MPLS Traffic Engineering Forwarding Adjacency

The MPLS Traffic Engineering Forwarding Adjacency feature allows a network administrator to handle a traffic engineering (TE) label switched path (LSP) tunnel as a link in an Interior Gateway Protocol (IGP) network based on the Shortest Path First (SPF) algorithm.

Both Intermediate System-to-Intermediate System (IS-IS) and Open Shortest Path First (OSPF) are supported.

- Finding Feature Information, page 1
- Prerequisites for MPLS Traffic Engineering Forwarding Adjacency, page 1
- Restrictions for MPLS Traffic Engineering Forwarding Adjacency, page 2
- Information About MPLS Traffic Engineering Forwarding Adjacency, page 2
- How to Configure MPLS Traffic Engineering Forwarding Adjacency, page 3
- Configuration Examples for MPLS Traffic Engineering Forwarding Adjacency, page 7
- Additional References, page 9
- Glossary, page 10
- Feature Information for MPLS Traffic Engineering Forwarding Adjacency, page 11

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and 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.

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.

Prerequisites for MPLS Traffic Engineering Forwarding Adjacency

Your network must support the following Cisco IOS XE features:

- Multiprotocol Label Switching (MPLS)
- IP Cisco Express Forwarding
- IS-IS

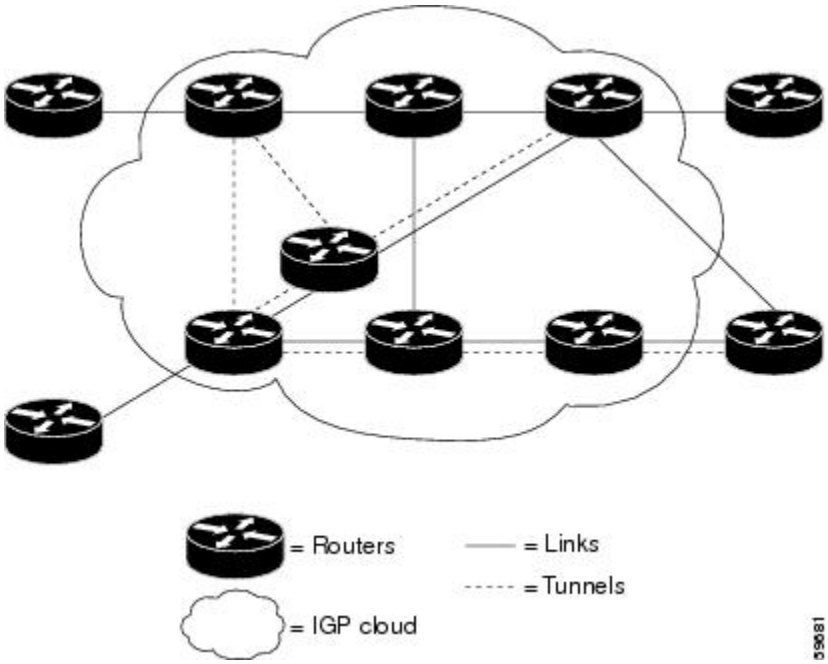
Restrictions for MPLS Traffic Engineering Forwarding Adjacency

- Using the MPLS Traffic Engineering Forwarding Adjacency feature increases the size of the IGP database by advertising a TE tunnel as a link.
- When the MPLS Traffic Engineering Forwarding Adjacency feature is enabled on a TE tunnel, the link is advertised in the IGP network as a type, length, value (TLV) 22 object without any TE sub-TLV.
- You must configure MPLS TE forwarding adjacency tunnels bidirectionally.

Information About MPLS Traffic Engineering Forwarding Adjacency

MPLS Traffic Engineering Forwarding Adjacency Functionality

The MPLS Traffic Engineering Forwarding Adjacency feature allows a network administrator to handle a TE LSP tunnel as a link in an IGP network based on the SPF algorithm. A forwarding adjacency can be created between routers regardless of their location in the network. The routers can be located multiple hops from each other, as shown in the figure below.



As a result, a TE tunnel is advertised as a link in an IGP network with the link's cost associated with it.

Routers outside of the TE domain see the TE tunnel and use it to compute the shortest path for routing traffic throughout the network.

MPLS Traffic Engineering Forwarding Adjacency Benefits

TE tunnel interfaces advertised for SPF--TE tunnel interfaces are advertised in the IGP network just like any other links. Routers can then use these advertisements in their IGPs to compute the SPF even if they are not the headend of any TE tunnels.

How to Configure MPLS Traffic Engineering Forwarding Adjacency

Configuring a Tunnel Interface for MPLS TE Forwarding Adjacency

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface tunnel** *number*
4. **exit**
5. **exit**

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 tunnel** *number* **Example:** `Router(config)# interface tunnel 0`	Designates a tunnel interface for the forwarding adjacency, and enters interface configuration mode.
Step 4	**exit** **Example:** `Router(config-if)# exit`	Exits interface configuration mode and returns to global configuration mode.
Step 5	**exit** **Example:** `Router(config)# exit`	Exits global configuration mode and returns to privileged EXEC mode.

Configuring MPLS TE Forwarding Adjacency on Tunnels

Note You must configure a forwarding adjacency on two LSP tunnels bidirectionally, from A to B and B to A. Otherwise, the forwarding adjacency is advertised, but not used in the IGP network.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface tunnel** *number*
4. **tunnel mpls traffic-eng forwarding-adjacency** [**holdtime** *value*]
5. **isis metric** {*metric-value*| **maximum**} {**level-1**| **level-2**}

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 tunnel** *number* **Example:** `Router(config)# interface tunnel 0`	Designates a tunnel interface for the forwarding adjacency, and enters interface configuration mode.
Step 4	**tunnel mpls traffic-eng forwarding-adjacency** [**holdtime** *value*] **Example:** `Router(config-if)# tunnel mpls traffic-eng forwarding-adjacency`	Advertises a TE tunnel as a link in an IGP network.
Step 5	**isis metric** {*metric-value*| **maximum**} {**level-1**| **level-2**} **Example:** `Router(config-if)# isis metric 2 level-1`	Configures the IS-IS metric for a tunnel interface to be used as a forwarding adjacency. • You should specify the **isis metric** command with level-1 or level-2 to be consistent with the IGP level at which you are performing traffic engineering. Otherwise, the metric has the default value of 10.

Verifying MPLS TE Forwarding Adjacency

SUMMARY STEPS

1. **enable**
2. **show mpls traffic-eng forwarding-adjacency** [*ip-address*]
3. **show isis** [*process-tag*] **database** [**level-1**] [**level-2**] [**l1**] [**l2**] [**detail**] [**lspid**]
4. **exit**

DETAILED STEPS

Step 1 **enable**
Use this command to enable privileged EXEC mode. Enter your password if prompted. For example:

Example:

```
Router> enable
Router#
```

Step 2 **show mpls traffic-eng forwarding-adjacency** [*ip-address*]
Use this command to see the current tunnels. For example:

Example:

```
Router# show mpls traffic-eng forwarding-adjacency

 destination 0168.0001.0007.00 has 1 tunnels
  Tunnel7     (traffic share 100000, nexthop 192.168.1.7)
                (flags:Announce Forward-Adjacency, holdtime 0)
Router# show mpls traffic-eng forwarding-adjacency 192.168.1.7
 destination 0168.0001.0007.00 has 1 tunnels
  Tunnel7     (traffic share 100000, nexthop 192.168.1.7)
                (flags:Announce Forward-Adjacency, holdtime 0)
```

Step 3 **show isis** [*process-tag*] **database** [**level-1**] [**level-2**] [**l1**] [**l2**] [**detail**] [**lspid**]
Use this command to display information about the IS-IS link-state database. For example:

Example:

```
Router# show isis database
IS-IS Level-1 Link State Database

LSPID                 LSP Seq Num    LSP Checksum  LSP Holdtime  ATT/P/OL
0000.0C00.0C35.00-00  0x0000000C     0x5696        792           0/0/0
0000.0C00.40AF.00-00  0x00000009     0x8452        1077          1/0/0
0000.0C00.62E6.00-00  0x0000000A     0x38E7        383           0/0/0
0000.0C00.62E6.03-00  0x00000006     0x82BC        384           0/0/0
0800.2B16.24EA.00-00  0x00001D9F     0x8864        1188          1/0/0
0800.2B16.24EA.01-00  0x00001E36     0x0935        1198          1/0/0

IS-IS Level-2 Link State Database
LSPID                 LSP Seq Num    LSP Checksum  LSP Holdtime  ATT/P/OL
0000.0C00.0C35.03-00  0x00000005     0x04C8        792           0/0/0
0000.0C00.3E51.00-00  0x00000007     0xAF96        758           0/0/0
```

```
0000.0C00.40AF.00-00  0x0000000A     0x3AA9        1077          0/0/0
```

Step 4 **exit**

Use this command to exit to user EXEC. For example:

Example:

```
Router# exit
Router>
```

Configuration Examples for MPLS Traffic Engineering Forwarding Adjacency

This section provides a configuration example for the MPLS Traffic Engineering Forwarding Adjacency feature using an IS-IS metric.

Example MPLS TE Forwarding Adjacency

The following output shows the configuration of a tunnel interface, a forwarding adjacency, and an IS-IS metric:

```
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# interface tunnel 7
Router(config-if)# tunnel mpls traffic-eng forwarding-adjacency
Router(config-if)# isis metric 2 level-1
```

Following is sample command output when a forwarding adjacency has been configured:

```
Router# show running-config
Building configuration...
Current configuration :364 bytes
!
interface Tunnel7
 ip unnumbered Loopback0
 no ip directed-broadcast
 tunnel destination 192.168.1.7
 tunnel mode mpls traffic-eng
 tunnel mpls traffic-eng forwarding-adjacency
 tunnel mpls traffic-eng priority 7 7
 tunnel mpls traffic-eng path-option 10 explicit name short
 isis metric 2 level 1
```

Note Do not specify the **tunnel mpls traffic-eng autoroute announce** command in your configuration when you are using forwarding adjacency.

Following is an example where forwarding adjacency is configured with OFPF:

```
Router# configure terminal
```

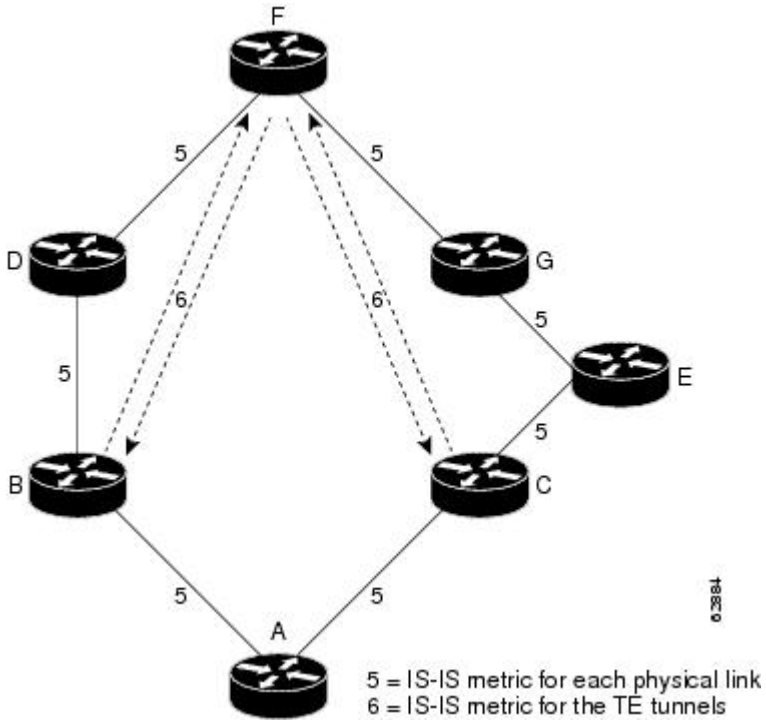
```
Router# show running-config

Building configuration...
Current configuration : 310 bytes
interface tunnel 1
!
interface Tunnel1
 ip unnumbered Loopback0
 ip ospf cost 6
 tunnel destination 172.16.255.5
 tunnel mode mpls traffic-eng
 tunnel mpls traffic-eng forwarding-adjacency  tunnel mpls
 traffic-eng priority 7 7
 tunnel mpls traffic-eng bandwidth 1000
 tunnel mpls traffic-eng path-option 10 dynamic
 end
Router# show mpls traffic-eng forwarding-adjacency

 destination 172.16.255.5, area ospf 172  area 0, has 1 tunnels
  Tunnel1      (load balancing metric 2000000, nexthop 172.16.255.5)
               (flags:  Forward-Adjacency, holdtime 0)
Router#
```

Usage Tips

In the figure below, if you have no forwarding adjacencies configured for the TE tunnels between Band F and C and F, all the traffic that A must forward to F goes through B because B is the shortest path from A to F. (The cost from A to F is 15 through B and 20 through C.)



If you have forwarding adjacencies configured on the TE tunnels between B and F and C and F and also on the TE tunnels between F and B and F and C, then when A computes the SPF algorithm, A sees two equal cost paths of 11 to F. As a result, traffic across the A-B and A-C links is shared.

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
MPLS traffic engineering commands	*Cisco IOS Multiprotocol Label Switching Command Reference*
IP switching commands	*Cisco IOS IP Switching Command Reference*
IS-IS TLVs	Intermediate System-to-Intermediate System (IS-IS) TLVs (white paper)

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 standards has not been modified by this feature.	To locate and download MIBs for selected platforms, Cisco software 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 and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Glossary

Cisco Express Forwarding --A scalable, distributed, Layer 3 switching solution designed to meet the future performance requirements of the Internet and enterprise networks.

forwarding adjacency --A traffic engineering link (or LSP) into an IS-IS/OSPF network.

IGP --Interior Gateway Protocol. Internet protocol used to exchange routing information within an autonomous system. Examples of common IGPs include Interior Gateway Routing Protocol (IGRP), Open Shortest Path First (OSPF), and Routing Information Protocol (RIP).

IS-IS --Intermediate System-to-Intermediate System. Open System Interconnection (OSI) link-state hierarchical routing protocol whereby Intermediate System (IS) routers exchange routing information based on a single metric to determine network topology.

label switched path (LSP) --A sequence of hops (R0...R*n*) in which a packet travels from R0 to R*n* through label switching mechanisms. A switched path can be chosen dynamically, based on normal routing mechanisms, or through configuration.

label switched path (LSP) tunnel --A configured connection between two routers, using label switching to carry the packets.

MPLS-- Multiprotocol Label Switching. A 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.

OSPF --Open Shortest Path First. A link-state, hierarchical IGP routing algorithm proposed as a successor to RIP in the Internet community. OSPF features include least-cost routing, multipath routing, and load balancing. OSPF was derived from an early version of the IS-IS protocol. *See also* IS-IS.

SPF --Shortest Path First. A routing algorithm used as the basis for OSPF operations. When an SPF router is powered up, it initializes its routing-protocol data structures and then waits for indications from lower-layer protocols that its interfaces are functional.

TLV --type, length, value. A block of information embedded in Cisco Discovery Protocol advertisements.

traffic engineering --The techniques and processes used to cause routed traffic to travel through the network on a path other than the one that would have been chosen if standard routing methods had been applied.

traffic engineering tunnel --A label switched tunnel that is used for traffic engineering. Such a tunnel is set up through means other than normal Layer 3 routing; it is used to direct traffic over a path different from the one that Layer 3 routing would cause the tunnel to take.

Feature Information for MPLS Traffic Engineering Forwarding Adjacency

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 Traffic Engineering Forwarding Adjacency

Feature Name	Releases	Feature Information
MPLS Traffic Engineering Forwarding Adjacency	12.0(15)S 12.0(16)ST 12.2(18)S 12.2(18)SXD 12.2(27)SBC 12.2(28)SB 12.4(20)T Cisco IOS XE Release 2.3	The MPLS Traffic Engineering Forwarding Adjacency feature allows a network administrator to handle a TE LSP tunnel as a link in an IGP network based on the SPF algorithm. In 12.0(15)S, this feature was introduced. In 12.0(16)ST, this feature was integrated. In 12.2(18)S, this feature was integrated. In 12.2(18)SXD, this feature was integrated. In 12.2(27)SBC, this feature was integrated. In 12.2(28)SB, this feature was integrated. In 12.4(20)T, this feature was integrated. In Cisco IOS XE Release 2.3, this feature was implemented on the Cisco ASR 1000 Series Aggregation Services Routers. The following commands were modified: **debug mpls traffic-eng forwarding-adjacency**, **show mpls traffic-eng forwarding-adjacency**, and **tunnel mpls traffic-eng forwarding-adjacency**.