interval is controlled by a variable called the refresh time.
Resv lifetime	Number of seconds remaining in the lifetime of the reservation.
Retry count	Number of times sanity polling periodically checks for an error condition in the FPC.
intrvl	Interval sets the time for the messages in order to control the session.
LSP Type	Type of ELSP signal.

show rsvp session count

Use this command to display session-related information for configured LSPs.

Command Syntax

```
show rsvp session count
show rsvp session count egress
show rsvp session count ingress
show rsvp session count transit
```

Parameters

`egress`	Use this parameter to display the number of configured egress sessions.
`ingress`	Use this parameter to display the number of configured ingress sessions.
`transit`	Use this parameter to display the number of configured transmit sessions.

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show rsvp session count
Total configured: 1520, Up 1520, Down 0
#
```

Table 2-11 explains the show command output fields.

Table 2-11: show rsvp session count output field

Field	Description
Total configured	Number of configured rsvp session in the interface.

show rsvp session egress

Use this command to display session-related information for an egress router.

Command Syntax

```
show rsvp session egress
show rsvp session egress A.B.C.D
show rsvp session egress X:X::X:X
show rsvp session egress detail
show rsvp session egress down
show rsvp session egress down detail
show rsvp session egress up
show rsvp session egress up detail
```

Parameters

`A.B.C.D`	Use this parameter to display an IPv4 address of an egress router
`X:X::X:X`	Use this parameter to display an IPv6 address of an egress router
`down`	Use this parameter to display sessions that are currently not operational
`up`	Use this parameter to display sessions that are currently operational
`detail`	Use this parameter to display detailed session-related information

Command Mode

Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#show rsvp session egress without parameters or with "up" or "down":
%s RSVP:
To               From             State                Pri Rt  Style Labelin
Labelout LSPName                            Uptime  Est.time   DSType
...
Total %d displayed

#show rsvp session egress with parameters:
"Bypass", "Primary", "Detour", "Secondary"
 Make-Before-Break Sibling for session with LSP-ID:prefix4: prefix6
  From: u.prefix4: u.prefix6
LSPstate: %s, LSPname:
      "Up/"Using Backup"/"Using Secondary"
      "Dn",
  Revert hold timer is ON due to expire in %d seconds
  Revert Timer Finished, Forced Switch to Secondary LSP In Effect
  CSPF usage: "Disabled" : "Enabled"
  , CSPF Retry Count: %d, CSPF Retry Interval: %d seconds"
  IGP-Shortcut: Enabled, LSP metric:
```

```
    IGP-Shortcut: Disabled, LSP metric:
    LSP Protection:
    Bypass trunk:
    Label in:
    Label out:
    Tspec rate:
    Fspec rate:
    Policer: Configured
        and installed in hardware
        but not installed in hardware
        Not Configured
    Tunnel Id: %d, LSP Id: %d
  Ext-Tunnel Id:
    Downstream:
    Upstream:
    Path refresh: %d seconds (RR enabled), (due in %d seconds)
    Path lifetime: %d seconds (due in %d seconds)
    Resv refresh: %d seconds (due in %d seconds)
    Resv lifetime: %d seconds (due in %d seconds)
    Retry count: %d, intrvl: %d seconds", # remaining, next retry in: %d
  seconds",
    RRO re-use as ERO:  "Enabled" : "Disabled"
    Label Recording: "Enabled" : "Disabled"
    FRR Admin Groups/Admin Groups:
       ***admin group info***
    Exclude path detail:
     Exclude "Link" : "Node
     Configured Path: "none" : "in use" : "not in use"
     %s Explicit Route Detail  "Configured" : "Received"
         "strict" : "loose"
    Record route: " <self>") "  ...incomplete"
    Style: %s\n", rsvp_style_to_str (style));
    Traffic type:  "guaranteed" : "controlled-load" : "none"
    Minimum Path MTU:
    Traffic type: N/A
    Minimum Path MTU: N/A
    LSP Type:  "ELSP_SIGNAL" : "ELSP_CONFIG"
    CLASS    DSCP_value     EXP_value
    The class to exp bits mapping is invalid.
    LSP Type:  L-LSP
    LLSP DSCP: %d%d%d%d%d%d   CLASS: %4s",
    DSTE CLass Type Number: Invalid, Class Type name(configured):
    DSTE Class Type Number: %d, Class Type name:
    Last Recorded Error Code: %s (%d)
    Last Recorded Error Value: %s (%d)
    Node where Last Recorded Error originated:
    Trunk Type: "gmpls" : "mpls"
    Tesid:
  Merge Point Adderss [%d] =
```

Table 2-12 explains the show command output fields.

Table 2-12: show rsvp session egress output field

Field	Description
LSP state	State of the LSP that is being handled by this RSVP session. It can be either Up, Dn (down), or Admin Dn. Admin Dn indicates that the LSP is being taken down gracefully.
LSP name	Name of the LSP.
CSPF usage	CSPF usage state in the rsvp session.
CSPF Retry Count	Number of times CSPF tried to find the path.
CSPF Retry Interval	The interval at which CSPF retry to find the path.
IGP-Shortcut	Status of IGP shortcut for the RSVP trunk.
LSP metric	Relative/Absolute metric value of the LSP.
LSP Protection	LSP Protection configured for the RSVP trunk.
Bypass trunk	Name for the configured Bypass trunk.
Tspec rate	Sender's traffic specification, which describes the sender's traffic parameters.
Fspec rate	Fspec peak rate values.
Policer	QoS Policy configured for the RSVP trunk.
Tunnel Id	Tunnel identifier (destination port) for the RSVP session.
LSP Id	Address of the LSP in the interface.
Ext-Tunnel Id	Ext Tunnel identifier (destination port) for the RSVP session.
Down stream	Specify the dn stream label for the bidirectional label-switched path (LSP).
Upstream	Address of the previous hop for the egress session.
Path refresh	Path messages are sent periodically to refresh path states. The refresh interval is controlled by a variable called the refresh time.
Path lifetime	Number of seconds remaining in the lifetime of the reservation.
Resv refresh	Remaining time in seconds for the next Resv refresh.
Resv lifetime	Number of seconds remaining in the lifetime of the reservation.
Retry count	Number of times sanity polling periodically checks for an error condition in the FPC.
intrvl	Interval sets the time for the messages in order to control the session.
next retry in	Remaining time in seconds for the next retry.
RRO re-use as ERO	Enabling to re-use Record route as Explicit route for rsvp session.
Label Recording	Enabling to record the labels exchanged by all the peers.
FRR Admin Groups/Admin Groups	Resource affinities associated with the rsvp session.

Table 2-12: show rsvp session egress output field

Field	Description
Exclude path detail	Detailed List of the link addresses to be excluded for RSVP Bypass session.
Exclude Link	Address of the Link to be excluded for RSVP Bypass session.
Configured Path	Configured path name associated with the rsvp session.
Record route	Established rsvp path with each hop information.
Style	Reservation style associated with the rsvp session.
Traffic type	Traffic type associated with the rsvp session.
Minimum Path MTU	Path maximum transmission unit (MTU) discovery in the interface.
LSP Type	Type of ELSP signal.
CLASS	Name of the class which is associated with rsvp session.
DSCP_value	DSCP value of diff-serv class which is associated with rsvp session.
EXP_value	EXP value of diff-serv class which is associated with rsvp sess
DSTE Class Type Number	Diff-serv class type number associated with rsvp session.
Class Type name	Diff-serv class type name associated with rsvp session.
Last Recorded Error Code	The last recorded error code for the RSVP session.
Last Recorded Error Value	The last recorded error for the RSVP session.
Node where Last Recorded Error originated	Error originated node in the rsvp session.
Trunk Type	Trunk type in the rsvp session.
Tesid	Traffic Engineering Service Instance Identifier
Merge Point Adderss	Address of the node where the Bypass LSP joins with the protected LSP.

show rsvp session ingress

Use this command to display session-related information for an ingress router.

Command Syntax

```
show rsvp session ingress
show rsvp session ingress A.B.C.D
show rsvp session ingress X:X::X:X
show rsvp session ingress detail
show rsvp session ingress down
show rsvp session ingress down detail
show rsvp session ingress up
show rsvp session ingress up detail
```

Parameters

A.B.C.D	Use this parameter to display an IPv4 address of an ingress router
X:X::X:X	Use this parameter to display an IPv6 address of an ingress router.
down	Use this parameter to display sessions that are currently not operational
up	Use this parameter to display sessions that are currently operational
detail	Use this parameter to display detailed session-related information

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

`#show rsvp session ingress` (without parameters or with `up` or `down`:)

```
%s RSVP:
To               From             State                 Pri Rt  Style Labelin
Labelout LSPName                            Uptime  Est.time   DSType
...
Total %d displayed

#show rsvp session ingress detail
Ingress (Primary)
41.41.41.31
From: 29.29.29.29, LSPstate: Up, LSPname: t1-Primary
Ingress FSM state: Operational
Establishment Time: 0s 3ms
Setup priority: 7, Hold priority: 0
CSPF usage: Enabled, CSPF Retry Count: 0, CSPF Retry Interval: 30 seconds
IGP-Shortcut: Disabled, LSP metric: 1
LSP Protection: None
```

```
Label in: -, Label out: 24320, ELC
```

`#show rsvp session ingress` (with parameters:)

```
"Bypass", "Primary", "Detour", "Secondary"
 Make-Before-Break Sibling for session with LSP-ID:prefix4: prefix6
  From: u.prefix4: u.prefix6
LSPstate: %s, LSPname:
      "Up/"Using Backup"/"Using Secondary"
      "Dn",
  Revert hold timer is ON due to expire in %d seconds
  Revert Timer Finished, Forced Switch to Secondary LSP In Effect
  CSPF usage: "Disabled" : "Enabled"
  CSPF Retry Count: %d, CSPF Retry Interval: %d seconds"
  IGP-Shortcut: Enabled, LSP metric:
  IGP-Shortcut: Disabled, LSP metric:
  LSP Protection:
  Bypass trunk:
  Label in:
  Label out:
  Tspec rate:
  Fspec rate:
  Policer: Configured
      and installed in hardware
      but not installed in hardware
      Not Configured
  Tunnel Id: %d, LSP Id: %d
Ext-Tunnel Id:
  Downstream:
  Upstream:
  Path refresh: %d seconds (RR enabled), (due in %d seconds)
  Path lifetime: %d seconds (due in %d seconds)
  Resv refresh: %d seconds (due in %d seconds)
  Resv lifetime: %d seconds (due in %d seconds)
  Retry count: %d, intrvl: %d seconds", # remaining, next retry in: %d
seconds",
  RRO re-use as ERO:  "Enabled" : "Disabled"
  Label Recording: "Enabled" : "Disabled"
  FRR Admin Groups/Admin Groups:
     ***admin group info***
  Exclude path detail:
   Exclude "Link" : "Node
   Configured Path: "none" : "in use" : "not in use"
   %s Explicit Route Detail  "Configured" : "Received"
       "strict" : "loose"
  Record route: " <self>") "  ...incomplete"
  Style: %s\n", rsvp_style_to_str (style));
  Traffic type:  "guaranteed" : "controlled-load" : "none"
  Minimum Path MTU:
  Traffic type: N/A
  Minimum Path MTU: N/A
  LSP Type:  "ELSP_SIGNAL" : "ELSP_CONFIG"
  CLASS    DSCP_value     EXP_value
  The class to exp bits mapping is invalid.
  LSP Type:  L-LSP
  LLSP DSCP: %d%d%d%d%d%d   CLASS: %4s",
  DSTE CLass Type Number: Invalid, Class Type name(configured):
```

```
      DSTE Class Type Number: %d, Class Type name:
      Last Recorded Error Code: %s (%d)
      Last Recorded Error Value: %s (%d)
      Node where Last Recorded Error originated:
      Trunk Type: "gmpls" : "mpls"
      Tesid:
    Merge Point Adderss [%d] =


    #show mpls forwarding-table
    Codes: > - installed FTN, * - selected FTN, p - stale FTN, B - BGP FTN, K -
    CLI FTN, t - tunnel
    L - LDP FTN, R - RSVP-TE FTN, S - SNMP FTN, I - IGP-Shortcut,
    U - unknown FTN, O - SR-OSPF FTN, i - SR-ISIS FTN, k - SR-CLI FTN

    Code    FEC          FTN-ID Tunnel-id  Pri  LSP-Type   Out- Label  ELC  Out-
    Intf  Nexthop
    R(t)> 2 9.29.29.29/32  1    5001      Yes LSP_DEFAULT   24322    yes
    eth2    1.41.41.31
    R(t)>   29.29.29.29/32  2   5001       No  LSP_DEFAULT   4322    yes
    eth1    69.69.69.42
```

Table 2-13 explains the show command output fields.

Table 2-13: show rsvp session ingress output field

Field	Description
LSP state	State of the LSP that is being handled by this RSVP session. It can be either Up, Dn (down), or Admin Dn. Admin Dn indicates that the LSP is being taken down gracefully.
LSP name	Name of the LSP.
CSPF usage	CSPF usage state in the rsvp session.
CSPF Retry Count	Number of times CSPF tried to find the path.
CSPF Retry Interval	The interval at which CSPF retry to find the path.
IGP-Shortcut	Status of IGP shortcut for the RSVP trunk.
LSP metric	Relative/Absolute metric value of the LSP.
LSP Protection	LSP Protection configured for the RSVP trunk.
Bypass trunk	Name for the configured Bypass trunk.
Tspec rate	Sender's traffic specification, which describes the sender's traffic parameters.
Fspec rate	Fspec peak rate values.
Policer	QoS Policy configured for the RSVP trunk.
Tunnel Id	Tunnel identifier (destination port) for the RSVP session.
LSP Id	Address of the LSP in the interface.
Ext-Tunnel Id	Ext Tunnel identifier (destination port) for the RSVP session.

Table 2-13: show rsvp session ingress output field

Field	Description
Down stream	Specify the dn stream label for the bidirectional label-switched path (LSP).
Upstream	Address of the previous hop for the egress session.
Path refresh	Path messages are sent periodically to refresh path states. The refresh interval is controlled by a variable called the refresh time.
Path lifetime	Number of seconds remaining in the lifetime of the reservation.
Resv refresh	Remaining time in seconds for the next Resv refresh.
Resv lifetime	Number of seconds remaining in the lifetime of the reservation.
Retry count	Number of times sanity polling periodically checks for an error condition in the FPC.
intrvl	Interval sets the time for the messages in order to control the session.
next retry in	Remaining time in seconds for the next retry.
RRO re-use as ERO	Enabling to re-use Record route as Explicit route for rsvp session.
Label Recording	Enabling to record the labels exchanged by all the peers.
FRR Admin Groups/Admin Groups	Resource affinities associated with the rsvp session.
Exclude path detail	Detailed List of the link addresses to be excluded for RSVP Bypass session.
Exclude Link	Address of the Link to be excluded for RSVP Bypass session.
Configured Path	Configured path name associated with the rsvp session.
Record route	Established rsvp path with each hop information.
Style	Reservation style associated with the rsvp session.
Traffic type	Traffic type associated with the rsvp session.
Minimum Path MTU	Path maximum transmission unit (MTU) discovery in the interface.
LSP Type	Type of ELSP signal.
CLASS	Name of the class which is associated with rsvp session.
DSCP_value	DSCP value of diff-serv class which is associated with rsvp session.
EXP_value	EXP value of diff-serv class which is associated with rsvp sess
DSTE Class Type Number	Diff-serv class type number associated with rsvp session.
Class Type name	Diff-serv class type name associated with rsvp session.
Last Recorded Error Code	The last recorded error code for the RSVP session.
Last Recorded Error Value	The last recorded error for the RSVP session.

Table 2-13: show rsvp session ingress output field

Field	Description
Node where Last Recorded Error originated	Error originated node in the rsvp session.
Trunk Type	Trunk type in the rsvp session.
Tesid	Traffic Engineering Service Instance Identifier.
Merge Point Adderss	Address of the node where the Bypass LSP joins with the protected LSP.

show rsvp session LSP-NAME

Use this command to display information only for sessions with a specified name.

Note: This command doesn't work for sessions with tunnel name larger than 32 characters or sessions originated from non-OcNOS solutions.

Command Syntax

```
show rsvp session LSP-NAME
show rsvp session LSP-NAME primary
show rsvp session LSP-NAME secondary
```

Parameters

`primary`	Use this parameter to display any primary LSP sessions
`secondary`	Use this parameter to display any secondary LSP sessions

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Usage

Following is a sample output from the command displaying session information about the LSP named `t1`.

```
#show rsvp session t1
Ingress (Primary)
192.168.0.90
  From: 192.168.0.63, LSPstate: Up, LSPname: t1
  Setup priority: 7, Hold priority: 0
  CSPF usage: Disabled, CSPF Retry Count: 0, CSPF Retry Interval: 30 seconds
  Label in: -,  Label out: 17,
  Tspec rate: 0
  Tunnel Id: 1, LSP Id: 1, Ext-Tunnel Id: 192.168.0.63
  Downstream: 10.10.23.60, eth0
  Path refresh: 30 seconds (due in 34 seconds)
  Resv lifetime 157 seconds (due in 155 seconds)
  Retry Count: 0, Retry Interval: 30 seconds
  RRO re-use as ERO: Enabled
  Labels Recording: Disabled
  Admin Groups: include-any -->  0(a)
  Configured Path: p1 (in use)
  Configured Explicit Route Detail :
   10.10.23.60/32 loose
  Session Explicit Route Detail :
   10.10.23.60/32 loose
   10.10.21.90/32 loose
  Record route: <self> 10.10.23.60 10.10.21.90
  Style: Shared Explicit Filter
  Traffic type: controlled-load
  Minimum Path MTU: 1500
```

```
    Last Recorded Error Code: None
    Last Recorded Error Value: None
  #
```

Table 2-14 explains the show command output fields.

Table 2-14: show rsvp session LSP-NAME output field

Field	Description
Ingress (Primary)	Information about ingress RSVP sessions. Each session has one line of output.
From	Source (ingress switch) of the session.
LSP state	State of the LSP that is being handled by this RSVP session. It can be either Up, Dn (down), or Admin Dn. Admin Dn indicates that the LSP is being taken down gracefully.
LSPname	Name of the LSP.
Setup priority	Value of the setup priority.
Hold priority	Determines the degree to which an LSP holds onto its session reservation after the LSP has been set up successfully.
CSPF usage	CSPF usage state in the rsvp session.
LSP Protection	Protects the traffic failures.
Label in	Incoming label for this LSP.
Label out	Outgoing label for this LSP.
Tspec rate	Sender's traffic specification, which describes the sender's traffic parameters.
Fspec rate	Fspec peak rate values.
Tunnel id	Tunnel address (destination port) for the session.
LSP id	Address of the LSP in the interface.
Ext-Tunnel Id	Session address for the ext-tunnel.
Down stream	Specify the dnstream label for the bidirectional label-switched path (LSP).
Path refresh	Path messages are sent periodically to refresh path states. The refresh interval is controlled by a variable called the refresh time.
Resv lifetime	Number of seconds remaining in the lifetime of the reservation.
Retry count	Number of times sanity polling periodically checks for an error condition in the FPC.
intrvl	Interval sets the time for the messages in order to control the session.
RRO re-use as ERO	Enabling to re-use Record route as Explicit route for rsvp session.
Label Recording	Enabling to record the labels exchanged by all the peers.
Admin Groups	Resource affinities associated with the rsvp session.

Table 2-14: show rsvp session LSP-NAME output field

Field	Description
Configured Path	Configured path name associated with the rsvp session.
Configured Explicit Route Detail	Configured explicit route with each hop information.
Session Explicit Route Detail	Established explicit route with each hop information.
Record route	Established rsvp path with each hop information.
Style	Reservation style associated with the rsvp session.
Traffic type	Traffic type associated with the rsvp session.
Minimum Path MTU	Path maximum transmission unit (MTU) discovery in the interface.
Last Recorded Error Code	Recorded error code for the last time service ran.
Last Recorded Error Value	No Recorded error value for the last time service ran.

show rsvp session transit

Use this command to display session-related information for the transit or intermediate router.

Command Syntax

```
show rsvp session transit
show rsvp session transit detail
show rsvp session transit up
show rsvp session transit down
show rsvp session transit up detail
show rsvp session transit down detail
```

Parameters

`up`	Use this parameter to display sessions that are operational
`down`	Use this parameter to display sessions that are not operational
`detail`	Use this parameter to display detailed session-related information

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

Following are sample outputs from the command displaying detailed session information for the transit router.

```
#show rsvp session transit detail
Transit (Primary)
10.10.21.3
  From: 1.1.1.1, LSPstate: Up, LSPname: t1
  Setup priority: 5, Hold priority: 5
  LSP Protection: None
  Label in: 16,  Label out: 3,
  Tspec rate: 10m, Fspec rate: 10m
  Tunnel Id: 1, LSP Id: 2, Ext-Tunnel Id: 1.1.1.1
  Downstream: 10.10.21.3, eth1   Upstream: 10.10.23.1, eth3
  Path refresh: 5 seconds (due in 6155 seconds)
  Path lifetime: 26 seconds (due in 25 seconds)
  Resv refresh: 5 seconds (due in 2533 seconds)
  Resv lifetime: 26 seconds (due in 25 seconds)
  RRO re-use as ERO: Disabled
  Label Recording: Disabled
  Admin Groups:   Received Explicit Route Detail :
   10.10.23.2/32 strict
  Record route: 10.10.23.1 <self> 10.10.21.3
  Style: Shared Explicit Filter
  Traffic type: controlled-load
  Minimum Path MTU: 1500
  LSP Type:  ELSP_SIGNAL
```

```
      CLASS    DSCP_value     EXP_value
      af43      100110           7
      DSTE Class Type Number: 0, Class Type name: default
    #
```

Table 2-15 explains the show command output fields.

Table 2-15: show rsvp session transit output field

Field	Description
Transit (Primary)	Transit RSVP sessions information in the interface.
From	Source (ingress switch) of the session.
LSP state	State of the LSP that is being handled by this RSVP session. It can be either Up, Dn (down), or Admin Dn. Admin Dn indicates that the LSP is being taken down gracefully.
LSP name	Name of the LSP.
Setup priority	Value of the setup priority.
Hold priority	Determines the degree to which an LSP holds onto its session reservation after the LSP has been set up successfully.
LSP Protection	Protects the traffic failures.
Label in	Incoming label for this LSP.
Label out	Outgoing label for this LSP.
Tspec rate	Sender's traffic specification, which describes the sender's traffic parameters.
Fspec rate	Fspec peak rate values.
Tunnel id	Tunnel address (destination port) for the session.
LSP id	Address of the LSP in the interface.
Ext-Tunnel Id	Session address for the ext-tunnel.
Down stream	Specify the dnstream label for the bidirectional label-switched path (LSP).
Path refresh	Path messages are sent periodically to refresh path states. The refresh interval is controlled by a variable called the refresh time.
Resv lifetime	Number of seconds remaining in the lifetime of the reservation.
RRO re-use as ERO	Enabling to re-use Record route as Explicit route for rsvp session.
Label Recording	Enabling to record the labels exchanged by all the peers.
Admin Groups	Resource affinities associated with the rsvp session.
Configured Explicit Route Detail	Configured path name associated with the rsvp session.

Table 2-15: show rsvp session transit output field

Field	Description
Record route	Recorded route for the session, taken from the record route object. Normally this value will be the same as that of explct route. Differences indicate that path rerouting has occurred, typically during fast reroute.
Style	Reservation style associated with the rsvp session.
Traffic type	Traffic type associated with the rsvp session.
Minimum Path MTU	Path maximum transmission unit (MTU) discovery in the interface.
LSP Type	Type of LSP for Diffserv services(E-LSP or L-LSP).
CLASS	Name of the class which is associated with rsvp session.
DSCP_value	DSCP value of diff-serv class which is associated with rsvp session.
EXP_value	EXP value of diff-serv class which is associated with rsvp session.
DSTE Class Type Number	Diff-serv class type number associated with rsvp session.
Class Type name	Diff-serv class type name associated with rsvp session.

show rsvp statistics

Use this command to display overall statistics of different type of RSVP control messages sent and received in a node.

Command Syntax

```
show rsvp statistics
```

Parameters

None

Command Mode

```
Exec and Privileged Exec modes
```

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show rsvp statistics
  PacketType              Total
                  Sent       Received
  Path             627          501
  PathErr            0           24
  PathTear           1           27
  Resv FF           30            9
  Resv WF            0            0
  Resv SE          646          583
  Resv Err           0            0
  ResvTear           0            0
  ResvConf           0            0
  Hello         330604       334461
  Bundle          1006          866
  Ack               50           14
  SRefresh       34348        32424
  Notify             0            0
```

show rsvp summary-refresh

Use this command to display RSVP summary refresh data.

Command Syntax

```
show rsvp summary-refresh
```

Parameters

None

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show rsvp summary-refresh:
Neighbor Addr       Tunnel ID  LSP ID     Ingress              Egress
```

Table 2-16 explains the show command output fields.

Table 2-16: show rsvp trunk output field

Field	Description
Neighbor Addr	Neighbor address on the primary address of the interface.
Tunnel ID	Tunnel identifier (destination port) for the RSVP session.
LSP ID	Address of the LSP in the interface.
Ingress	Information about ingress RSVP sessions.
Egress	Information about egress RSVP sessions.

show rsvp trunk

Use this command to display information for a specific trunk or for all trunks.

Command Syntax

```
show rsvp trunk
show rsvp trunk NAME
show rsvp trunk detail
```

Parameters

NAME	Enter the name of a trunk
detail	Use this parameter to display detailed information for all trunks

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show rsvp trunk
Trunk Name       Trunk ID  Type         # Sess        Egress Address(es)
T1               101       P2P              1         4.4.4.4
T2               102       P2P              2         5.5.5.5
Total trunks configured: 3.
#
```

Following is a sample output from the command using the detail parameter.

```
#show rsvp trunk detail
Trunk name: T1, tunnel-id: 101
 Type: P2P
 Ext-tunnel-id: 1.1.1.1/32
 Egress: 4.4.4.4/32
 # of LSPs in trunk: 1
 Mapped-routes: none

Trunk name: T2, tunnel-id: 102
 Type: P2P
 Ext-tunnel-id: 1.1.1.1/32
 Egress: 5.5.5.5/32
 # of LSPs in trunk: 2
 Mapped-routes: none
```

Table 2-17 explains the show command output fields.

Table 2-17: show rsvp trunk output field

Field	Description
Trunk Name	Name of the trunk.
Trunk ID	Session address for the trunk.
Type	Trunk type in the rsvp session.
Sess	Number of sessions associated with rsvp trunk.
Egress	Information about egress RSVP sessions.
Total trunks configured	Number of configured trunk in the rsvp session.
Ext-tunnel-id	Extended Tunnel identifier (destination port) for the RSVP session.
Mapped-routes	Map the route of the interface.

show rsvp trunk multi-sec-detail

Use this command to display secondary priority details specific to a trunk or for all trunks

Command Syntax

```
show rsvp trunk multi-sec-detail
show rsvp trunk NAME multi-sec-detail
```

Parameters

`NAME`	Enter the name of a trunk

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
# show rsvp trunk multi-sec-detail
Ingress (Secondary-Priority1)
5.5.5.5
  From: 6.6.6.6, LSPstate: Dn, LSPname: t2-Secondary-Priority-1
  Ingress FSM state: Idle
  Setup priority: 7, Hold priority: 0
  CSPF usage: Enabled, CSPF Retry Count: 0, CSPF Retry Interval: 30 seconds
  LSP Re-Optimization: Disabled, Re-Optimization Timer: NA
  IGP-Shortcut: Disabled, LSP metric: 65
  LSP Protection: None
  Label in: -,  Label out: -,
  Tspec rate: 0, Fspec rate: 0
  Policer: Not Configured
  Tunnel Id: 5001, LSP Id: 2206, Ext-Tunnel Id: 6.6.6.6
  Last Recorded Error Code: Routing Problem (24)
  Last Recorded Error Value: No route available toward destination (5)
  Node where Last Recorded Error originated: None
  Trunk Type: mpls
Ingress (Secondary-Priority3)
5.5.5.5
  From: 6.6.6.6, LSPstate: Dn, LSPname: t2-Secondary-Priority-3
  Ingress FSM state: Idle
  Setup priority: 7, Hold priority: 0
  CSPF usage: Enabled, CSPF Retry Count: 0, CSPF Retry Interval: 30 seconds
  LSP Re-Optimization: Disabled, Re-Optimization Timer: NA
  IGP-Shortcut: Disabled, LSP metric: 65
  LSP Protection: None
  Label in: -,  Label out: -,
  Tspec rate: 0, Fspec rate: 0
  Policer: Not Configured
  Tunnel Id: 5001, LSP Id: 2206, Ext-Tunnel Id: 6.6.6.6
  Last Recorded Error Code: Routing Problem (24)
  Last Recorded Error Value: No route available toward destination (5)
```



```
Node where Last Recorded Error originated: None
Trunk Type: mpls
```


show rsvp version

Use this command to display the version of the RSVP daemon. Current RSVP version is 1.

Command Syntax

```
show rsvp version
```

Parameters

None

Command Mode

Exec and Privileged Exec modes

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#show rsvp version
Resource ReSerVation Protocol, version 1. rfc2205
   RSVP protocol       = Enabled
   R(refresh timer)    = 30 seconds
   K(keep multiplier) = 3
   Preemption          = Normal
#
```

Table 2-18 explains the show command output fields.

Table 2-18: show rsvp version output field

Field	Description
Resource Reservation Protocol	RSVP software version.
RSVP protocol	Status of RSVP.
R (refresh timer)	Configured time interval used to generate periodic RSVP messages.
K (keep multiplier)	Number of RSVP messages that can be lost before an RSVP state is declared stale.
Preemption	Currently configured preemption capability.

CHAPTER 3 Fast Reroute Commands

This chapter describes the RSVP-TE Fast Reroute commands.

-
- detour-allow-primary-upstream-path
- detour-identification
- from X:X::X:X
- primary fast-reroute bandwidth
- primary fast-reroute hold-priority
- primary fast-reroute hop-limit
- primary fast-reroute node-protection
- primary fast-reroute protection
- primary fast-reroute setup-priority

detour-allow-primary-upstream-path

Use this command to ensure detour formation to consider the upstream path of protected LSPs. This is a deviation to RFC 4090 section 6.2 recommendation (https://datatracker.ietf.org/doc/html/rfc4090). This command is intended to be used in special cases where detour protection is required on ring topology if no alternate path is available.

Use the no parameter with this command to bypass the upstream path to the protected LSP when choosing a detour path.

This command is intended to be used in ring topology if detour support is required at the cost of resource and link bandwidth. This command is not recommended to be configured otherwise.

For more information, refer to the command reference page for detour-allow-primary-upstream-path in the RSVP Detour Over Ring Topology section of the *OcNOS Key Feature document*, Release 6.4.1.

default-frr-protection

Use this command to configure the default method of fast reroute protection when sender has not specified a method via FRR object but asked for local protection. This command is particularly useful with interop with Cisco as Cisco doesn't send FRR object in path message. By default, default FRR protection considered to be one-to-one in OcNOS and in case of interop with Cisco where default protection needed is facility, this command shall be configured on all OcNOS devices in the network.

Note: Having this command configured in one OcNOS device and not configured in other OcNOS device in the network will cause unpredictable behavior as RFC recommendation for merge node behavior of facility and one-to-one are different.

Note: This command is applicable only when path message contains local protection flag set but doesn't contain FRR object. When FRR object mentions protection type explicitly, this command is not applicable and also, if path message doesn't request local protection, then also this command is not applicable.

Command Syntax

```
default-frr-protection (one-to-one | facility)
no default-frr-protection
```

Parameters

`facility`	Facility Backup (Bypass) protection
`one-to-one`	One-to-One protection mechanism

Default

By default, if local protection requested but FRR object not available, one-to-one protection is considered.

Command Mode

Router mode

Applicability

This command was introduced in OcNOS version 6.3.1.

Examples

```
#configure terminal
(config)#router rsvp
(config-router)# default-frr-protection facility
(config-router)# commit
(config-router)# no default-frr-protection
(config-router)# commit
```

detour-identification

Use this command to set a path-specific detour LSP identification method, using the detour object.

Use the no parameter with this command to unset the detour LSP identification method.

Note: This command helps identify the backup LSP identification method for one-to-one protection only.

Command Syntax

```
detour-identification (path|sender-template)
no detour-identification
```

Parameters

`path` Set a path-specific detour identification method

`sender-template` Set a sender template-specific detour identification method

Default

By default, detour identification is sender template

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#router rsvp
(config-router)#detour-identification path

#configure terminal
(config)#router rsvp
(config-router)#detour-identification sender-template

#configure terminal
(config)#router rsvp
(config-router)#no detour-identification
```

from X:X::X:X

Use this command to specify a “from” IPv6 address for tunnel ingress.

Use the `no` parameter with this command to remove an IPv6 address from tunnel ingress.

Command Syntax

```
from X:X::X:X
no from X:X::X:X
no from
```

Parameters

None

Default

By default, from X:X::X:X is disabled

Command Mode

Router mode or Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk mytrunk
(config-trunk)#from 3ffe::3:34

#configure terminal
(config)#router rsvp
(config-router)#from 3ffe::3:34
```

primary fast-reroute bandwidth

Use this command to set the detour LSP bandwidth.

Note: This command helps identify attributes of the FRR backup LSP for the one-to-one protection method.

Use the `no` parameter with this command to unset fast-reroute LSP bandwidth.

Command Syntax

```
primary fast-reroute bandwidth BANDWIDTH
no primary fast-reroute bandwidth BANDWIDTH
no primary fast-reroute BANDWIDTH
```

Parameter

BANDWIDTH	<1-999>k for 1 to 999 kilobits/s
	<1-999>m for 1 to 999 megabits/s
	<1-100>g for 1 to 100 gigabits/s

Default

By default, primary fast reroute bandwidth is disabled

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk T1
(config-trunk)#primary fast-reroute bandwidth 10000000
```

primary fast-reroute hold-priority

Use this command to set the hold-priority for a detour LSP.

Note: This command helps identify attributes of the FRR backup LSP for the one-to-one protection method.

Use the `no` parameter with this command to unset the detour LSP hold-priority.

Command Syntax

```
primary fast-reroute hold-priority <0-7>
no primary fast-reroute hold-priority (<0-7>|)
```

Parameter

`<0-7>`	Set the value for hold-priority

Default

By default, primary fast reroute hold priority is 0

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk T1
(config-trunk)#primary fast-reroute hold-priority 3
```

primary fast-reroute hop-limit

Use this command to set the hop-limit for a detour LSP.

Note: This command helps identify attributes of the FRR backup LSP for the one-to-one protection method.

Use the `no` parameter with this command to unset the detour LSP hop-limit.

Command Syntax

```
primary fast-reroute hop-limit <1-255>
no primary fast-reroute hop-limit (<1-255>|)
```

Parameter

<1-255>	Set the number of hops

Default

By default, primary fast reroute hop limit is 255

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk T1
(config-trunk)#primary fast-reroute hop-limit 25
```


primary fast-reroute node-protection

Use this command to set node protection.

Note: This command helps identify attributes of the FRR backup LSP for the one-to-one protection method.

Use the `no` parameter with this command to remove node protection.

Command Syntax

```
primary fast-reroute node-protection
no primary fast-reroute node-protection
```

Parameters

None

Default

By default, primary fast reroute node protection is disabled

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk T1
(config-trunk)#primary fast-reroute node-protection
```

primary fast-reroute protection

Use this command to create an Fast Reroute backup and to set an LSP one-to-one protection mechanism.

Note: This command helps identify attributes of the FRR backup LSP for the one-to-one protection method.

Use the `no` parameter with this command to remove LSP protection mechanism.

Parameters

None

Command Syntax

```
primary fast-reroute protection (one-to-one|facility)
no primary fast-reroute protection (one-to-one|facility)
```

Parameters

`one-to-one`	Set the one-to-one protection mechanism
`facility`	Facility backup (bypass) protection

Default

By default, primary fast reroute protection is disabled

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk T1
(config-trunk)#primary fast-reroute protection one-to-one
```


primary fast-reroute setup-priority

Use this command to configure a setup-priority for the detour LSP.

Note: This command helps identify attributes of the FRR backup LSP for the one-to-one protection method.

Use the `no` parameter with this command to remove the detour LSP setup-priority.

Command Syntax

```
primary fast-reroute setup-priority <0-7>
no primary fast-reroute setup-priority (<0-7>|)
```

Parameter

`<0-7>`	Set a value for setup priority

Default

By default, primary fast reroute setup priority is 0

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk T1
(config-trunk)#primary fast-reroute setup-priority 2
```

CHAPTER 4 Refresh Reduction Commands

This chapter describes the RSVP-TE Refresh Reduction commands:

- ack-send-timer
- ack-wait-timeout
- message-ack
- refresh-reduction
- rsvp ack-wait-timeout
- rsvp message-ack
- rsvp refresh-reduction

ack-send-timer

Use this command to configure the timer to send an acknowledgement message. Timer configuration increases the chances of piggy backing multiple acknowledgement messages but also adds delay in acknowledgment received by neighbor node. So, use this command with exact knowledge of optimum time.

Note: Configure this command with a value within the limit of ack-wait-timeout to avoid frequent timeout.

Command Syntax

```
ack-send-timer <1-5>
no ack-send-timer
```

Parameter

`<1-5>`	Value in seconds for acknowledgement send timer.

Default

By default, acknowledgement message is transmitted immediately without piggy-backing.

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 6.4.1.

Examples

```
#configure terminal
(config)#router rsvp
(config-router)# ack-send-timer 1
(config-router)# commit
(config-router)# no ack-send-timer
(config-router)# commit
```


ack-wait-timeout

Use this command to configure the acknowledgement wait timeout for all RSVP-TE neighbors.

Use the `no` parameter with this command to revert to the default acknowledgement wait timeout.

Command Syntax

```
ack-wait-timeout <1-65535>
no ack-wait-timeout <1-65535>
no ack-wait-timeout
```

Parameter

`<1-65535>`	Specify a value for the acknowledgement wait timeout in seconds. The default timeout value is 10 seconds.

Default

By default, ack wait timeout is 10 seconds

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#router rsvp
(config-router)#ack-wait-timeout 5

(config)#router rsvp
(config-router)#no ack-wait-timeout 5
```

message-ack

Use this command to enable message acknowledgment for all messages being sent to neighbors that are known to support refresh reduction.

Use the `no` parameter with this command to disable message acknowledgment for all messages being sent to neighbors.

Command Syntax

```
message-ack
no message-ack
```

Parameters

None

Default

By default, Message Acknowledgment is disabled

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#router rsvp
(config-router)#message-ack

(config)#router rsvp
(config-router)#no message-ack
```

refresh-reduction

Use this command to enable refresh reduction capability advertisement for all interfaces.

Use the `no` parameter with this command disable refresh reduction capability advertisement for all interfaces.

Command Syntax

```
refresh-reduction
no refresh-reduction
```

Parameters

None

Default

By default, Refresh reduction mechanism is enabled

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#router rsvp
(config-router)#refresh-reduction

(config)#router rsvp
(config-router)#no refresh-reduction
```

rsvp ack-wait-timeout

Use this command to configure the acknowledgment wait timeout for all neighbors detected via the specific interface.

Use the `no` parameter with this command to revert to the default acknowledgment wait timeout for the specified interface.

Command Syntax

```
rsvp ack-wait-timeout <1-65535>
no rsvp ack-wait-timeout <1-65535>
no rsvp ack-wait-timeout
```

Parameters

`<1-65535>`	Specify a value for the acknowledgment wait timeout in seconds. The default timeout value is 10 seconds.

Default

By default, rsvp ack wait timeout is 10 seconds

Command Mode

Interface mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#interface eth0
(config-if)#rsvp ack-wait-timeout 5

(config)#interface eth0
(config-if)#no rsvp ack-wait-timeout 5
```


rsvp message-ack

Use this command to enable message acknowledgment for all messages being sent to the neighbors that have been detected via the specific interface.

Use the `no` parameter with this command to disable message acknowledgment for all messages being sent to the neighbors that have been detected via the specified interface.

Command Syntax

```
rsvp message-ack
no rsvp message-ack
```

Parameters

None

Default

By default, Message Acknowledgment is disabled

Command Mode

Interface mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#interface eth0
(config-if)#rsvp message-ack

(config)#interface eth0
(config-if)#no rsvp message-ack
```

rsvp refresh-reduction

Use this command to enable Refresh Reduction capability advertisement for a specific interface.

Use the `no` parameter with this command disable Refresh Reduction capability advertisement for the specified interface.

Command Syntax

```
rsvp refresh-reduction
no rsvp refresh-reduction
```

Parameters

None

Default

Refresh Reduction mechanism is enabled by default for all interfaces.

Command Mode

Interface mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#interface eth0
(config-if)#rsvp refresh-reduction

(config)#interface eth0
(config-if)#no rsvp refresh-reduction
```


CHAPTER 5 Facility Backup Commands

This chapter describes the RSVP-TE bypass commands for facility backup protection

- backup-bw-type
- bandwidth
- bypass-lsp-addr-query-interval
- cspf-retry-limit
- cspf-retry-timer
- filter
- hold-priority
- hop-limit
- label-record
- no record
- path
- preemption-type
- record
- retry-limit
- retry-timer
- reuse-route-record
- rsvp-bypass
- setup-priority
- to A.B.C.D
- traffic

backup-bw-type

Use this command to select the bypass trunk bandwidth support type.

Bypass trunks of dedicated bandwidth type will serve only bandwidth protections requested LSPs. The total bandwidth requirement of served LSPs will be less than or equal to the bandwidth configured on the bypass trunk. If an LSP with bandwidth protection and higher setup priority requests protection and bypass doesn't have sufficient bandwidth available, then LSPs with lower hold priority will be preempted to serve the LSP with higher setup priority.

Use the `no` parameter to remove configured backup bandwidth type.

Command Syntax

```
backup-bw-type (dedicated | best-effort)
no backup-bw-type
```

Parameters

`dedicated`	Dedicated backup bandwidth support
`best-effort`	Best effort backup bandwidth support

Default

best-effort

Command Mode

Bypass mode

Applicability

This command was introduced in OcNOS version 6.3.0.

Examples

```
#configure terminal
(config)#rsvp-bypass bp1
(config-bypass)#backup-bw-type dedicated
```

bandwidth

Use this command to reserve the bypass bandwidth in bits per second for the current trunk.

Each LSP has an associated bandwidth attribute. The bandwidth value is included in the sender's RSVP Path message and specifies the bandwidth to be reserved for the LSP. It is specified in bits per second, with a higher value indicating a greater user traffic volume. A zero bandwidth reserves no resources, although exchanges labels.

Use the `no` parameter to remove configured bandwidth information.

Command Syntax

```
bandwidth BANDWIDTH
no bandwidth BANDWIDTH
no bandwidth
```

Parameter

BANDWIDTH	<1-999>k for 1 to 999 kilobits/s
	<1-999>m for 1 to 999 megabits/s
	<1-100>g for 1 to 100 gigabits/s

Default

The default bandwidth is 0 bits per second, which allows data to flow through but does not reserve bandwidth.

Command Mode

Bypass mode

Applicability

This command was introduced in OcNOS version 6.3.0.

Examples

```
#configure terminal
(config)#rsvp-bypass bp1
(config-bypass)#bandwidth 100m
(config-bypass)#no bandwidth
```

bypass-lsp-addr-query-interval

Use this command to set the interval at which bypass trunk must query CSPF for LSP address. This mechanism ensures to update bypass trunk LSP addresses regularly so that, it can verify regularly if it can protect any LSP requesting protection.

Use the `no` parameter with this command to reset the interval to default value.

Note: Reducing interval to lower values may impact performance.

Command Syntax

```
bypass-lsp-addr-query-interval <10-60>
no bypass-lsp-addr-query-interval
```

Parameter

`<10-60>`	Set interval of bypass trunk querying LSP address.

Default

By default, interval is set to 60 seconds.

Command Mode

Router mode

Applicability

This command was introduced in OcNOS version 6.3.0.

Examples

```
#configure terminal
(config)#router rsvp
(config-router)# bypass-lsp-addr-query-interval 50
```


cspf-retry-limit

Use this command to specify the number of retries that CSPF should carry out for a request received from RSVP.

Use the `no` parameter with this command to disable this configuration.

Command Syntax

```
cspf-retry-limit <1-65535>
no cspf-retry-limit
```

Parameter

`<1-65535>`	Set the number of times CSPF should retry for this LSP

Default

By default, retry-limit is 0 which means infinite retry.

Command Mode

Bypass mode

Applicability

This command was introduced in OcNOS version 6.3.0.

Examples

```
#configure terminal
(config)#rsvp-bypass bp1
(config-bypass)#cspf-retry-limit 535

(config)#rsvp-bypass bp1
(config-bypass)#no cspf-retry-limit
```

cspf-retry-timer

Use this command to specify the time between each retry that CSPF might carry out for a request received from RSVP. Use the no parameter with this command to disable this configuration.

Command Syntax

```
primary cspf-retry-timer <1-600>
no primary cspf-retry-timer
```

Parameter

<1-600>	Timeout between successive retries, in seconds

Default

By default, retry-timer is 0

Command Mode

Bypass mode

Applicability

This command was introduced in OcNOS version 6.3.0.

Examples

```
#configure terminal
(config)#rsvp-bypass bp1
(config-bypass)#cspf-retry-timer 45

(config)#rsvp-bypass bp1
(config-bypass)#no cspf-retry-timer
```


filter

Use this command to set the filter to the fixed or shared style for an LSP.

- The shared filter style identifies a shared reservation environment. It creates a single reservation into which flows from all senders are mixed.
- The fixed filter style designates a distinct reservation. A distinct reservation request is created for data packets from a particular sender. The fixed filter style is also used style to prevent rerouting of an LSP and to prevent another LSP from using this bandwidth.

Use the `no` parameter to reset the configured filter to the default.

Command Syntax

```
filter fixed
no filter
```

Parameters

`fixed`	Use a fixed filter for this LSP

Default

By default, bypass filter is shared-explicit.

Command Mode

Bypass mode

Applicability

This command was introduced in OcNOS version 6.3.0.

Examples

```
#configure terminal
(config)#rsvp-bypass bp1
(config-bypass)#filter fixed
```

hold-priority

Use this command to configure the hold priority value for the selected bypass trunk. In case of insufficient bandwidth, remove less important existing LSPs to free up a portion of the bandwidth. This can be done by preempting one or more of the signaled LSPs. Hold priority determines the degree to which an LSP holds onto its reservation for a session after the LSP has been configured successfully. When the hold priority is high, the existing LSP is less likely to give up its reservation.

Use the `no` parameter to reset the trunk to the default hold-priority value.

Command Syntax

```
hold-priority <0-7>
no hold-priority
```

Parameters

`<0-7>`	Set a hold priority for the bypass LSP

Default

The default hold-priority value is 0, which is the highest. Once a session is configured with a hold priority of 0, no other session can preempt it.

Command Mode

Bypass mode

Applicability

This command was introduced in OcNOS version 6.3.0.

Examples

```
#configure terminal
(config)#rsvp-bypass bp1
(config-bypass)#hold-priority 2
```

hop-limit

Use this command to specify a limit of hops for an RSVP bypass trunk. Hop-limit data is sent to the CSPF server if CSPF is used.

Upon configuration of an arbitrary hop-limit, the hop-limit is compared with the number of hops configured in the bypass path, if a bypass path has been configured. If the number of hops in the bypass path exceeds the hop-limit configured, no Path messages are sent, and any existing session is torn down. If no bypass path is configured, the bypass trunk is processed normally and Path messages are sent.

Use the `no` parameter to reset the bypass trunk to the default hop-limit value.

Command Syntax

```
hop-limit <1-255>
no hop-limit
```

Parameters

`<1-255>`	Set the number of acceptable hops for the LSP

Default

By default, bypass hop limit is 255

Command Mode

Bypass mode

Applicability

This command was introduced in OcNOS version 6.3.0

Examples

```
#configure terminal
(config)#rsvp-bypass bp1
(config-bypass)#hop-limit 23
```

label-record

Use this command to record all labels exchanged between RSVP-enabled routers during the reservation setup process.

Use the `no` parameter with this command to turn off recording.

Command Syntax

```
label-record
no label-record
```

Parameters

None

Default

By default, bypass label record is disabled

Command Mode

Bypass mode

Applicability

This command was introduced in OcNOS version 6.3.0.

Examples

```
#configure terminal
(config)#rsvp-bypass bp1
(config-bypass)#label-record
```


no record

Use this command to disable recording of the route taken by Path and Reservation Request (Resv) messages to confirm establishment of reservations and identify errors. Routes are recorded by means of the Route Record Object (RRO) in RSVP messages.

Use the `record` command to return to the default settings.

Command Syntax

```
no record
```

Parameters

None

Default

By default, routes are recorded

Command Mode

Bypass mode

Applicability

This command was introduced in OcNOS version 6.3.0.

Examples

```
#configure terminal
(config)#rsvp-bypass bp1
(config-bypass)#no record
```

path

Use this command to specify an RSVP path to be used. The PATHNAME in this command is the string (name) used to identify an RSVP path defined for the node (refer to rsvp-path command).

Use the `no` parameter with this command to remove a configured RSVP path.

Command Syntax

```
path PATHNAME
no path
```

Parameters

PATHNAME	The name of the path to use

Default

By default, bypass path is disabled

Command Mode

Bypass mode

Applicability

This command was introduced in OcNOS version 6.3.0.

Examples

```
#configure terminal
(config)#rsvp-bypass bp1
(config-bypass)#path mypath
```


preemption-type

Use this command to configure preemption type which decides the criteria to be considered in case of preemption.

Use the `no` parameter to remove configured preemption type.

Command Syntax

```
preemption-type (less-lsp-preempted | less-unused-bandwidth)
no preemption-type
```

Parameters

`less-lsp-preempted`	Set preemption type to minimize number of LSPs preempted
`less-unused-bandwidth`	Set preemption type to ensure less bypass bandwidth unused

Default

By default, preemption type is set to less-lsp-preempted.

Command Mode

Router mode

Applicability

This command was introduced in OcNOS version 6.3.0.

Examples

```
#configure terminal
(config)#router rsvp
(config-router)#preemption-type less-unused-bandwidth
```

record

Use this command to enable recording of the route taken by Path and Reservation Request (Resv) messages to confirm establishment of reservations and identify errors. Routes are recorded by means or the Route Record Object (RRO) in RSVP messages.

Use the `no record` command to disable recording of routes.

Command Syntax

```
record
```

Parameters

None

Default

By default, routes are recorded

Command Mode

Bypass mode

Applicability

This command was introduced in OcNOS version 6.3.0.

Examples

```
#configure terminal
(config)#rsvp-bypass bp1
(config-bypass)#record
```


retry-limit

Use this command to specify a retry count this RSVP bypass Trunk.

If a session is in a nonexistent state due to a path error message, the system tries to recreate the LSP for the number of times specified by the retry-limit command.

Although the same retry command controls both the trunk and the session, the retry-limit value affects only the session and not the trunk. If the trunk is in an incomplete state, the code keeps trying forever to bring it to a complete state regardless of the retry-limit value.

Use the `no` parameter with this command to revert to the default retry-limit value.

Command Syntax

```
retry-limit <1-65535>
no retry-limit
```

Parameter

`<1-65535>`	The set number of times the system should try setting up the LSP

Default

By default, the retry-limit value is 0, and the trunk and session try to create the LSP indefinitely.

Command Mode

Bypass mode

Applicability

This command was introduced in OcNOS version 6.3.0.

Examples

```
#configure terminal
(config)#rsvp-bypass bp1
(config-bypass)#retry-limit 256
```

retry-timer

Use this command to specify a retry interval for an RSVP bypass Trunk. When an ingress node tries to configure an LSP and the setup fails due to the receipt of a Path Error message, the system waits for the time configured with this command, before retrying the LSP setup process.

Use the `no` parameter with this command to revert to the default retry-time value.

Command Syntax

```
retry-timer <1-600>
no retry-timer
```

Parameters

`<1-600>`	Time in seconds after which the system should retry setting up the LSP

Default

By default, retry-timer value is 30 seconds.

Command Mode

Bypass mode

Applicability

This command was introduced in OcNOS version 6.3.0.

Examples

```
#configure terminal
(config)#rsvp-bypass bp1
(config-bypass)#retry-timer 12
```

reuse-route-record

Use this command to use the updated Route Record List as an Explicit Route (with all strict nodes) when a path message is sent out at the next refresh.

The ERO list contains the hops to be taken to reach the egress from the current LSR. If CSPF is not available, to place an ERO with all strict routes, use this command to modify the ERO after receiving the Resv message. The future Path messages have the ERO with all strict nodes, identifying each and every node to be traversed.

Use the `no` parameter with this command to disable the use of the Route Record List as the explicit route.

Command Syntax

```
reuse-route-record
no reuse-route-record
```

Parameters

None

Default

By default, reuse route record is disabled

Command Mode

Bypass mode

Applicability

This command was introduced in OcNOS version 6.3.0.

Examples

```
#configure terminal
(config)#rsvp-bypass bp1
(config-bypass)#reuse-route-record
```

rsvp-bypass

Use this command to create a new RSVP bypass trunk. When the bypass trunk is created, the attributes required to configure an explicitly-routed or traditionally-routed LSP are set. Once a trunk is configured with the required attributes, an RSVP bypass session (and PSB) is created for this trunk, which enables the exchange of messages and completes the LSP setup.

This command also modifies an existing RSVP path to configure an explicitly-routed or traditionally-routed LSP.

Use the `no` parameter with this command to remove an RSVP bypass trunk and all configured attributes.

Note: The RSVP bypass' name (BYPASSNAME) is limited to 32 characters.

Command Syntax

```
rsvp-bypass BYPASSNAME
no rsvp-bypass BYPASSNAME
```

Parameters

BYPASSNAME	Name to use for the bypass trunk

Default

By default, `rsvp bypass trunk` is disabled

Command Mode

Configure mode

Applicability

This command was introduced in OcNOS version 6.3.0.

Examples

The command prompt changes from `config` to `config-bypass` as illustrated below:

```
#configure terminal
(config)#rsvp-bypass bp1
(config-bypass)#
```

setup-priority

Use this command to configure a setup priority value for a trunk. In case of insufficient bandwidth, users must remove less important LSPs to free up the bandwidth. This can be done by preempting one or more of the existing LSPs. The primary setup priority determines if a new LSP can preempt an existing LSP.

The setup priority of the new LSP must be higher than the hold priority of an existing LSP for the existing LSP to be preempted. Note that for a trunk, the setup priority should not be higher than the hold priority.

Use the `no` parameter with this command to revert to the default primary setup priority value.

Command Syntax

```
setup-priority <0-7>
no setup-priority
```

Parameters

`<0-7>`	Set the priority value

Default

By default, setup priority is 7, which is the lowest.

Command Mode

Bypass mode

Applicability

This command was introduced in OcNOS version 6.3.0.

Examples

```
#configure terminal
(config)#rsvp-bypass bp1
(config-bypass)#setup-priority 2
```

to A.B.C.D

Use this command to specify an IPv4 egress for a bypass LSP. When configuring an LSP, you must specify the address of the egress router by using this command in the bypass node. An egress definition is a mandatory attribute; no RSVP session is created when an egress is not defined.

Use the `no` parameter with this command to unset the configured egress address.

Command Syntax

```
to A.B.C.D
no to
```

Parameters

None

Default

The operator must specify an egress for LSP initialization to begin.

Command Mode

Bypass mode

Applicability

This command was introduced in OcNOS version 6.3.0.

Examples

```
#configure terminal
(config)#rsvp-bypass bp1
(config-bypass)#to 10.10.0.5
```

traffic

Use this command to specify the traffic type for this RSVP bypass Trunk.

Use the `no` parameter with this command to reset the configured traffic type.

Command Syntax

```
traffic (guaranteed|controlled-load)
no traffic
```

Parameters

`controlled-load`	Controlled loaded traffic
`guaranteed`	Guaranteed traffic

Default

By default, primary traffic type is controlled-load

Command Mode

Bypass mode

Applicability

This command was introduced in OcNOS version 6.3.0.

Examples

```
#configure terminal
(config)#rsvp-bypass bp1
(config-bypass)#traffic guaranteed
```

CHAPTER 6 Differentiated Services Commands

This chapter describes the RSVP Differentiated Services (DiffServ) commands.

map-route A.B.C.D

Use this command to map a IPv4 prefix route onto a trunk. This route is to be used for packets that are mapped to a specific RSVP trunk.

Use the `no` parameter with this command for unmapping routes from specified trunks.

Command Syntax

```
map-route A.B.C.D A.B.C.D
map-route A.B.C.D A.B.C.D CLASS
map-route A.B.C.D/M
map-route A.B.C.D/M CLASS
no map-route A.B.C.D A.B.C.D
no map-route A.B.C.D A.B.C.D CLASS
no map-route A.B.C.D/M
no map-route A.B.C.D/M CLASS
```

Parameters

`A.B.C.D`	Specify the IPV4 address to be mapped.
`A.B.C.D`	Specify a mask to be applied to the address being mapped.
`A.B.C.D/M`	Specify the IPV4 address to be mapped, with mask.
`CLASS`	Specify the DiffServ Class Name (for example, `be`, `ef` etc.) used for selecting incoming IP packets to be mapped to a specified RSVP trunk.

Default

By default, map route A.B.C.D is disabled

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#rsvp-trunk T1
(config-trunk)#map-route 1.1.2.2/24 be
```

map-route X:X::X:X

Use this command to map a IPv6 prefix route onto a trunk. This route is to be used for packets that are mapped to a specific RSVP trunk.

Use the `no` parameter with this command for unmapping routes from specified trunks.

Command Syntax

```
map-route X:X::X:X X:X::X:X
map-route X:X::X:X X:X::X:X CLASS
map-route X:X::X:X/M
map-route X:X::X:X/M CLASS
no map-route X:X::X:X X:X::X:X
no map-route X:X::X:X X:X::X:X CLASS
no map-route X:X::X:X/M
no map-route X:X::X:X/M CLASS
```

Parameters

`X:X::X:X`	Specify the IPV6 address to be mapped.
`X:X::X:X`	Specify a mask to be applied to the address being mapped.
`X:X::X:X/M`	Specify the IPV6 address to be mapped, with mask.
`CLASS`	Specify the DiffServ Class Name (for example, `be`, `ef` etc.) used for selecting incoming IP packets to be mapped to a specified RSVP trunk.

Default

By default, map route X:X::X:X is disabled

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#rsvp-trunk T1
(config-trunk)#map-route 1.1.2.2/24 be
```

override-diffserv

Use this command to enable the Differentiated Services (Diff-Serv) override configuration.

If a Path message is received without a Diff-Serv object by a Diff-Serv enabled node, it can be interpreted either as a request for an E-LSP (EXP-Inferred-PSC LSP) or as a request for Non-Diff-Serv LSP. This command supports the override option and when configured, the LSR interprets a path message without a Diff-Serv object as a request for Non-Diff-Serv LSP.

Use the `no` parameter with this command disable this feature.

Command Syntax

```
override-diffserv

no override-diffserv
```

Parameters

None

Default

By default, override diffserv is disabled

Command Mode

Router mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#router rsvp
(config-router)#override-diffserv
```

primary map class

Use this command to configure a primary PHB-EXP (Per-Hop Behavior-Experimental) mapping to be used by an E-LSP (EXP-Inferred-PSC LSP). This mapping is different from the node level PHB-EXP mapping.

Use the `no` parameter with this command to remove a PHB-EXP mapping configuration from current E-LSP PHB-EXP mapping.

Command Syntax

```
primary map class <0-7> exp <0-7>
no primary map class <0-7> exp <0-7>
```

Parameters

`<0-7>`	Diff-Serv class (queue) mapped to the particular PHB.
`<0-7>`	Exp bit which is to be mapped to this PHB.

Default

By default, primary map class is disabled

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk T1
(config-trunk)#primary map class 4 exp 3

(config)#rsvp-trunk T1
(config-trunk)#no primary map class 4 exp 3
```


primary elsp-signaled

Use this command to configure a primary Diff-Serv (Differentiated Services) explicitly signaled E-LSP (EXP-Inferred-PSC LSP) interface.

The classes 1 to 7 are optional parameters that can be selected from node level PHB-EXP (Per-Hop Behavior) mapping as PHBs, which will then be used for an E-LSP. If you do not specify a class with this command, all classes will be selected for the E-LSP.

Use the no parameter with this command to remove the configuration.

Command Syntax

```
primary elsp-signaled
primary elsp-signaled class <0-7>
primary elsp-signaled class <0-7> <0-7>
primary elsp-signaled class <0-7> <0-7> <0-7>
primary elsp-signaled class <0-7> <0-7> <0-7> <0-7>
primary elsp-signaled class <0-7> <0-7> <0-7> <0-7> <0-7>
primary elsp-signaled class <0-7> <0-7> <0-7> <0-7> <0-7> <0-7>
primary elsp-signaled class <0-7> <0-7> <0-7> <0-7> <0-7> <0-7> <0-7>
no primary elsp-signaled
```

Parameter

`CLASS<0-7>`	Diff-Serv class (queue).

Default

By default, primary elsp signaled is disabled

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk T1
(config-trunk)#primary elsp-signaled 2 5 0 6

(config)#rsvp-trunk T1
(config-trunk)#no primary elsp-signaled
```


primary llsp

Use this command to configure a primary Differentiated Services Label-Only-Inferred-PSC (Diff-Serv L-LSP) interface, which will use Diff-Serv Class as its PHB Scheduling Class (PSC).

Use the no parameter with this command to remove the Diff-Serv L-LSP configuration.

Command Syntax

```
primary llsp class <0-7>
no primary llsp
```

Parameters

<0-7>	Diff-Serv class (queue).

Default

By default, primary llsp is disabled

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk T1
(config-trunk)#primary llsp class 4

(config)#rsvp-trunk T1
(config-trunk)#no primary llsp
```

secondary map class

Use this command to configure a secondary PHB-EXP (Per-Hop Behavior-Experimental) mapping to be used by an E-LSP (EXP-Inferred-PSC LSP). This mapping is different from the node level PHB-EXP mapping.

Use the no parameter with this command to remove a PHB-EXP mapping configuration from current E-LSP PHB-EXP mapping.

Command Syntax

```
secondary map class <0-7> exp <0-7>
no secondary map class <0-7> exp <0-7>
```

Parameters

<0-7>	Diff-Serv class (queue) mapped to the particular PHB.
<0-7>	Exp bit that is to be mapped to this PHB.

Default

By default, secondary map class is disabled

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk T1
(config-trunk)#secondary map class 4 exp 3

(config)#rsvp-trunk T1
(config-trunk)#no secondary map class 4 exp 3
```


secondary elsp-signaled

Use this command to configure a secondary Diff-Serv (Differentiated Services) explicitly signaled E-LSP (EXP-Inferred-PSC LSP) interface. The classes 1 to 7 are optional parameters can be selected from the node level PHB-EXP (Per-Hop Behavior) mapping as PHBs. They will then be used for an E-LSP. If you do not specify a class with this command, all classes will be selected for the E-LSP.

Use the no parameter with this command to remove the configuration.

Command Syntax

```
secondary elsp-signaled
secondary elsp-signaled class <0-7>
secondary elsp-signaled class <0-7> <0-7>
secondary elsp-signaled class <0-7> <0-7> <0-7>
secondary elsp-signaled class <0-7> <0-7> <0-7> <0-7>
secondary elsp-signaled class <0-7> <0-7> <0-7> <0-7> <0-7>
secondary elsp-signaled class <0-7> <0-7> <0-7> <0-7> <0-7> <0-7>
secondary elsp-signaled class <0-7> <0-7> <0-7> <0-7> <0-7> <0-7> <0-7>
no secondary elsp-signaled
```

Parameters

CLASS<0-7>	Diff-Serv class (queue).

Default

By default, secondary elsp signaled is disabled

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Examples

```
#configure terminal
(config)#rsvp-trunk T1
(config-trunk)#secondary elsp-signaled class 3 6 2 0 5

(config)#rsvp-trunk T1
(config-trunk)#no secondary elsp-signaled
```

secondary llsp

Use this command to configure a secondary Differentiated Services Label-Only-Inferred-PSC (Diff-Serv L-LSP) interface, which will use Diff-Serv Class as its PHB Scheduling Class (PSC).

Use the no parameter with this command to remove the Diff-Serv L-LSP configuration.

Command Syntax

```
secondary llsp class <0-7>
no secondary llsp
```

Parameters

`CLASS<0-7>`	Diff-Serv class (queue).

Default

By default, secondary llsp is disabled

Command Mode

Trunk mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

```
#configure terminal
(config)#rsvp-trunk T1
(config-trunk)#secondary llsp class 5

(config)#rsvp-trunk T1
(config-trunk)#no secondary llsp
```


show rsvp diffserv-info

Use this command to display node level Differentiated Services (Diff-Serv) configuration information. This information includes the node level PHB-EXP mapping configured for ELSP-signaled LSP.

Command Syntax

```
show rsvp diffserv-info
```

Parameters

None

Command Mode

Exec mode and Privileged Exec mode

Applicability

This command was introduced before OcNOS version 1.3.

Example

Following is a sample output of the `show rsvp diffserv-info` command.

```
#show rsvp diffserv-info
E-LSP SIGNAL CLASS-EXP mapping:
CLASS    EXP_value
    5      0
    0      1
    1      2
    3      3
    2      4
    4      5
    6      6
    7      7
```

Table 6-1 explains the show command output fields.

Table 6-1: show rsvp diffserv-info output fields

Field	Description
CLASS	MPLS class type that corresponds to the DiffServ traffic engineering class.
EXP_value	Exp value is initialized at the ingress routing device only and overrides the rewrite configuration established for that forwarding class.