

MPLS Traffic Engineering Forwarding Adjacency

Feature History

Release	Modification
12.0(15)S	This feature was introduced.

This document describes the Multiprotocol Label Switching (MPLS) Traffic Engineering (TE) Forwarding Adjacency feature in Cisco IOS Release 12.0(15)S. It identifies the supported platforms, provides configuration examples, and lists related IOS command line interface (CLI) commands.

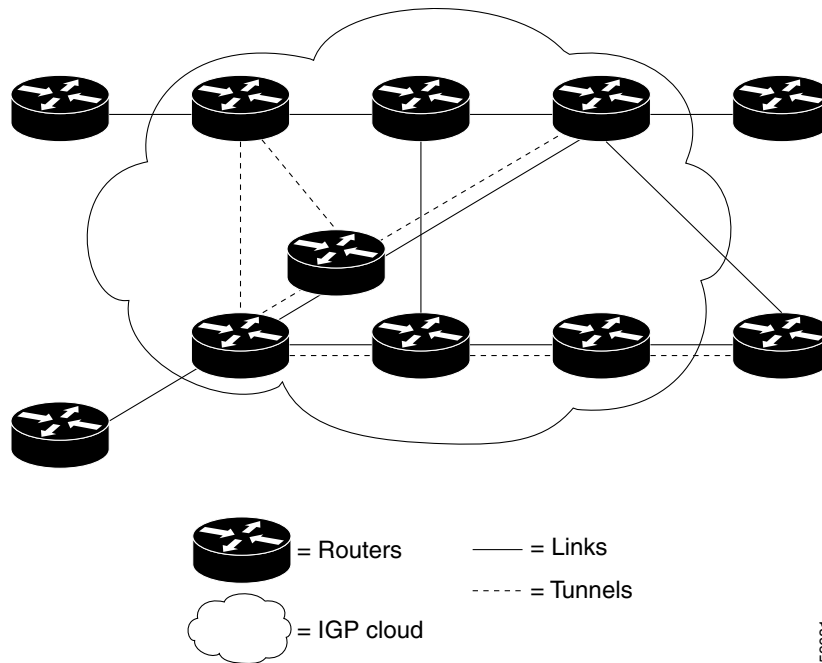
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Feature Overview

The MPLS TE Forwarding Adjacency feature allows a network administrator to handle a traffic engineering, label-switched path (LSP) tunnel as a link in an Interior Gateway Protocol (IGP) network based on the Shortest Path First (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 [Figure 1](#).

Figure 1 Forwarding Adjacency Topology



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.

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 IGP to compute the SPF even if they are not the head end of any TE tunnels.

Restrictions

- Using the MPLS TE Forwarding Adjacency feature increases the size of the IGP database by advertising a TE tunnel as a link.
- The MPLS TE Forwarding Adjacency feature is supported by Intermediate System-to-Intermediate System (IS-IS). Open Shortest Path First (OSPF) support will be available in a future release.
- When the MPLS TE Forwarding Adjacency feature is enabled on a TE tunnel, the link is advertised in the IGP network as a Type Length Value (TLV) 22 without any TE sub-TLV.
- MPLS TE forwarding adjacency tunnels must be configured bidirectionally.

Related Features and Technologies

The MPLS TE Forwarding Adjacency feature is related to the Resource Reservation Protocol (RSVP) and MPLS traffic engineering features. (See the section on “[Related Documents](#)”.)

Related Documents

- [Cisco IOS Release 12.0 Switching Services Configuration Guide](#)
- [Cisco IOS Release 12.0 Switching Services Command Reference](#)
- [Intermediate System-to-Intermediate System \(IS-IS\) TLVs](#) (white paper)

Supported Platforms

- Cisco 7200 series
- Cisco 7500 series
- Cisco 12000 series

Determining Platform Support Through Feature Navigator

Cisco IOS software is packaged in feature sets that support specific platforms. To get updated information regarding platform support for this feature, access Cisco Feature Navigator. Cisco Feature Navigator dynamically updates the list of supported platforms as new platform support is added for the feature.

Cisco Feature Navigator is a web-based tool that enables you to quickly determine which Cisco IOS software images support a specific set of features and which features are supported in a specific Cisco IOS image. You can search by feature or release. Under the release section, you can compare releases side by side to display both the features unique to each software release and the features in common.

To access Cisco Feature Navigator, you must have an account on Cisco.com. If you have forgotten or lost your account information, send a blank e-mail to cco-locksmith@cisco.com. An automatic check will verify that your e-mail address is registered with Cisco.com. If the check is successful, account details with a new random password will be e-mailed to you. Qualified users can establish an account on Cisco.com by following the directions at <http://www.cisco.com/register>.

Cisco Feature Navigator is updated regularly when major Cisco IOS software releases and technology releases occur. For the most current information, go to the Cisco Feature Navigator home page at the following URL:

<http://www.cisco.com/go/fn>

Supported Standards, MIBs, and RFCs

Standards

No new or modified standards are supported by this feature.

MIBs

No new or modified MIBs are supported by this feature.

To obtain lists of supported MIBs by platform and Cisco IOS release, and to download MIB modules, go to the Cisco MIB website on Cisco.com at the following URL:

<http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml>

RFCs

- RFC 2205 (Resource Reservation Protocol (RSVP))
- RFC 1142 (IS-IS)
- RFC 1195 (Use of OSI IS-IS for Routing in TCP/IP and Dual Environments)

Prerequisites

Your network must support the following Cisco IOS features before enabling the MPLS TE Forwarding Adjacency feature:

- Multiprotocol Label Switching (MPLS)
- IP Cisco Express Forwarding (CEF)
- Intermediate System-to-Intermediate System (IS-IS)

Configuration Tasks

See the following sections for configuration tasks for the MPLS TE Forwarding Adjacency feature. Each task in the list is identified as either required or optional.

- [Configuring a Tunnel Interface for MPLS TE Forwarding Adjacency](#) (required)
- [Configuring MPLS TE Forwarding Adjacency](#) (required)
- [Configuring IS-IS for MPLS TE Forwarding Adjacency](#) (required)

Configuring a Tunnel Interface for MPLS TE Forwarding Adjacency

To configure a tunnel interface for an MPLS TE forwarding adjacency, use the following commands, beginning in global configuration mode:

	Command	Purpose
Step 1	Router# configure terminal	Enters global configuration mode.
Step 2	Router(config)# interface tunnel {number}	Designates a tunnel interface for the forwarding adjacency.

Configuring MPLS TE Forwarding Adjacency

To configure an MPLS TE forwarding adjacency, use the following command, beginning in interface configuration mode:

Command	Purpose
Router(config-if)# tunnel mpls traffic-eng forwarding-adjacency {holdtime value}	Advertises a TE tunnel as a link in an IGP network.

**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.

Configuring IS-IS for MPLS TE Forwarding Adjacency

To configure an IS-IS metric for an MPLS TE forwarding adjacency, use the following command, beginning in interface configuration mode:

Command	Purpose
Router(config-if)# isis metric default-metric {level-1 level-2}	Configures the cost metric for a tunnel interface to be used as a forwarding adjacency.
	 Note You should configure the isis metric command with level 1 or 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

To verify MPLS TE forwarding adjacency configuration, use this procedure:

- Step 1** Use the **show mpls traffic-eng forwarding-adjacency** command to see the current tunnels:

```
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)
```

Monitoring and Maintaining MPLS TE Forwarding Adjacency

To monitor and maintain an MPLS TE forwarding adjacency, use the following commands in EXEC mode:

Command	Purpose
Router# show mpls traffic-eng forwarding-adjacency	Displays information about traffic engineering tunnels.
Router# show isis area-tag database [level-1] [level-2] [11] [12] [detail] [lspid]	Displays information about the IS-IS link-state database.

Configuration Examples

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

MPLS TE Forwarding Adjacency Example

The following output shows a tunnel interface, a forwarding adjacency, and an IS-IS metric being configured:

```
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
```

Here is sample output in which a forwarding adjacency has been configured:

```
Router# show run
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
```

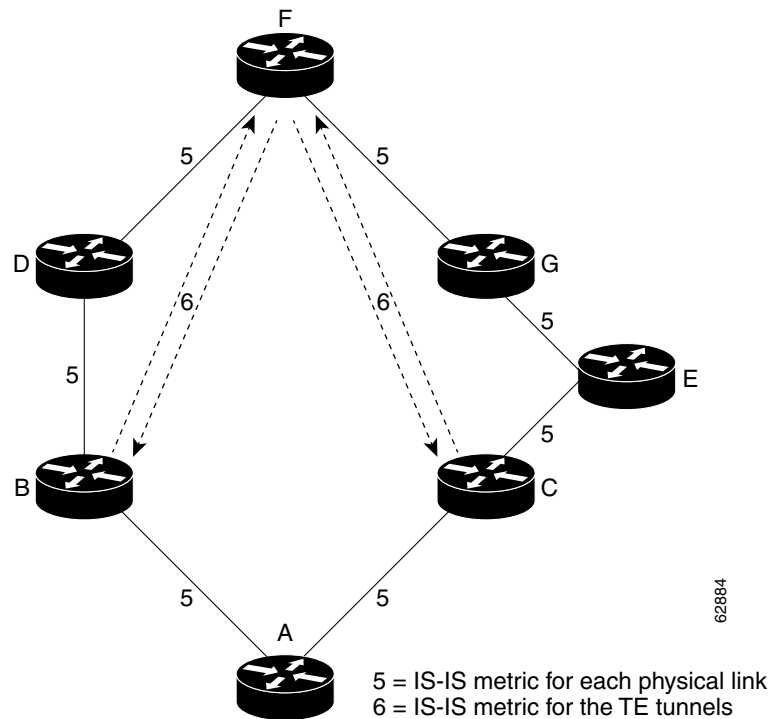


Note

We do not recommend using the `tunnel mpls traffic-eng autoroute announce` statement in your configuration when you are using forwarding adjacency. This is because they both attract traffic down a TE tunnel by interfacing with IGP SPF, but at different points in the process.

Usage Tips

Figure 2 Using Forwarding Adjacencies



In [Figure 2](#), if you have no forwarding adjacencies configured for the TE tunnels between B-F and C-F, all the traffic that A has to forward to F goes through B since 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-F and C-F and also on the TE tunnels between F-B and F-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.

Command Reference

This section documents new commands. All other commands used with this feature are documented in the Cisco IOS Release 12.0 command reference publications.

New Commands

- [debug mpls traffic-eng forwarding-adjacency](#)
- [show mpls traffic-eng forwarding-adjacency](#)
- [tunnel mpls traffic-eng forwarding-adjacency](#)

debug mpls traffic-eng forwarding-adjacency

To display debug messages for TE forwarding-adjacency events, use the **debug mpls traffic-eng forwarding-adjacency** command in privileged EXEC mode. To disable debugging output, use the **no** form of this command.

debug mpls traffic-eng forwarding adjacency

no debug mpls traffic-eng forwarding adjacency

Syntax Description

This command has no arguments or keywords.

Defaults

This command is disabled by default.

Command Modes

Privileged EXEC

Command History

Release	Modification
12.0(15)S	This command was introduced.
12.0(16)ST	This command was integrated into Cisco IOS Release 12.0(16)ST.

Usage Guidelines

Use the **debug mpls traffic-eng forwarding-adjacency** command to troubleshoot any problems that occur after you configure the **tunnel mpls traffic-eng forwarding-adjacency** command.

Examples

The following is sample output from the **debug mpls traffic-eng forwarding-adjacency** command:

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

```
MPLS traffic-eng debugging is on
```

With a tunnel configured, the following output appears:

```
interface Tunnel0
 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 dynamic
end
```

When the tunnel comes up, it generates the following debug output:

```
*Oct 2 12:27:07.846:TE-Auto:announcement that destination 0168.0001.0007.00 has 1 tunnels
*Oct 2 12:27:07.846: Tunnel0 (traffic share 142857, nexthop 192.168.1.7)
*Oct 2 12:27:07.846: (flags: Forward-Adjacency, holdtime 0)
```

debug mpls traffic-eng forwarding-adjacency

Related Commands	Command	Description
	show debug	Displays active debug output.
	show mpls traffic-eng forwarding-adjacency	Displays TE tunnels being advertised as links in an IGP network.
	tunnel mpls traffic-eng forwarding-adjacency	Advertises a TE tunnel as a link in an IGP network.

show mpls traffic-eng forwarding-adjacency

To display TE tunnels that are advertised as links in an IGP network, use the **show mpls traffic-eng forwarding-adjacency** command in EXEC mode.

```
show mpls traffic-eng forwarding-adjacency ip address
```

Syntax Description	<i>ip address</i> (Optional) Destination address for forwarding-adjacency tunnels.
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Defaults	No default behavior or values.
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Command Modes	EXEC
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Command History	Release	Modification
	12.0(15)S	This command was introduced.
	12.0(16)ST	This command was integrated into Cisco IOS Release 12.0(16)ST.

Usage Guidelines	Use the show mpls traffic-eng forwarding-adjacency command to display information about tunnels configured with the tunnel mpls traffic-eng forwarding-adjacency command.
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Examples	The following is sample output from the show mpls traffic-eng forwarding-adjacency command:
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```
Router# show mpls traffic-eng forwarding-adjacency ?
  A.B.C.D destination address for forwarding-adjacency tunnels
  |      Output modifiers
  <cr>
```

Here is sample output in which a forwarding adjacency is enabled:

```
Router# show run
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
end
```

■ show mpls traffic-eng forwarding-adjacency

Use the **show mpls traffic-eng forwarding-adjacency** command again to see the current tunnels:

```
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)
```

Related Commands

Command	Description
debug mpls traffic-eng forwarding-adjacency	Displays debug messages for traffic-engineering, forwarding-adjacency events.
tunnel mpls traffic-eng forwarding-adjacency	Advertises a TE tunnel as a link in an IGP network.

tunnel mpls traffic-eng forwarding-adjacency

To advertise a TE tunnel as a link in an IGP network, use the **tunnel mpls traffic-eng forwarding-adjacency** command in interface configuration mode. To disable the functionality, use the **no** form of this command.

```
tunnel mpls traffic-eng forwarding-adjacency {holdtime value}
```

```
no tunnel mpls traffic-eng forwarding-adjacency
```

Syntax Description

holdtime <i>value</i>	(Optional) Time in milliseconds (ms) that a TE tunnel waits after going down before informing the network. The range is 0 to 4,294,967,295 ms. The default value is 0.
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Defaults

The default value is 0.

Command Modes

Interface configuration

Command History

Release	Modification
12.0(15)S	This command was introduced.
12.0(16)ST	This command was integrated into Cisco IOS Release 12.0(16)ST.

Usage Guidelines

Use the **tunnel mpls traffic-eng forwarding-adjacency** command with the **isis metric** command to avoid inefficient forwarding behavior. Ensure that any nodes traversed by the TE tunnel being advertised do not consider the TE tunnel as part of the shortest path to the destination.



Note The **tunnel mpls traffic-eng forwarding-adjacency** command requires IS-IS support.

Examples

In the following example, the holdtime is set to 10,000 milliseconds:

```
Router(config-if)# tunnel mpls traffic-eng forwarding-adjacency holdtime 10000
```

In the following example, the holdtime defaults to 0:

```
Router(config-if)# tunnel mpls traffic-eng forwarding-adjacency
```

Related Commands

Command	Description
debug mpls traffic-eng forwarding-adjacency	Displays debug messages for traffic engineering, forwarding-adjacency events.

Command	Description
<code>isis metric</code>	Configures the cost metric for an interface.
<code>show mpls traffic-eng forwarding-adjacency</code>	Displays TE tunnels being advertised as links in an IGP network.

Glossary

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 IGRP, OSPF, and RIP.

IS-IS—Intermediate System-to-Intermediate System. 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...Rn) in which a packet travels from R0 to Rn 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 (formerly known as tag switching). A method for directing packets primarily through Layer 2 switching rather than Layer 3 routing. In MPLS, packets are assigned short fixed-length labels at the ingress to an MPLS cloud by using the concept of forwarding equivalence classes. Within the MPLS domain, the labels are used to make forwarding decisions mostly without recourse to the original packet headers.

OSPF—Open Shortest Path First. A link-state routing protocol used for routing.

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 Values. Blocks of information embedded in Cisco Discovery Protocol (CDP) 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.

