



# MPLS Traffic Engineering – Bundled Interface Support

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**Note** This technology is not applicable for the Cisco ASR 900 RSP3 Module.

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The MPLS Traffic Engineering - Bundled Interface Support feature enables Multiprotocol Label Switching (MPLS) traffic engineering (TE) tunnels over the bundled interfaces—EtherChannel and Gigabit EtherChannel (GEC).

The Resource Reservation Protocol (RSVP) notifies TE about bandwidth changes that occur when member links are added or deleted, or when links become active or inactive. TE notifies other nodes in the network via Interior Gateway Protocol (IGP) flooding. By default, the bandwidth available to TE Label-Switched Paths (LSPs) is 75 percent of the interface bandwidth. You can change the percentage of the global bandwidth available for TE LSPs by using an RSVP command on the bundled interface. Bandwidth reservation and preemption are supported.

The Fast Reroute (FRR) feature is supported on bundled interfaces. FRR is activated when a bundled interface goes down; for example, if you enter the **shutdown** command to shut down the interface or fewer than the required minimum number of links are operational.

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## Prerequisites for MPLS TE – Bundled Interface Support

- Configure Multiprotocol Label Switching (MPLS) traffic engineering (TE) tunnels.
- Enable Cisco Express Forwarding in global configuration mode.
- Enable Resource Reservation Protocol (RSVP) feature.
- Configure EtherChannel.
- Configure Gigabit EtherChannel.

## Restrictions for MPLS TE – Bundled Interface Support

- Traffic engineering over switch virtual interfaces (SVIs) is not supported unless the SVI consists of a bundle of links that represent a single point-to-point interface.
- There must be a valid IP address configuration on the bundled interface and there must not be an IP address configuration on the member links.

## Information About MPLS TE – Bundled Interface Support

### Cisco EtherChannel Overview

Cisco EtherChannel technology builds upon standards-based 802.3 full-duplex Fast Ethernet to provide network managers with a reliable, high-speed solution for the campus network backbone. EtherChannel technology provides bandwidth scalability within the campus by providing up to 800 Mbps, 8 Gbps, or 80 Gbps of aggregate bandwidth for a Fast EtherChannel, Gigabit EtherChannel, or 10 Gigabit EtherChannel connection, respectively. Each of these connection speeds can vary in amounts equal to the speed of the links used (100 Mbps, 1 Gbps, or 10 Gbps). Even in the most bandwidth-demanding situations, EtherChannel technology helps to aggregate traffic, keeps oversubscription to a minimum, and provides effective link-resiliency mechanisms.

#### Cisco EtherChannel Benefits

Cisco EtherChannel technology allows network managers to provide higher bandwidth among servers, routers, and switches than a single-link Ethernet technology can provide.

Cisco EtherChannel technology provides incremental scalable bandwidth and the following benefits:

- Standards-based—Cisco EtherChannel technology builds upon IEEE 802.3-compliant Ethernet by grouping multiple, full-duplex point-to-point links. EtherChannel technology uses IEEE 802.3 mechanisms for full-duplex autonegotiation and autosensing, when applicable.
- Flexible incremental bandwidth—Cisco EtherChannel technology provides bandwidth aggregation in multiples of 100 Mbps, 1 Gbps, or 10 Gbps, depending on the speed of the aggregated links. For example, network managers can deploy EtherChannel technology that consists of pairs of full-duplex Fast Ethernet links to provide more than 400 Mbps between the wiring closet and the data center. In the data center, bandwidths of up to 800 Mbps can be provided between servers and the network backbone to provide large amounts of scalable incremental bandwidth.
- Load balancing—Cisco EtherChannel technology comprises several Fast Ethernet links and is capable of load balancing traffic across those links. Unicast, broadcast, and multicast traffic is evenly distributed across the links, providing improved performance and redundant parallel paths. When a link fails, traffic is redirected to the remaining links within the channel without user intervention and with minimal packet loss.
- Resiliency and fast convergence—When a link fails, Cisco EtherChannel technology provides automatic recovery by redistributing the load across the remaining links. When a link fails, Cisco EtherChannel technology redirects traffic from the failed link to the remaining links in less than one second. This convergence is transparent to the end user—no host protocol timers expire and no sessions are dropped.

## Cisco Gigabit EtherChannel Overview

Cisco Gigabit EtherChannel (GEC) is a high-performance Ethernet technology that provides transmission rates in Gigabit per second (Gbps). A Gigabit EtherChannel bundles individual ethernet links (Gigabit Ethernet and 10 Gigabit Ethernet) into a single logical link that provides the aggregate bandwidth up to four physical links. All LAN ports in each EtherChannel must be of the same speed and must be configured as either Layer 2 or Layer 3 LAN ports. Inbound broadcast and multicast packets on one link in an EtherChannel are blocked from returning on any other link in the EtherChannel.

## Load Balancing and Min-Links in EtherChannel

Load balancing affects the actual and practical bandwidth that can be used for TE. Multilink load balancing uses a per-packet load balancing method. All of the bundle interface bandwidth is available. EtherChannel load balancing has various load balancing methods, depending on the traffic pattern and the load balancing configuration. The total bandwidth available for TE may be limited to the bandwidth of a single member link.

On EtherChannel, min-links is supported only in the Link Aggregation Control Protocol (LACP). For other EtherChannel protocols, the minimum is one link, by default, and it is not configurable. To configure min-links for EtherChannel, use the **port-channel min-links** command.

## How to Configure MPLS TE – Bundled Interface Support

### Configuring MPLS TE on an EtherChannel Interface

#### SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number* [*name-tag*]
4. **ip address** *ip-address mask* [**secondary**]
5. **mpls traffic-eng tunnels**
6. **mpls traffic-eng backup-path** *tunnel*
7. **port-channel min-links** *min-num*
8. **ip rsvp bandwidth** [*interface-kbps*] [*single-flow-kbps*]
9. **end**

#### DETAILED STEPS

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

	Command or Action	Purpose
	Device# configure terminal	
<b>Step 3</b>	<b>interface</b> <i>type number</i> [ <i>name-tag</i> ] <b>Example:</b> Device(config)# interface port-channel 1	Creates an EtherChannel bundle, assigns a group number to the bundle, and enters interface configuration mode.
<b>Step 4</b>	<b>ip address</b> <i>ip-address mask</i> [ <b>secondary</b> ] <b>Example:</b> Device(config-if)# ip address 10.0.0.4 255.255.255.0	Specifies an IP address for the EtherChannel group.
<b>Step 5</b>	<b>mpls traffic-eng tunnels</b> <b>Example:</b> Device(config-if)# mpls traffic-eng tunnels	Enables MPLS TE tunnel signaling on an interface. <ul style="list-style-type: none"> <li>• MPLS TE tunnel should be enabled on the device before enabling the signaling.</li> </ul>
<b>Step 6</b>	<b>mpls traffic-eng backup-path</b> <i>tunnel</i> <b>Example:</b> Device(config-if)# mpls traffic-eng backup-path Tunnel120	(Optional) Configures the physical interface to use a backup tunnel in the event of a detected failure on that interface.
<b>Step 7</b>	<b>port-channel min-links</b> <i>min-num</i> <b>Example:</b> Device(config-if)# port-channel min-links 2	Specifies that a minimum number of bundled ports in an EtherChannel is required before the channel can be active.
<b>Step 8</b>	<b>ip rsvp bandwidth</b> [ <i>interface-kbps</i> ] [ <i>single-flow-kbps</i> ] <b>Example:</b> Device(config-if)# ip rsvp bandwidth 100	Enables RSVP for IP on an interface and specifies a percentage of the total interface bandwidth as available in the RSVP bandwidth pool.
<b>Step 9</b>	<b>end</b> <b>Example:</b> Device(config-if)# end	Exits interface configuration mode and returns to privileged EXEC mode.

## Configuration Examples for MPLS TE Bundled Interface Support

### Example: Configuring MPLS TE on an EtherChannel Interface

```
Device> enable
```

```

Device# configure terminal
Device(config)# interface port-channel 1
Device(config-if)# ip address 10.0.0.4 255.255.255.0
Device(config-if)# mpls traffic-eng tunnels
Device(config-if)# mpls traffic-eng backup-path Tunnel 120
Device(config-if)# port-channel min-links 2
Device(config-if)# ip rsvp bandwidth 100
Device(config-if)# end

```

## Example: Configuring MPLS TE - Bundled Interface Support over Gigabit Etherchannel

The following example shows how to enable MPLS TE – bundled interface support over GEC on Cisco devices:

```

Device> enable
Device# configure terminal

! Enable global MPLS TE on routers
Device(config)# router ospf 100
Device(config-router)# network 10.0.0.1 0.0.0.255 area 0
Device(config-router)# mpls traffic-eng area 0
Device(config-router)# mpls traffic-eng router-id Loopback 0
Device(config-router)# exit

! Configure GEC interface and enable MPLS TE and RSVP on interface
Device(config)# interface Port-channel 1
Device(config-if)# ip address 10.0.0.1 255.255.255.0
Device(config-if)# mpls traffic-eng tunnels
Device(config-if)# ip rsvp bandwidth
Device(config-if)# exit

! Define explicit path
Device(config)# ip explicit-path name primary enable
Device(cfg-ip-expl-path)# next-address 172.12.1.2
Device(cfg-ip-expl-path)# next-address 172.23.1.2
Device(cfg-ip-expl-path)# next-address 172.34.1.2
Device(cfg-ip-expl-path)# next-address 10.4.4.4
Device(cfg-ip-expl-path)# exit

! Configure primary tunnel on head-end device
Device(config)# interface Tunnel 14
Device(config-if)# ip unnumbered Loopback 0
Device(config-if)# tunnel mode mpls traffic-eng
Device(config-if)# tunnel destination 10.10.10.0
Device(config-if)# tunnel mpls traffic-eng autoroute announce
Device(config-if)# tunnel mpls traffic-eng path-option 10 explicit name primary
Device(config-if)# tunnel mpls traffic-eng fast-reroute
Device(config-if)# exit

! Configure backup tunnel on head-end or mid-point device
Device(config)# interface Tunnel 23
Device(config-if)# ip unnumbered Loopback 0
Device(config-if)# tunnel mode mpls traffic-eng
Device(config-if)# tunnel destination 10.20.10.0
Device(config-if)# tunnel mpls traffic-eng path-option 10 explicit name backup
Device(config-if)# exit

```

## Example: Configuring MPLS TE - Bundled Interface Support over Gigabit Etherchannel

```

! Configure backup tunnel on protected GEC interface
Device(config)# interface Port-channel 1
Device(config-if)# ip address 10.0.0.1 255.255.255.0
Device(config-if)# mpls traffic-eng tunnels
Device(config-if)# mpls traffic-eng backup-path Tunnel 23
Device(config-if)# ip rsvp bandwidth percent 20
Device(config-if)# lacp min-bundle 2
Device(config-if)# exit

! Configure GEC interface
Device(config)# interface GigabitEthernet 0/0/1
Device(config-if)# no ip address
Device(config-if)# channel-group 1 mode active
Device(config-if)# exit

! Configure GEC interface
Device(config)# interface GigabitEthernet 0/0/2
Device(config-if)# no ip address
Device(config-if)# channel-group 1 mode active
Device(config-if)# exit

```

The **show mpls traffic-eng tunnels** command output displays information about a tunnel or one-line information about all tunnels configured on the device:

```

Device# show mpls traffic-eng tunnels tunnel 14

Name: ASR1013_t14                               (Tunnel10) Destination: 10.4.4.4
Status:
  Admin: up           Oper: up           Path: valid           Signalling: connected
  path option 1, type explicit toR4overR3R3 (Basis for Setup, path weight 3)

Config Parameters:
  Bandwidth: 0           kbps (Global) Priority: 7 7 Affinity: 0x0/0xFFFF
  Metric Type: TE (default)
  AutoRoute: enabled LockDown: disabled Loadshare: 0 [0] bw-based
  auto-bw: disabled
Active Path Option Parameters:
  State: explicit path option 1 is active
  BandwidthOverride: disabled LockDown: disabled Verbatim: disabled

  InLabel : -
  OutLabel : Port-channell, 1608
  Next Hop : 172.16.1.2
  FRR OutLabel : Tunnel23, 4868
  RSVP Signalling Info:
    Src 10.1.1.1, Dst 10.4.4.4, Tun_Id 14, Tun_Instance 35
  RSVP Path Info:
    My Address: 172.12.1.1
    Explicit Route: 172.12.1.2 172.23.1.1 172.23.1.2 172.34.1.1
                   172.34.1.2 10.4.4.4

History:
  Tunnel:
    Time since created: 17 hours
    Time since path change: 18 minutes, 22 seconds
    Number of LSP IDs (Tun_Instances) used: 35
    Current LSP: [ID: 35]
    Uptime: 18 minutes, 22 seconds
    Selection: reoptimization
    Prior LSP: [ID: 32]

```

```
ID: path option unknown
Removal Trigger: signalling shutdown
```

```
Device# show mpls traffic-eng tunnels brief
```

```
show mpls traffic-eng tunnels brief
```

```
Signalling Summary:
```

```
LSP Tunnels Process:          running
Passive LSP Listener:        running
RSVP Process:                 running
Forwarding:                   enabled
Periodic reoptimization:     every 3600 seconds, next in 3299 seconds
Periodic FRR Promotion:      Not Running
Periodic auto-bw collection:  every 300 seconds, next in 299 seconds
```

```
P2P TUNNELS/LSPs:
```

TUNNEL NAME	DESTINATION	UP IF	DOWN IF	STATE/PROT^M	
ASR1013_t14	10.4.1.1		-	Po12	up/up

```
On Mid Router:
```

```
P2P TUNNELS/LSPs:
```

TUNNEL NAME	DESTINATION	UP IF	DOWN IF	STATE/PROT	
ASR1013_t14	10.4.1.1		Po12	Po23	up/up
ASR1002F_t23	10.2.1.1		Po25	-	up/up

The **show mpls traffic-eng fast-reroute** command output displays information about FRR-protected MPLS TE tunnels originating, transmitting, or terminating on this device.

```
Device# show mpls traffic-eng fast-reroute database
```

```
P2P Headend FRR information:
```

Protected tunnel	In-label	Out intf/label	FRR intf/label	Status
-----	-----	-----	-----	-----

```
P2P LSP midpoint frr information:
```

LSP identifier	In-label	Out intf/label	FRR intf/label	Status
-----	-----	-----	-----	-----
10.1.1.1 1 [2]	16	Po23:16	Tu23:16	active

