MPLS TE Bundled Interface Support

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The MPLS TE: Bundled Interface Support feature enables Multiprotocol Label Switching (MPLS) traffic engineering (TE) tunnels over the bundled interfaces EtherChannel and Multilink PPP (MLP).

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 IGP flooding. By default, the bandwidth available to TE LSPs is 75% 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 the bundled interfaces. FRR is activated when a bundled interface goes down: for example, if you enter the **shut** command to shut down the interface, or fewer than the required minimum number of links are operational.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

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Prerequisites for MPLS TE Bundled Interface Support

- Configure MPLS TE tunnels.
- Enable Cisco Express Forwarding in global configuration mode.
- Enable RSVP.
- Configure EtherChannel.
- Configure MLP.

Restrictions for MPLS TE Bundled Interface Support

- Traffic engineering over Service 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.
- To ensure that the Fast Reroute feature functions correctly in MLP, enter the **multilinkmin-links** command (to specify the preferred minimum number of links) along with the **mandatory** keyword (to deactivate the MLP bundle if the minimum number of links is not present).

Information About MPLS TE Bundled Interface Support

MLP Overview

MLP provides the capability of splitting and recombining packets to a single end system across a logical pipe (also called a bundle) formed by multiple links. MLP provides bandwidth on demand and reduces transmission latency across WAN links.

MLP allows packets to be fragmented and the fragments to be sent at the same time over multiple point-to-point links to the same remote address. The multiple links come up in response to a dialer load threshold that you define. The load can be calculated on inbound traffic, outbound traffic, or on either, as needed for the traffic between the specific sites. MLP provides bandwidth on demand and reduces transmission latency across WAN links.

MLP is designed to work over single or multiple interfaces of the following types that are configured to support both dial-on-demand rotary groups and PPP encapsulation:

- Asynchronous serial interfaces
- Basic Rate Interfaces
- Primary Rate Interfaces

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 aggregate traffic and keep oversubscription to a minimum, while providing effective link-resiliency mechanisms.

Cisco EtherChannel Benefits

Cisco EtherChannel technology allows network managers to provide higher bandwidth among servers, routers, and switches than 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, so no sessions are dropped.

Load Balancing and Min-Links in MLP and 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.

Min-links affects how FRR works. Multilink PPP Minimum Links (min-links) allows you to configure the minimum number of links in an MLP bundle required to keep that bundle active. To configure min-links for MLP, use the **multilinkmin-links** command. It is *recommended* that you specify the **mandatory** keyword. To use FRR, you *must* specify the **mandatory** keyword. On EtherChannel, min-link 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-link for EtherChannel, use the **port-channelmin-links** command.

How to Configure MPLS TE Bundled Interface Support

Configuring MPLS TE on an MLP Interface

To configure MPLS TE on an MLP interface, perform the following steps.

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. **ppp multilink** [**ppp**]
8. **multilink min-links** *links* [**mandatory**]
9. **multilink-group** *group-number*
10. **ip rsvp bandwidth** [*interface-kbps*] [*single-flow-kbps*]
11. **keepalive** [*period*[*retries*]]
12. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* [*name-tag*] **Example:** `Router(config)# interface multilink 1`	Creates a multilink bundle, assigns a group number to the bundle, and enters interface configuration mode.

	Command or Action	Purpose
Step 4	**ip address** *ip-address mask* [**secondary**] **Example:** `Router(config-if)# ip address 10.0.0.7 255.255.255.0`	Specifies an IP address for the multilink group.
Step 5	**mpls traffic-eng tunnels** **Example:** `Router(config-if)# mpls traffic-eng tunnels`	Enables MPLS traffic engineering tunnel signaling on an interface (assuming that it is enabled on the device).
Step 6	**mpls traffic-eng backup-path** *tunnel* **Example:** `Router(config-if)# mpls traffic-eng backup-path Tunnel50`	(Optional) Enables FRR.
Step 7	**ppp multilink** [**ppp**] **Example:** `Router(config-if)# ppp multilink`	Enables MLP on an interface and, optionally, enables Bandwidth Allocation Control Protocol (BACP) and its Bandwidth Allocation Protocol (BAP) subset for dynamic bandwidth allocation.
Step 8	**multilink min-links** *links* [**mandatory**] **Example:** `Router(config-if)# multilink min-links 2 mandatory`	Specifies the preferred minimum number of links in an MLP bundle. **Note** To use FRR, you must enter the **mandatory** keyword.
Step 9	**multilink-group** *group-number* **Example:** `Router(config-if)# multilink-group 1`	Restricts a physical link to joining only a designated multilink-group interface.
Step 10	**ip rsvp bandwidth** [*interface-kbps*] [*single-flow-kbps*] **Example:** `Router(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.

	Command or Action	Purpose
Step 11	**keepalive** [*period*[*retries*]] **Example:** `Router(config-if)# keepalive 3`	Enables keepalive packets and specifies the number of times that the Cisco IOS software tries to send keepalive packets without a response before bringing down the interface or before bringing the tunnel protocol down for a specific interface.
Step 12	**end** **Example:** `Router(config-if)# end`	Returns to global configuration mode.

Configuring MPLS TE on an EtherChannel Interface

To configure MPLS TE on an EtherChannel interface, perform the following steps.

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	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.

Command or Action	Purpose
Step 3 **interface** *type number* [*name-tag*] **Example:** `Router(config)# interface port-channel 1`	Creates an EtherChannel bundle, assigns a group number to the bundle, and enters interface configuration mode.
Step 4 **ip address** *ip-address mask* [**secondary**] **Example:** `Router(config-if)# ip address 10.0.0.4 255.255.255.0`	Specifies an IP address for the EtherChannel group.
Step 5 **mpls traffic-eng tunnels** **Example:** `Router(config-if)# mpls traffic-eng tunnels`	Enables MPLS TE tunnel signaling on an interface (assuming that it is enabled on the device).
Step 6 **mpls traffic-eng backup-path** *tunnel* **Example:** `Router(config-if)# mpls traffic-eng backup-path Tunnel120`	(Optional) Enables FRR.
Step 7 **port-channel min-links** *min-num* **Example:** `Router(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.
Step 8 **ip rsvp bandwidth** [*interface-kbps*] [*single-flow-kbps*] **Example:** `Router(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.
Step 9 **end** **Example:** `Router(config-if)# end`	Returns to global configuration mode.

Configuration Examples for MPLS TE Bundled Interface Support

Configuring MPLS TE on an MLP Interface Example

The following example shows how to configure MPLS TE on an MLP interface:

```
interface multilink 1
ip address 10.0.0.7 255.255.255.0
mpls traffic-eng tunnels
mpls traffic-eng backup-path Tunnel50
ppp multilink
multilink min-links 2 mandatory
multilink-group 1
ip rsvp bandwidth 100
keepalive 3
```

Configuring MPLS TE on an EtherChannel Interface Example

The following example shows how to configure MPLS TE on an EtherChannel interface:

```
interface port-channel 1
ip address 10.0.0.4 255.255.255.0
mpls traffic-eng tunnels
mpls traffic-eng backup-path Tunnel120
port-channel min-links 2
ip rsvp bandwidth 100
```

Additional References

The following sections provide references related to the MPLS TE: Bundled Interface Support feature.

Related Documents

Related Topic	Document Title
Configuring EtherChannel	Configuring EtherChannels
EtherChannel Load Balancing	Configuring EtherChannels

Standards

Standard	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	—

MIBs

MIB	MIBs Link
No new or modified MIBs are supported by this feature, and support for existing MIBs has not been modified by this feature.	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFC	Title
No new or modified RFCs are supported by this feature, and support for existing RFCs has not been modified by this feature.	—

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/techsupport

Feature Information for MPLS TE Bundled Interface Support

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 1 Feature Information for MPLS TE: Bundled Interface Support

Feature Name	Releases	Feature Information
MPLS TE: Bundled Interface Support	12.2(33)SRC	The MPLS TE: Bundled Interface Support feature enables MPLS traffic engineering (TE) tunnels over the bundled interfaces EtherChannel and Multilink MLP. In 12.2(33)SRC, this feature was introduced.

Glossary

bundle —A group of interfaces that comprise an aggregate interface; for example, MLP and EtherChannel.

Cisco Express Forwarding —A means for accelerating the forwarding of packets within a router, by storing route lookup information in several data structures instead of in a route cache.

EtherChannel —EtherChannel is a trunking technology that groups multiple full-duplex 802.3 Ethernet interfaces to provide fault-tolerant high-speed links between switches, routers, and servers. EtherChannel is a logical aggregation of multiple Ethernet interfaces. EtherChannel forms a single higher bandwidth routing or bridging endpoint.

Fast EtherChannel —Fast EtherChannel is a technology-leveraging, standards-based Fast Ethernet that provides the additional bandwidth network backbones require today. It provides flexible, scalable bandwidth with resiliency and load sharing across links for switches, router interfaces, and servers. It supports up to eight links per channel.

Gigabit EtherChannel —Gigabit EtherChannel is high-performance Ethernet technology that provides gigabit per second transmission rates. It provides flexible, scalable bandwidth with resiliency and load sharing across links for switches, router interfaces, and servers. It supports up to eight links per channel.

member link —An interface that is part of a bundle.

min-links —Minimum number of links in an MLP bundle.

MLP —Multilink PPP provides load balancing functionality over multiple WAN links, while providing multivendor interoperability, packet fragmentation, proper sequencing, and load calculation on both inbound and outbound traffic.

MPLS —Multiprotocol Label Switching. Switching method that forwards IP traffic using a label. This label instructs the routers and the switches in the network where to forward the packets based on preestablished IP routing information.

PPP —Point-to-Point Protocol. A successor to SLIP that provides router-to-router and host-to-network connections over synchronous and asynchronous circuits. PPP was designed to work with several network layer protocols (such as IP, IPX, and ARA). PPP also has built-in security mechanisms (such as CHAP and PAP). PPP relies on two protocols: LCP and NCP.

RSVP —Resource Reservation Protocol. Protocol that supports the reservation of resources across an IP network. Applications running on IP end systems can use RSVP to indicate to other nodes the nature (bandwidth, jitter, maximum burst, and so on) of the packet streams they want to receive. RSVP depends on IPv6. Also known as Resource Reservation Setup Protocol.

traffic engineering —Techniques and processes that cause routed traffic to travel through the network on a path other than the one that would have been chosen if standard routing methods were used.