Multiprotocol Label Switching (MPLS) Traffic Engineering

Feature Overview

Multiprotocol Label Switching (MPLS) traffic engineering software enables an MPLS backbone to replicate and expand upon the traffic engineering capabilities of Layer 2 ATM and Frame Relay networks.

Traffic engineering is essential for service provider and Internet service provider (ISP) backbones. Such backbones must support a high use of transmission capacity, and the networks must be very resilient, so that they can withstand link or node failures.

MPLS traffic engineering provides an integrated approach to traffic engineering. With MPLS, traffic engineering capabilities are integrated into Layer 3, which optimizes the routing of IP traffic, given the constraints imposed by backbone capacity and topology.

MPLS traffic engineering routes traffic flows across a network based on the resources the traffic flow requires and the resources available in the network.

MPLS traffic engineering employs "constraint-based routing," in which the path for a traffic flow is the shortest path that meets the resource requirements (constraints) of the traffic flow. In MPLS traffic engineering, the flow has bandwidth requirements, media requirements, a priority versus other flows, and so on.

MPLS traffic engineering gracefully recovers to link or node failures that change the topology of the backbone by adapting to the new set of constraints.

Why Use MPLS Traffic Engineering?

WAN connections are an expensive item in an ISP budget. Traffic engineering enables ISPs to route network traffic in such a way that they can offer the best service to their users in terms of throughput and delay.

Currently, some ISPs base their services on an overlay model. In this approach, transmission facilities are managed by Layer 2 switching. The routers see only a fully meshed virtual topology, making most destinations appear one hop away. The use of the explicit Layer 2 transit layer gives you precise control over the ways in which traffic uses the available bandwidth. However, the overlay model has a number of disadvantages. MPLS traffic engineering provides a way to achieve the same traffic engineering benefits of the overlay model without needing to run a separate network, and without needing a non-scalable full mesh of router interconnects.

Existing Cisco IOS software releases (for example, Cisco IOS Release 12.0) contain a set of features that enable elementary traffic engineering capabilities. Specifically, you can create static routes and control dynamic routes through the manipulation of link state metrics. This functionality is useful in some tactical situations, but is insufficient for all the traffic engineering needs of ISPs.

With MPLS traffic engineering, you do not have to manually configure the network devices to set up explicit routes. Instead, you can rely on the MPLS traffic engineering functionality to understand the backbone topology and the automated signalling process.

MPLS traffic engineering accounts for link bandwidth and for the size of the traffic flow when determining explicit routes across the backbone.

The need for dynamic adaptation is also necessary. MPLS traffic engineering has a dynamic adaptation mechanism that provides a full solution to traffic engineering a backbone. This mechanism enables the backbone to be resilient to failures, even if many primary paths are precalculated off-line.

How MPLS Traffic Engineering Works

MPLS is an integration of Layer 2 and Layer 3 technologies. By making traditional Layer 2 features available to Layer 3, MPLS enables traffic engineering. Thus, you can offer in a one-tier network what now can be achieved only by overlaying a Layer 3 network on a Layer 2 network.

MPLS traffic engineering automatically establishes and maintains the tunnel across the backbone, using RSVP. The path used by a given tunnel at any point in time is determined based on the tunnel resource requirements and network resources, such as bandwidth.

Available resources are flooded via extensions to a link-state based Interior Protocol Gateway (IPG).

Tunnel paths are calculated at the tunnel head based on a fit between required and available resources (constraint-based routing). The IGP automatically routes the traffic into these tunnels. Typically, a packet crossing the MPLS traffic engineering backbone travels on a single tunnel that connects the ingress point to the egress point.

MPLS traffic engineering is built on the following IOS mechanisms:

- Label-switched path (LSP) tunnels, which are signalled through RSVP, with traffic engineering extensions. LSP tunnels are represented as IOS tunnel interfaces, have a configured destination, and are unidirectional.
- A link-state IGP (such as IS-IS) with extensions for the global flooding of resource information, and extensions for the automatic routing of traffic onto LSP tunnels as appropriate.
- An MPLS traffic engineering path calculation module that determines paths to use for LSP tunnels.
- An MPLS traffic engineering link management module that does link admission and bookkeeping of the resource information to be flooded.
- Label switching forwarding, which provides routers with a Layer 2-like ability to direct traffic across multiple hops as directed by the resource-based routing algorithm.

One approach to engineer a backbone is to define a mesh of tunnels from every ingress device to every egress device. The IGP, operating at an ingress device, determines which traffic should go to which egress device, and steers that traffic into the tunnel from ingress to egress. The MPLS traffic engineering path calculation and signalling modules determine the path taken by the LSP tunnel, subject to resource availability and the dynamic state of the network. For each tunnel, counts of packets and bytes sent are kept.

Sometimes, a flow is so large that it cannot fit over a single link, so it cannot be carried by a single tunnel. In this case multiple tunnels between a given ingress and egress can be configured, and the flow is load shared among them.

For more information about MPLS (also referred to as Tag Switching), see the Cisco documentation on the World Wide Web at http://www.cisco.com/univercd/cc/td/doc/product/software/ios111/ct111/rn111ct.htm.

The following sections describe how conventional hop-by-hop link-state routing protocols interact with new traffic engineering capabilities. In particular, these sections describe how Dijkstra's shortest path first (SPF) algorithm has been adapted so that a link-state IGP can automatically forward traffic over tunnels that are set up by traffic engineering.

Mapping Traffic into Tunnels

Link-state protocols like integrated IS-IS use Dijkstra's SPF algorithm to compute a shortest path tree to all nodes in the network. Routing tables are derived from this shortest path tree. The routing tables contain ordered sets of destination and first-hop information. If a router does normal hop-by-hop routing, the first hop is a physical interface attached to the router.

New traffic engineering algorithms calculate explicit routes to one or more nodes in the network. These explicit routes are viewed as logical interfaces by the originating router. In the context of this document, these explicit routes are represented by LSPs and referred to as traffic engineering tunnels (TE tunnels).

The following sections describe how link-state IGPs can make use of these shortcuts, and how they can install routes in the routing table that point to these TE tunnels. These tunnels use explicit routes, and the path taken by a TE tunnel is controlled by the router that is the headend of the tunnel. In the absence of errors, TE tunnels are guaranteed not to loop, but routers must agree on how to use the TE tunnels. Otherwise traffic might loop through two or more tunnels.

Enhancement to the SPF Computation

During each step of the SPF computation, a router discovers the path to one node in the network. If that node is directly connected to the calculating router, the first-hop information is derived from the adjacency database. If a node is not directly connected to the calculating router, the node inherits the first-hop information from the parent(s) of that node. Each node has one or more parents and each node is the parent of zero or more downstream nodes.

For traffic engineering purposes, each router maintains a list of all TE tunnels that originate at this router. For each of those TE tunnels, the router at the tailend is known.

During the SPF computation, when a router finds the path to a new node, the new node is moved from the TENTative list to the PATHS list. The router must determine the first-hop information. There are three possible ways to do this:

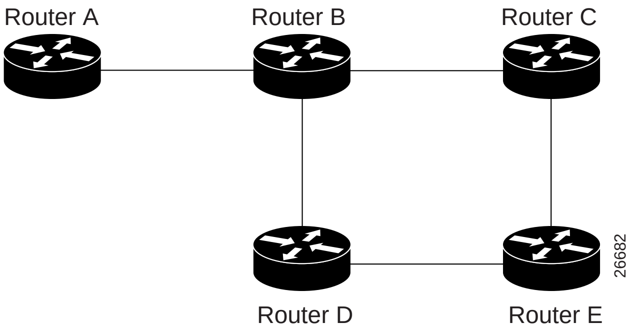
1. Examine the list of tailend routers directly reachable by way of a TE tunnel. If there is a TE tunnel to this node, use the TE tunnel as the first-hop.
2. If there is no TE tunnel, and the node is directly connected, use the first-hop information from the adjacency database.
3. If the node is not directly connected, and is not directly reachable by way of a TE tunnel, the first-hop information is copied from the parent node(s) to the new node.

As a result of this computation, traffic to nodes that are the tailend of TE tunnels flows over those TE tunnels. Traffic to nodes that are downstream of the tailend nodes also flows over those TE tunnels. If there is more than one TE tunnel to different intermediate nodes on the path to destination node X, traffic flows over the TE tunnel whose tailend node is closest to node X.

Special Cases and Exceptions

The SPF algorithm finds equal-cost parallel paths to destinations. The enhancement previously described does not change this. Traffic can be forwarded over one or more native IP paths, over one or more TE tunnels, or over a combination of native IP paths and TE tunnels.

A special situation occurs in the following topology:



Assume that all links have the same cost and that a TE tunnel is set up from Router A to Router D. When the SPF calculation puts Router C on the TENTative list, it realizes that Router C is not directly connected. It uses the first-hop information from the parent, which is Router B. When the SPF calculation on Router A puts Router D on the TENTative list, it realizes that Router D is the tailend of a TE tunnel. Thus Router A installs a route to Router D by way of the TE tunnel, and not by way of Router B.

When Router A puts Router E on the TENTative list, it realizes that Router E is not directly connected, and that Router E is not the tailend of a TE- tunnel. Therefore Router A copies the first-hop information from the parents (Router C and Router D) to the first-hop information of Router E.

Traffic to Router E now load-balances over the native IP path by way of Router A to Router B to Router C, and the TE tunnel Router A to Router D.

If parallel native IP paths and paths over TE tunnels are available, these implementations allow you to force traffic to flow over TE tunnels only or only over native IP paths.

Additional Enhancements to SPF Computation Using Configured Tunnel Metrics

When an IGP route is installed into a router information base (RIB) by means of TE tunnels as next hops, the distance or metric of the route must be calculated. Normally, you could make the metric the same as the IGP metric over native IP paths as if the TE tunnels did not exist. For example, Router A can reach Router C with the shortest distance of 20. X is a route advertised in IGP by Router C. Route X is installed in Router A's RIB with the metric of 20. When a TE tunnel from Router A to Router C comes up, by default the route is installed with a metric of 20, but the next-hop information for X is changed.

Although the same metric scheme can work well in other situations, for some applications it is useful to change the TE tunnel metric. For instance, when there are equal cost paths through TE tunnel and native IP links. You can adjust TE tunnel metrics to force the traffic to prefer the TE tunnel, to prefer the native IP paths, or to load share among them.

Again, suppose that multiple TE tunnels go to the same or different destinations. TE tunnel metrics can force the traffic to prefer some TE tunnels over others, regardless of IGP distances to those destinations.

Setting metrics on TE tunnels does not affect the basic SPF algorithm. It affects only two questions in only two areas: (1) whether the TE tunnel is installed as one of the next hops to the destination routers, and (2) what the metric value is of the routes being installed into the RIB. You can modify the metrics for determining the first-hop information:

- If the metric of the TE tunnel to the tailend routers is higher than the metric for the other TE tunnels or native hop-by-hop IGP paths, this tunnel is not installed as the next hop.
- If the metric of the TE tunnel is equal to the metric of either other TE tunnels or native hop-by-hop IGP paths, this tunnel is added to the existing next hops.
- If the metric of the TE tunnel is lower than the metric of other TE tunnels or native hop-by-hop IGP paths, this tunnel replaces them as the only next hop.

In each of the above cases, routes associated with those tailend routers and their downstream routers are assigned metrics related to those tunnels.

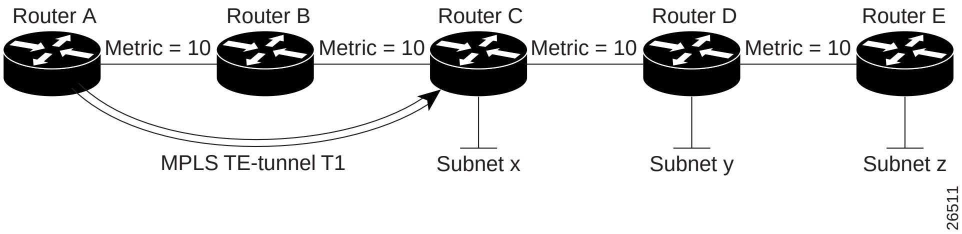
This mechanism is loop free because the traffic through the TE tunnels is basically source routed. The end result of TE tunnel metric adjustment is the control of traffic loadsharing. If there is only one way to reach the destination through a single TE tunnel, then no matter what metric is assigned, the traffic has only one way to go.

You can represent the TE tunnel metric in two different ways: (1) as an absolute (or fixed) metric or (2) as a relative (or floating) metric.

If you use an absolute metric, the routes assigned with the metric are fixed. This metric is used not only for the routes sourced on the TE tunnel tailend router, but also for each route downstream of this tailend router that uses this TE tunnel as one of its next hops.

For example, if you have TE tunnels to two core routers in a remote point of presence (POP), and one of them has an absolute metric of 1, all traffic going to that POP traverses this low-metric TE tunnel.

If you use a relative metric, the actual assigned metric value of routes is based on the IGP metric. This relative metric can be positive or negative, and is bounded by minimum and maximum allowed metric values. For example, assume the following topology:



If there is no TE tunnel, Router A installs routes x, y, and z and assigns metrics 20, 30, and 40 respectively. Suppose that Router A has a TE tunnel T1 to Router C. If the relative metric -5 is used on tunnel T1, the routers x, y, and z have the installed metric of 15, 25, and 35. If an absolute metric of 5 is used on tunnel T1, routes x, y and z have the same metric 5 installed in the RIB for Router A. The assigning of no metric on the TE tunnel is a special case, a relative metric scheme where the metric is 0.

Transitioning an IS-IS Network to a New Technology

This section discusses two different ways to migrate an existing IS-IS network from the standard ISO 10589 protocol, towards a new flavor of IS-IS with extensions.

New Extensions for the IS-IS Routing Protocol

Recently new extensions have been designed and implemented for the IS-IS routing protocol. The extensions serve multiple purposes.

One goal is to remove the 6-bit limit on link metrics. A second goal is to allow for inter-area IP routes. A third goal is to enable IS-IS to carry different kinds of information for the purpose of traffic engineering. In the future, more extensions might be needed.

To serve all these purposes, two new TLVs have been defined (TLV stands for type, length, and value object). One TLV (TLV #22) describes links (or rather adjacencies). It serves the same purpose as the "IS neighbor option" in ISO 10589 (TLV #2). The second new TLV (TLV #135) describes reachable IP prefixes. Similar to the IP Neighbor options from rfc1195 (TLVs #128 and #130).

Both new TLVs have a fixed length part, followed by optional sub-TLVs. The metric space in these new TLVs has been enhanced from 6 bits to 24 or 32 bits. The sub-TLVs allow you to add new properties to links and prefixes. Traffic engineering is the first technology to make use of this ability to describe new properties of a link.

For the purpose of briefness, these two new TLVs, #22 and #135, are referred to as "new-style TLVs." TLVs #2, #128 and #130 are referred to as "old-style TLVs."

The Problem in Theory

Link-state routing protocols compute loop-free routes. This can be guaranteed because all routers calculate their routing tables based on the same information from the link-state database (LSPDB). The problem arises when some routers look at old-style TLVs and some routers look at new-style TLVs. In that case, the information on which they base their SPF calculation can be different. This different view of the world can cause routing loops among routers. Network administrators have to take great care to make sure that routers see the same view of the world.

The Problem in Practice

The easiest way to migrate from old-style TLVs towards new-style TLVs would be to introduce a "flag day." A flag day means you reconfigure all routers during a short period of time, during which service is interrupted. Assuming the implementation of a flag day is not an acceptable solution, a network administrator needs to find a viable solution for modern existing networks

Therefore, it becomes necessary to find a way to smoothly migrate a network from using IS-IS with old-style TLVs to IS-IS with new-style TLVs.

Another problem that arises and requires a solution is the need for new traffic engineering software to be tested in existing networks. Network administrators want the ability to test this software on a limited number of routers. They can not upgrade all their routers before they start testing—not in their production networks and not in their test networks.

The new extensions allow for a network administrator to use old-style TLVs in one area, and new-style in another area. However, this is not a solution for administrators that need or want to run their network in one single area.

Network administrators need a way to run an IS-IS network where some routers are advertising and using the new-style TLVs, and, at the same time, other routers are only capable of advertising and using old-style TLVs.

First Solution

One solution when you are migrating from old-style TLVs towards new-style TLVs is to advertise the same information twice—once in old-style TLVs and once in new-style TLVs. This ensures that all routers have the opportunity to understand what is advertised.

However, with this approach the two obvious drawbacks are

1. The size of the LSPs—During transition the LSPs grow roughly twice in size. This might be a problem in networks where the LSPDB is large. An LSPDB can be large because there are many routers and thus LSPs. Or the LSPs are large because of many neighbors or IP prefixes per router. A router that advertises a lot of information causes the LSPs to be fragmented.

   A large network in transition is pushing the limits regarding LSP flooding and SPF scaling. During transition you can expect some extra network instability. During this time, you especially do not want to test how far you can push an implementation. There is also the possibility that the traffic engineering extensions might cause LSPs to be reflooded more often. For a large network, this solution could produce unpredictable results.

2. The problem of ambiguity—If you choose this solution, you may get ambiguous answers to questions such as these:

   What should a router do if it encounters different information in the old-style TLVs and new-style TLVs?

This problem can be largely solved in an easy way by using:

- all information in old-style and new-style TLVs in an LSP.
- the adjacency with the lowest link metric if an adjacency is advertised more than once.

The main benefit is that network administrators can use new-style TLVs before all routers in the network are capable of understanding them.

Transition Steps During the First Solution

Here are some steps you can follow when transitioning from using IS-IS with old-style TLVs to new-style TLVs.

1. Advertise and use only old-style TLVs if all routers run old software.
2. Upgrade some routers to newer software.
3. Configure some routers with new software to advertise both old-style and new-style TLVs. They accept both styles of TLVs. Configure other routers (with old software) to remain advertising and using only old-style TLVs.
4. Test traffic engineering in parts of their network; however, wider metrics cannot be used yet.
5. If the whole network needs to migrate, upgrade and configure all remaining routers to advertise and accept both styles of TLVs.
6. Configure all routers to only advertise and accept new-style TLVs
7. Configure metrics larger than 63

Second Solution

Routers advertise only one style of TLVs at the same time, but are able to understand both types of TLVs during migration.

One benefit is that LSPs stay roughly the same size during migration. Another benefit is that there is no ambiguity between the same information advertised twice inside one LSP.

The drawback is that all routers must understand the new-style TLVs before any router can start advertising new-style TLVs. So this transition scheme is useful when transitioning the whole network (or a whole area) to use wider metrics. It does not help the second problem, where network administrators want to use the new-style TLVs for traffic engineering, while some routers are still only capable of understanding old-style TLVs.

Transition Steps During the Second Solution

1. Advertise and use only old-style TLVs if all routers run old software.
2. Upgrade all routers to newer software.
3. Configure all routers one-by-one to advertise old-style TLVs, but to accept both styles of TLVs.
4. Configure all routers one-by-one to advertise new-style TLVs, but to accept both styles of TLVs.
5. Configure all routers one-by-one to only advertise and to accept new-style TLVs.
6. Configure metrics larger than 63.

Configuration Commands

Cisco IOS has a new "router isis" command line interface (CLI) subcommand called metric-style. Once you are in the router isis subcommand mode, you have the option to choose the following:

- Metric-style narrow—enables the router to advertise and accept only old-style TLVs
- Metric-style wide—enables the router to advertise and accept only new-style TLVs
- Metric-style transition—enables the router to advertise and accept both styles
- Metric-style narrow transition—enables the router to advertise old-style TLVs and accept both styles
- Metric-style wide transition—enables the router to advertise new-style TLVs and accept both styles

There are two transition schemes that you can employ using the metric-style commands. They are

1. Narrow to transition to wide
2. Narrow to narrow transition to wide transition to wide

For more information on command syntax, see the Command Reference section found in this document.

Implementation in IOS

IOS implements both transition schemes. Network administrators can choose the scheme that suits them best. For test networks, the first solution is ideal. For real transition, both schemes can be used. The first scheme requires less steps and thus less configuration. Only the largest of largest networks that do not want to risk doubling their LSPDB during transition need to use the second solution.

Benefits

MPLS traffic engineering offers benefits in two main areas:

1. Higher return on network backbone infrastructure investment. Specifically, the best route between a pair of POPs is determined taking into account the constraints of the backbone network and the total traffic load on the backbone.

2. Reduction in operating costs. Costs are reduced because a number of important processes are automated, including set up, configuration, mapping, and selection of Multiprotocol Label Switching traffic engineered tunnels (MPLS TE) across a Cisco 12000 series backbone.

Related Features and Technologies

The MPLS traffic engineering feature is related to the IS-IS, RSVP, and Tag Switching features, which are documented in the Cisco Product Documentation (see the sections on Related Documents and How MPLS Traffic Engineering Works).

Related Documents

- Cisco IOS Release 12.0 *Network Protocols Configuration Guide, Part 1,* "Configuring Integrated IS-IS" chapter.
- Cisco IOS Release 12.0 *Network Protocols Command Reference, Part 1,* "Integrated IS-IS Commands" chapter.
- Cisco IOS Release 11.3 *Network Protocols Configuration Guide, Part 1,* "Configuring RSVP" chapter.
- Cisco IOS Release 11.3 *Network Protocols Command Reference, Part 1,* "RSVP Commands" chapter.
- Cisco IOS Release 12.0 *Switching Services Configuration Guide,* "Tag Switching" chapter.
- Cisco IOS Release 12.0 *Switching Services Command Reference,* "Tag Switching Commands" chapter.

Supported Platforms

- Cisco 7200 Series
- Cisco 7500 Series
- Cisco 12000 Series

Prerequisites

Your network must support the following Cisco IOS features before enabling MPLS traffic engineering:

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

Supported MIBs and RFCs

MIBs

There are no MIBs supported by this feature.

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

List of Terms and Acronyms

affinity bits—an MPLS traffic engineering tunnel's requirements on the attributes of the links it will cross. The tunnel's affinity bits and affinity mask must match up with the attributes of the various links carrying the tunnel.

call admission precedence—an MPLS traffic engineering tunnel with a higher priority will, if necessary, preempt an MPLS traffic engineering tunnel with a lower priority. An expected use is that tunnels that are harder to route will have a higher priority, and can preempt tunnels that are easier to route, on the assumption that those lower priority tunnels can find another path.

constraint-based routing—Procedures and protocols used to determine a route across a backbone taking into account resource requirements and resource availability, instead of simply using the shortest path.

flow—A traffic load entering the backbone at one point—point of presence (POP)—and leaving it from another, that must be traffic engineered across the backbone. The traffic load will be carried across one or more LSP tunnels running from the entry POP to the exit POP.

headend—The upstream, transmit end of a tunnel.

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 hierarchal routing protocol whereby Intermediate System (IS) routers exchange routing information based on a single metric to determine network topology.

label-switched path (LSP) tunnel—A configured connection between two routers, using label switching to carry the packets. **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 Switching Router (LSR)—A Layer 3 router that forwards packets based on the value of a label encapsulated in the packets.

LCAC—Link-level (per hop) call admission control.

LSA—Link-state advertisement. Flooded packet used by OSPF that contains information about neighbors and path costs. In IS-IS LSAs are used by the receiving routers to maintain their routing tables.

Multiprotocol Label Switching traffic engineering—MPLS traffic engineering. A constraint-based routing algorithm for routing TSP tunnels. For this early field trial (EFT) effort, the constraints of concern are bandwidth, path length, call admission precedence (CAP), and some basic policy mechanisms.

RSVP—Resource Reservation Protocol. Protocol for reserving network resources to provide Quality of Service guarantees to application flows.

tailend—The downstream, receive end of a tunnel.

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 used.

Configuration Tasks

Perform the following tasks before enabling MPLS traffic engineering:

- Turn on MPLS tunnels
- Turn on Cisco Express Forwarding (CEF)
- Turn on IS-IS

Perform the following tasks to configure MPLS traffic engineering:

- Configuring a Device to Support Tunnels
- Configuring an Interface to Support RSVP-based Tunnel Signalling and IGP Flooding
- Configuring an MPLS Traffic Engineering Tunnel
- Configuring IS-IS for MPLS Traffic Engineering

Configuring a Device to Support Tunnels

To configure a device to support tunnels, perform these steps in configuration mode.

Step	Command	Purpose
1	`Router(config)#` **`ip cef`**	Enable standard CEF operation. For information about CEF configuration and command syntax, see the *Cisco IOS Switching Solutions Configuration Guide and Command Reference*.
2	`Router(config)#` **`mpls traffic-eng tunnels`**	Enables the MPLS traffic engineering tunnel feature on a device.

Configuring an Interface to Support RSVP-based Tunnel Signalling and IGP Flooding

To configure an interface to support RSVP-based tunnel signalling and IGP flooding, perform these steps in the interface configuration mode.

Note You need to enable the tunnel feature and specify the amount of reservable RSVP bandwidth if you have an interface that supports MPLS traffic engineering.

Step	Command	Purpose
1	`Router(config-if)#` **`mpls traffic-eng tunnels`**	Enable the MPLS traffic engineering tunnel feature on an interface.
2	`Router(config-if)#` **`ip rsvp bandwidth`** *`bandwidth`*	Enable RSVP for IP on an interface and specify amount of bandwidth to be reserved. For a description of IP RSVP command syntax, see the *Cisco IOS Quality of Service Command Reference*.

Configuring an MPLS Traffic Engineering Tunnel

To configure an MPLS traffic engineering tunnel, perform these steps in the interface configuration mode. This tunnel has two path setup options—a preferred explicit path and a backup dynamic path.

Step	Command	Purpose
1	`Router(config)# interface tunnel1`	Configure an interface type and enter interface configuration mode.
2	`Router(config-if)# tunnel destination A.B.C.D`	Specify the destination for a tunnel.
3	`Router(config-if)# tunnel mode mpls traffic-eng`	Set encapsulation mode of the tunnel to MPLS traffic engineering.
4	`Router(config-if)# tunnel mpls traffic-eng bandwidth bandwidth`	Configure bandwidth for the MPLS traffic engineering tunnel.
5	`Router(config-if)# tunnel mpls traffic-eng path-option 1 explicit name boston`	Configure a named IP explicit path.
6	`Router(config-if)# tunnel mpls traffic-eng path-option 2 dynamic`	Configure a backup path to be dynamically calculated from the traffic engineering topology database.

Configuring IS-IS for MPLS Traffic Engineering

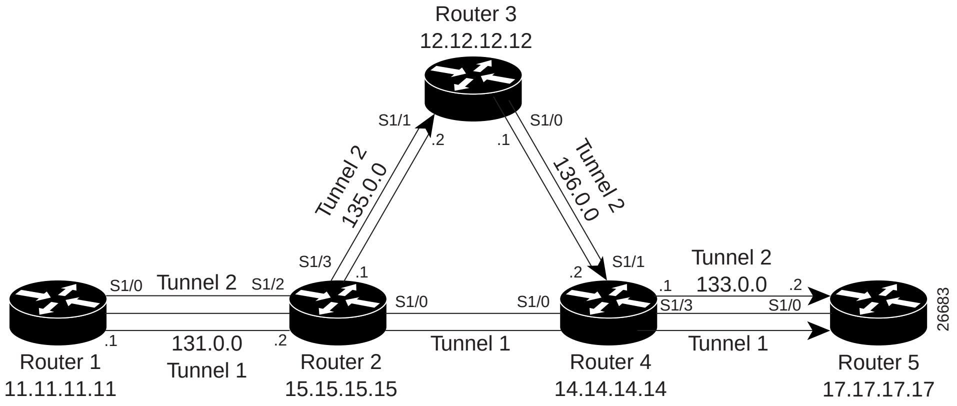
The following tasks include IS-IS traffic engineering commands. For a description of IS-IS commands (excluding the IS-IS traffic engineering commands), see the *Cisco IOS Network Protocols, Part 1 Command Reference*.

Step	Command	Purpose
1	`Router(config)# router isis`	Enable IS-IS routing and specify an IS-IS process for IP, which places you in router configuration mode.
2	`Router(config-router)# mpls traffic-eng level 1`	Turn on MPLS traffic engineering for IS-IS level 1.
3	`Router(config-router)# mpls traffic-eng router-id loopback0`	Specify the traffic engineering router identifier for the node to be the IP address associated with interface loopback0.
4	`Router(config-router)# metric-style wide`	Configure a router to generate and accept only new-style TLVs.

Configuration Example

Figure 1 illustrates a sample MPLS topology. The sections that follow contain sample configuration commands you enter to implement the following basic tunnel configuration.

Figure 1 Sample MPLS Traffic Engineering Tunnel Configuration



Configuring an MPLS Traffic Engineering Tunnel

This example shows you how to configure a dynamic tunnel and how to add a second tunnel to the same destination with an explicit path. Note that this example specifies point-to-point outgoing IP addresses. Before you configure MPLS traffic engineering tunnels, you must enter the following global, IS-IS, and interface commands on the router.

```
configure terminal
ip cef
mpls traffic-eng tunnels
interface loopback 0
 ip address 11.11.11.11 255.255.255.255
 ip router isis

interface s1/0
 ip address 131.0.0.1 255.255.0.0
 ip router isis
 mpls traffic-eng tunnels
 ip rsvp bandwidth 1000
 mpls traffic-eng administrative-weight 10

router isis
net 47.0000.0011.0011.00
is-type level-1
metric-style wide
  mpls traffic-eng router-id Loopback0
  mpls traffic-eng level-1
```

This example includes the commands for configuring a dynamic tunnel from Router 1 to Router 5.

```
configure terminal
interface tunnel1
  ip unnumbered loopback 0
  tunnel destination 17.17.17.17
  tunnel mode mpls traffic-eng
  tunnel mpls traffic-eng autoroute announce
  tunnel mpls traffic-eng bandwidth 100
  tunnel mpls traffic-eng priority 1 1
  tunnel mpls traffic-eng path-option 1 dynamic
```

To verify that the tunnel is up and traffic is routed through the tunnel, enter these commands:

```
show mpls traffic-eng tunnel
show ip route 17.17.17.17
show mpls traffic-eng autoroute
ping 17.17.17.17
show interface tunnel1 accounting
show interface s1/0 accounting
```

To create an explicit path, enter these commands:

```
configure terminal
ip explicit-path identifier 1
 next-address 131.0.0.1
 next-address 135.0.0.1
 next-address 136.0.0.1
 next-address 133.0.0.1
```

To add a second tunnel to the same destination with an explicit path, enter these commands:

```
configure terminal
interface tunnel2
  ip unnumbered loopback 0
  tunnel destination 17.17.17.17
  tunnel mode mpls traffic-eng
  tunnel mpls traffic-eng autoroute announce
  tunnel mpls traffic-eng bandwidth 100
  tunnel mpls traffic-eng priority 1 1
  tunnel mpls traffic-eng path-option 1 explicit identifier 1
```

To verify that the tunnel is up and traffic is routed through the tunnel, enter these commands:

```
show mpls traffic-eng tunnel
show ip route 17.17.17.17
show mpls traffic-eng autoroute
ping 17.17.17.17
show interface tunnel1 accounting
show interface s1/0 accounting
```

Command Reference

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

- **append-after**
- **index**
- **ip explicit-path**
- **list**
- **metric-style narrow**
- **metric-style transition**
- **metric-style wide**
- **mpls traffic-eng**
- **mpls traffic-eng area**
- **mpls traffic-eng administrative-weight**
- **mpls traffic-eng attribute-flags**
- **mpls traffic-eng flooding thresholds**
- **mpls traffic-eng link timers bandwidth-hold**
- **mpls traffic-eng link timers bandwidth-hold**
- **mpls traffic-eng link timers periodic-flooding**
- **mpls traffic-eng reoptimize timers frequency**
- **mpls traffic-eng router-id**
- **mpls traffic-eng tunnels (configuration)**
- **mpls traffic-eng tunnels (interface)**
- **mpls traffic-eng tunnels (configuration)**
- **show ip explicit-paths**
- **show ip rsvp host**
- **show isis database verbose**
- **show isis mpls traffic-eng adjacency-log**
- **show isis mpls traffic-eng advertisements**
- **show isis mpls traffic-eng tunnel**
- **show mpls traffic-eng autoroute**
- **show mpls traffic-eng link-management admission-control**
- **show mpls traffic-eng link-management advertisements**
- **show mpls traffic-eng link-management bandwidth-allocation**
- **show mpls traffic-eng link-management igp-neighbors**
- **show mpls traffic-eng link-management interfaces**
- **show mpls traffic-eng link-management summary**

- **show mpls traffic-eng topology**
- **show mpls traffic-eng tunnel**
- **show mpls traffic-eng tunnel summary**
- **tunnel mpls traffic-eng affinity**
- **tunnel mpls traffic-eng autoroute announce**
- **tunnel mpls traffic-eng autoroute metric**
- **tunnel mpls traffic-eng bandwidth**
- **tunnel mpls traffic-eng path-option**
- **tunnel mpls traffic-eng priority**
- **tunnel mode mpls traffic-eng**

In Cisco IOS Release 12.0(1)T or later, you can search and filter the output for **show** and **more** commands. This functionality is useful when you need to sort through large amounts of output, or if you want to exclude output that you do not need to see.

To use this functionality, enter a **show** or **more** command followed by the “pipe” character (|), one of the keywords **begin**, **include**, or **exclude**, and an expression that you want to search or filter on:

> *command* **|** {**begin** | **include** | **exclude**} *regular-expression*

Following is an example of the **show atm vc** command in which you want the command output to begin with the first line where the expression “PeakRate” appears:

> **show atm vc | begin PeakRate**

For more information on the search and filter functionality, refer to the Cisco IOS Release 12.0(1)T feature module titled *CLI String Search*.

append-after

To insert a path entry after a specific index number, use the **append-after** IP explicit path subcommand.

append-after *index command*

Syntax Description

index	Previous index number. Valid range is 0 to 65534.
command	One of the IP explicit path configuration commands that creates a path entry. (Currently, only the next-address command can be used.)

Default

No default behavior or values.

Command Mode

IP explicit path subcommand

Command History

Release	Modification
12.0(5)S	This command was introduced.

Example

The following command inserts th**e next-addres**s subcommand after the specific index:

```
Router(config-ip-expl-path)# append-after 5 next-address 3.3.27.3
```

Related Commands

Command	Description
index	Specifies a path entry modifying command with an index that indicates which entry should be modified or created.
ip explicit-path	Enters the subcommand mode for IP explicit paths
list	Displays all or part of the explicit path(s).
next-address	Specifies the next IP address in the explicit path configuration.
show ip explicit paths	Shows configured IP explicit paths.

index

To insert or modify a path entry at a specific index, use the **index** IP explicit path subcommand.

index *index command*

Syntax Description

index	Specifies entry index number. Valid range is 0 to 65534.
command	One of the IP explicit path configuration commands that creates or modifies a path entry. (Currently, only the **next-address** command can be used.)

Default

No default behavior or values.

Command Mode

IP explicit path subcommand

Command History

Release	Modification
12.0(5)S	This command was introduced.

Example

The following command specifies where the **next-address** command should be inserted in the list:

```
Router(cfg-ip-expl-path)#index 6 next-address 3.3.29.3
Explicit Path identifier 6:
    6: next-address 3.3.29.3
```

Related Commands

Command	Description
append-after	Similar to the **index** subcommand, except that the new path entry is inserted after the specified index number. Renumbering of commands may be performed as a result.
ip explicit-path	Enters the subcommand mode for IP explicit paths
list	Displays all or part of the explicit path(s).
next-address	Specifies the next IP address in the explicit path.
show ip explicit paths	Shows configured IP explicit paths.

ip explicit-path

To enter the subcommand mode for IP explicit paths to create or modify the named path, use the **ip explicit-path** command. An IP explicit path is a list of IP addresses, each representing a node or link in the explicit path.

ip explicit-path {name *WORD* **| identifier** *number***} [{enable | disable}]**

Syntax Description

name *Word*	Specifies explicit path by name.
identifier *number*	Specifies explicit path by number. You can specify a number from 1 to 65535.
enable	Sets the state of the path to be enabled.
disable	Prevents the path from being used for routing while it is being configured.

Default

Enabled

Command Mode

Configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.

Example

The following command enters the explicit path subcommand mode for IP explicit paths and creates a path with the number 500.

```
Router(config)# ip explicit-path identifier 500
Router(config-ip-expl-path)
```

Related Commands

Command	Description
append-after	Similar to the **index** subcommand, except that the new path entry is inserted after the specified index number. Renumbering of commands may be performed as a result.
index	Specifies a path entry modifying command with an index that indicates which entry should be modified or created.
list	Displays all or part of the explicit path(s).
next-address	Specifies the next IP address in the explicit path.
show ip explicit paths	Shows configured IP explicit paths.

list

To show all or part of the explicit path or paths, use the **list** IP explicit path subcommand.

list [{*starting index number*}]

Syntax Description

starting index number	Displays the list starting at the entry index number. Valid range is 1 to 65535.

Default

No default behavior or values.

Command Mode

IP explicit path subcommand

Command History

Release	Modification
12.0(5)S	This command was introduced.

Example

The following example shows the explicit path starting at the index number 2.

```
Router(cfg-ip-expl-path# list
Explicit Path name Joe:
    1:next-address 10.0.0.1
    2:next-address 10.0.0.2
Router(cfg-ip-expl-path# list 2
Explicit Path name Joe:
    2:next-address 10.0.0.2
Router(cfg-ip-expl-path#
```

Related Commands

Command	Description
append-after	Similar to the **index** subcommand, except that the new path entry is inserted after the specified index number. Renumbering of commands may be performed as a result.
index	Specifies a path entry modifying command with an index that indicates which entry should be modified or created.
ip explicit-path	Enters the subcommand mode for IP explicit paths
next-address	Specifies the next IP address in the explicit path.
show ip explicit paths	Shows configured IP explicit paths.

metric-style narrow

To configure a router to generate and accept old-style TLVs (TLV stands for type, length, and value object), use the **metric-style narrow** command.

metric-style narrow [**transition**] [{**level-1** | **level-2** | **level-1-2**}]

Syntax Description

transition	(Optional) Instructs the router to use both old and new style TLVs.
level-1	Enables this command on routing level 1.
level-2	Enables this command on routing level 2.
level-1-2	Enables this command on routing levels 1 and 2.

Default

IS-IS traffic engineering extensions include new-style TLVs with wider metric fields than old-style TLVs. By default, the MPLS traffic engineering image generates old-style TLVs only. To do MPLS traffic engineering, a router needs to generate new-style TLVs.

Command Mode

Router configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.

Example

The following command instructs the router to generate and accept old-style TLVs on router level 1.

```
Router(config)# metric-style narrow level-1
```

Related Commands

Command	Description
metric-style wide	Configures a router to generate and accept only new-style TLVs.
metric-style transition	Configures a router to generate both old-style and new-style TLVs.

metric-style transition

To configure a router to generate and accept both old-style and new-style TLVs (TLV stands for type, length, and value object), use the **metric-style transition** command.

metric-style transition [{**level-1** | **level-2** | **level-1-2**}]

Syntax Description

level-1	Enables this command on routing level 1.
level-2	Enables this command on routing level 2.
level-1-2	Enables this command on routing levels 1 and 2.

Default

IS-IS traffic engineering extensions include new-style TLVs with wider metric fields than old-style TLVs. By default, the MPLS traffic engineering image generates old-style TLVs only. To do MPLS traffic engineering, a router needs to generate new-style TLVs.

Command Mode

Router configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.

Example

The following command configures a router to generate and accept both old-style and new-style TLVs on level 2.

```
Router(config)# metric-style transition level-2
```

Related Commands

Command	Description
metric-style narrow	Configures a router to generate and accept old-style TLVs
metric-style wide	Configures a router to generate and accept only new-style TLVs.

metric-style wide

To configure a router to generate and accept only new-style TLVs (TLV stands for type, length, and value object), use the **metric-style wide** command.

metric-style wide [**transition**] [{**level-1** | **level-2** | **level-1-2**}]

Syntax Description

transition	(Optional) Instructs the router to accept both old and new style TLVs.
level -1	Enables this command on routing level 1.
level-2	Enables this command on routing level 2.
level-1-2	Enables this command on routing levels 1 and 2.

Default

IS-IS traffic engineering extensions include new-style TLVs with wider metric fields than old-style TLVs. By default, the MPLS traffic engineering image generates old-style TLVs only. To do MPLS traffic engineering, a router needs to generate new-style TLVs.

Command Mode

Router configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.

Usage Guidelines

If you enter the metric-wide style command, a router generates and accepts only new-style TLVs. Therefore, the router uses less memory and other resources rather than generating both old-style and new-style TLVs.

This style is appropriate for enabling MPLS traffic engineering across an entire network.

Note This discussion of metric-styles and transition strategies is oriented towards traffic engineering deployment. Other commands and models may be appropriate if the new-style TLVs are desired for other reasons. For example, a network may require wider metrics, but may not use traffic engineering.

Example

The following command configures a router to generate and accept only new-style TLVs on level 1:

```
Router(config)# metric-style wide level-1
```

Related Commands

Command	Description
metric-style narrow	Configures a router to generate and accept old-style TLVs
metric-style transition	Configures a router to generate and accept both old-style and new-style TLVs

mpls traffic-eng

To turn on flooding of MPLS traffic engineering link information into the indicated IS-IS level, use the **mpls traffic-eng** command.

mpls traffic-eng isis-level {level-1 | level-2}

Syntax Description

level-1	Flood MPLS traffic engineering link information into IS-IS level 1.
level-2	Flood MPLS traffic engineering link information into IS-IS level 2.

Default

Flooding is disabled.

Command Mode

Router configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.

Usage Guidelines

This command appears as part of the routing protocol tree, and causes link resource information (for instance, bandwidth available) for appropriately configured links to be flooded in the IS-IS link state database.

Example

The following command turns on MPLS traffic engineering for IS-IS Level 1.

```
Router(router-config)# mpls traffic-eng isis-level level 1
```

Related Commands

Command	Description
mpls traffic-eng router-id	Specifies the traffic engineering router identifier for the node to be the IP address associated with the given interface.

mpls traffic-eng area

To turn on MPLS traffic engineering for the indicated ISIS level, use the **mpls traffic-eng area** command.

mpls traffic-eng area *l-n*

Syntax Description

l-n

Default

Command Mode

Router configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.

Usage Guidelines

This command is included in the routing protocol configuration tree, and is supported for both OSPF and IS-IS. The command only affects the operation of MPLS traffic engineering if MPLS traffic engineering is enabled for that routing protocol instance.

Currently, only a single level may be enabled for traffic engineering.

Example

The following command

```
mpls traffic-eng area
```

Related Commands

Command	Description

mpls traffic-eng administrative-weight

To override the Internet Gateway Protocol's (IGP) administrative weight (cost) of the link, use the **mpls traffic-eng administrative-weight** command. To disable this feature, use the **no** form of this command.

mpls traffic-eng administrative-weight *weight*
no mpls traffic-eng administrative-weight *weight*

Syntax Description

weight	Cost of the link.

Default

Matches IGP cost

Command Mode

Interface configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.

Example

The following example overrides the IGP's cost of the link and sets the cost to 20.

```
Router(config_if)# mpls traffic-eng administrative-weight 20
```

Related Commands

Command	Description
mpls traffic-eng attribute-flags	Sets the user-specified attribute-flags for an interface.

mpls traffic-eng attribute-flags

To set the user-specified attribute-flags for the interface, use the **mpls traffic-eng attribute-flags** command. The interface is flooded globally so that it can be used as a tunnel headend path selection criterion. To disable this feature, use the **no** form of this command.

mpls traffic-eng attribute-flags *0x0-0xFFFFFFFF*
no mpls traffic-eng attribute flags *0x0-0xFFFFFFF*

Syntax Description

0x0-0xFFFFFFF	Represents 32 bits. This mask is compared with a tunnel's affinity bits during dynamic path selection.

Default

Default is 0x0.

Command Mode

Interface configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.

Usage Guidelines

The purpose of this command is to assign attributes to a link in order to cause tunnels with matching attributes (as represented by their affinity bits) to prefer this link over others which do not match.

Example

The following example sets the attribute flags:

```
Router(config-if)# mpls traffic-eng attribute-flags 0x0101
```

Related Commands

Command	Description
mpls traffic-eng administrative weight	Overrides the Interior Gateway Protocol's (IGP) administrative weight of the link.

mpls traffic-eng flooding thresholds

To set a link's reserved bandwidth thresholds, use the **mpls traffic-eng flooding thresholds** commands. If a bandwidth threshold is crossed, the link's bandwidth information is immediately flooded throughout the network. To return to the default settings, use the **no** form of this command.

mpls traffic-eng flooding thresholds {**down** | **up**} *percent* [*percent...*]
no mpls traffic-eng flooding thresholds {**down** | **up**} *percent* [*percent...*]

Syntax Description

down	Sets the thresholds for decreased resource availability. The range is 0 to 99 percent.
up	Sets the thresholds for increased resource availability. The range is 1 to 100 percent.
percent [*percent*]	Specifies the bandwidth threshold level.

Default

The default for **down** is

100, 99, 98, 97, 96, 95, 90, 85, 80, 75, 60, 45, 30, 15.

The default for **up** is

15, 30, 45, 60, 75, 80, 85, 90, 95, 97, 98, 99, 100.

Command Mode

Interface configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.

Usage Guidelines

When a threshold is crossed, MPLS traffic engineering link management advertises updated link information. Similarly, if no thresholds are crossed, changes may be flooded periodically unless periodic flooding has been disabled.

Example

The following example sets the link's reserved bandwidth for decreased resource availability (down) and for increased resource availability (up) thresholds.

```
Router(config-if)# mpls traffic-eng flooding thresholds down 100 75 25
Router(config-if)# mpls traffic-eng flooding thresholds up 25 50 100
```

Related Commands

Command	Description
mpls traffic-eng link-timers periodic-flooding	Sets the length of the interval used for periodic flooding.
show mpls traffic-eng link-management advertisements	Shows local link information currently being flooded by MPLS traffic engineering link management into the global traffic engineering topology.
show mpls traffic-eng link-management bandwidth-allocation	Shows current local link information.

mpls traffic-eng link timers bandwidth-hold

To set the length of time that bandwidth is "held" for a RSVP Path message while waiting for the corresponding RSVP Resv message to come back, use the **mpls traffic-eng link timers bandwidth-hold** command.

mpls traffic-eng link timers bandwidth-hold *hold-time*

Syntax Description

hold-time	Sets the length of time that bandwidth can be held. The range is from 1 to 300 seconds.

Default

15 seconds

Command Mode

Configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.

Example

The following example sets the length of time that bandwidth is held to 10 seconds.

```
Router(config)# mpls traffic-eng link-management timers bandwidth-hold 10
```

Related Command

Command	Description
show mpls traffic-eng link-management bandwidth-allocation	Shows current local link information.

mpls traffic-eng link timers periodic-flooding

To set the length of the interval used for periodic flooding, use the **mpls traffic-eng link timers periodic-flooding** command.

mpls traffic-eng link timers periodic-flooding *interval*

Syntax Description

interval	Length of interval used for periodic flooding (in seconds). The range is 0-3600. If you set this value to 0, you turn off periodic flooding. If you set this value anywhere in the range from 1 to 29, it is treated at 30.

Default

3 minutes

Command Mode

Configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.

Usage Guidelines

Use this command to set the length of the interval used for periodic flooding to advertise link state information changes that do not trigger immediate action (for example, a change to the amount of bandwidth allocated that does not cross a threshold).

Example

The following example sets the interval length for periodic flooding to advertise flooding changes to 120 seconds.

```
Router(config)# mpls traffic-eng timers periodic-flooding 120
```

Related Commands

Command	Description
mpls traffic-eng flooding thresholds	Sets a link’s reserved bandwidth threshold.

mpls traffic-eng reoptimize timers frequency

To control the frequency at which tunnels with established LSPs are checked for better LSPs, use the **mpls traffic-eng reoptimize timers frequency** command.

mpls traffic-eng reoptimize timers frequency *seconds*

Syntax Description

seconds	Sets the frequency of reoptimization, in seconds. A value of 0 disables reoptimization.

Default

3600 seconds (1 hour) with a range of 0 to 604800 seconds (1 week).

Command Mode

Configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.

Usage Guidelines

A device with traffic engineering tunnels periodically examines tunnels with established LSPs to see if better LSPs are available. If a better LSP seems to be available, the device attempts to signal the better LSP and, if successful, replaces the old and inferior LSP with the new and better LSP.

Example

The following example sets the reoptimization frequency to one day.

```
Router(config)# mpls traffic-eng reoptimize timers frequency 86400
```

Related Commands

Command	Description
mpls traffic-eng reoptimize (exec)	Does a reoptimization check now.
tunnel mpls traffic-eng lockdown	Does not do a reoptimization check on this tunnel.

mpls traffic-eng router-id

To specify the traffic engineering router identifier for the node to be the IP address associated with the given interface, use the **mpls traffic-eng router-id** command.

mpls traffic-eng router-id *interface*

Syntax Description

interface

Default

No default behavior or values.

Command Mode

Router configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.

Usage Guidelines

This router identifier acts as a stable IP address for the traffic engineering configuration. This stable IP address is flooded to all nodes. For all traffic engineering tunnels originating at other nodes and ending at this node, the tunnel destination must be set to the destination node's traffic engineering router identifier, since that is the address the traffic engineering topology database at the tunnel head uses for its path calculation.

Example

Related Commands

Command	Description
mpls traffic-eng	Turn on flooding of MPLS traffic-engineering link information into the indicated IGP level/area.

mpls traffic-eng tunnels (configuration)

To enable MPLS traffic engineering tunneling signalling on a device, use the **mpls traffic-eng tunnels** command.

mpls traffic-eng tunnels
no mpls traffic-eng tunnels

Syntax Description

This command has no arguments or keywords.

Default

The feature is disabled.

Command Mode

Configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.

Usage Guidelines

Enables the MPLS traffic-engineering feature on a device. To use the feature, MPLS traffic engineering must also be enabled on the desired interfaces.

Example

The following command turns on the MPLS traffic engineering feature for a device:

```
Router(config)# mpls traffic-eng tunnels
```

Related Commands

Command	Description
mpls traffic-eng tunnels (interface)	Enables MPLS traffic engineering tunnel signalling on an interface.

mpls traffic-eng tunnels (interface)

To enable MPLS traffic engineering tunnel signalling on an interface, assuming it is enabled for the device, use the **mpls traffic-eng tunnels** command.

mpls traffic-eng tunnels
no mpls traffic-eng tunnels

Syntax Description

This command has no arguments or keywords.

Default

The feature is disabled on all interfaces.

Command Mode

Interface configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.

Usage Guidelines

Enables the MPLS traffic-engineering feature on the interface. To use the feature, MPLS traffic engineering must also be enabled on the device. An enabled interface has its resource information flooded into the appropriate IGP link state database, and accepts traffic engineering tunnel signalling requests.

Example

The following commands turns on MPLS traffic engineering on interface Ethernet0/0.

```
Router# configure terminal
Router(config)# interface Ethernet0/0
Router(config-if)# mpls traffic-eng tunnels
```

Related Commands

Command	Description
mpls traffic-eng tunnels (configuration)	Enables MPLS traffic engineering tunneling signalling on a device.

next-address

To specify the next IP address in the explicit path, use the **next-address** IP explicit path subcommand.

next-address *A.B.C.D*

Syntax Description

A.B.C.D	Specifies the IP address in the explicit path.

Default

No default behavior or values.

Command Mode

IP explicit path subcommand

Command History

Release	Modification
12.0(5)S	This command was introduced.

Usage Guidelines

For a point-to-point interface, specify the IP address of the outgoing interface. For an Ethernet interface, specify the IP address for the outbound interface and inbound interface. For point-to-point or Ethernet interfaces, specify the MPLS traffic engineering router ID.

Example

The following commands assign the number 60 to the IP explicit path, set the state of the path to be enabled, and specify 3.3.27.3 as the next IP address in the list of IP addresses.

```
Router# configure terminal

Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# mpls traffic-eng tunnels
Router(config)# ip explicit-path identifier 60 enable
Router(cfg-ip-expl-path)# next-address 3.3.27.3
Explicit Path identifier 60:
    1: next-address 3.3.27.3
```

Related Commands

Command	Description
append-after	Similar to the **index** subcommand, except that the new path entry is inserted after the specified index number. Renumbering of commands may be performed as a result.
index	Specifies a path entry modifying command with an index that indicates which entry should be modified or created.
ip explicit-path	Enters the subcommand mode for IP explicit paths.
list	Displays all or part of the explicit path(s).
show ip explicit paths	Shows configured IP explicit paths.

show ip explicit-paths

To enter the subcommand mode for IP explicit paths to create or modify the named path, use the **show explicit-paths** EXEC command. An IP explicit path is a list of IP addresses, each representing a node or link in the explicit path.

show ip explicit-paths [{**name** *Word* | **identifier** *number*}] [**detail**]

Syntax Description

name *Word*	Specifies explicit path by name.
identifier *number*	Specifies explicit path by number.
detail	(Optional) Display information in long form.

Default

No default behavior or values.

Command Mode

EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.

Example

The following example shows output from the **show ip explicit-paths** command:

```
Router# show ip explicit-paths

PATH 200 (strict source route, path complete, generation 6)
    1: next-address 3.3.28.3
    2: next-address 3.3.27.3
```

Table 1 lists the fields displayed in this example.

Table 1 Show IP Explicit-Paths Field Descriptions

Field	Description
PATH	Path name or number, followed by path status.
1: next-address	The first IP address in the path.
2. next-address	The second IP address in the path.

Related Commands

Command	Description
append-after	Similar to the **index** subcommand, except that the new path entry is inserted after the specified index number. Renumbering of commands may be performed as a result.
index	Specifies a path entry modifying command with an index that indicates which entry should be modified or created.
ip explicit-paths	Enters the subcommand mode for IP explicit paths.
list	Displays all or part of the explicit path(s).
next-address	Specifies a **next-address** subcommand with an index that specifies where the command should be inserted in the list.

show ip rsvp host

To display RSVP terminal point information for receivers or senders, use the **show ip rsvp host** EXEC command.

show ip rsvp host {host {receivers | senders} | installed | interface | neighbor | request | reservation | sender}

Syntax Description

host	Displays RSVP endpoint senders and receivers information.
installed	Displays RSVP installed reservations.
interface	Displays RSVP interface information.
neighbor	Displays RSVP neighbor information.
request	Displays RSVP reservations upstream information.
reservation	Displays RSVP reservation Requests from Downstream
sender	Displays RSVP path state information
temp-psb	Displays RSVP PATH requests awaiting policy decision
temp-rsb	Displays RSVP reservation requests awaiting policy decisions

Default

No default behavior or values.

Command Mode

EXEC

Command History

Release	Modification
11.2	This command was introduced.
12.0(5)S	The keyword host was added.

Sample Display

The following examples show output from **show ip rsvp host receivers** command:

```
router# show ip rsvp host receivers
To            From          Pro DPort Sport Next Hop      I/F   Fi Serv BPS Bytes
10.0.0.11     10.1.0.4      0   10011 1                         SE LOAD 100K  1K
```

Table 2 lists the fields displayed in this example.

Table 2 Show IP RSVP Host Field Descriptions

Field	Description
To	IP address of the receiver.
From	IP address of the sender.
Pro	Protocol code.
DPort	Destination port number.
Sport	Source port number.
Next Hop	IP address of the next hop.
I/F	Interface of the next hop.
Fi	Filter (Wild Card Filter, Shared Explicit Filter, or Fixed Filter).
Serv	Service (value can be **rate** or **load**).
BPS	Reservation rate in bits per second.
Bytes	Bytes of burst size requested.

show isis database verbose

To display more information about the database, use the **show isis database verbose** EXEC command.

show isis database verbose

Syntax Description

This command has no arguments or keywords.

Default

No default behavior or values.

Command Mode

EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.

Sample Display

The following example shows output from the **show isis database verbose** command:

```
Router# show isis database verbose

IS-IS Level-1 Link State Database
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
dtp-5.00-00         * 0x000000E6   0xC9BB        1042              0/0/0
  Area Address:49.0001
  NLPID:       0xCC
  Hostname:dtp-5
  Router ID:   5.5.5.5
  IP Address:  172.21.39.5
  Metric:10         IP 172.21.39.0/24
dtp-5.00-01         * 0x000000E7   0xAB36        1065              0/0/0
  Metric:10         IS-Extended dtp-5.01
    Affinity:0x00000000
    Interface IP Address:172.21.39.5
    Physical BW:10000000 bits/sec
    Reservable BW:1166000 bits/sec
    BW Unreserved[0]: 1166000 bits/sec, BW Unreserved[1]: 1166000 bits/sec
    BW Unreserved[2]: 1166000 bits/sec, BW Unreserved[3]: 1166000 bits/sec
    BW Unreserved[4]: 1166000 bits/sec, BW Unreserved[5]: 1166000 bits/sec
    BW Unreserved[6]: 1166000 bits/sec, BW Unreserved[7]: 1153000 bits/sec
  Metric:0          ES dtp-5
```

Table 3 lists the fields displayed in this example.

Table 3 Show IS-IS Database Verbose Field Descriptions

Field	Description
LSPID	The LSP identifier. The first six octets form the System ID of the router that originated the LSP. The next octet is the pseudonode ID. When this byte is zero, the LSP describes links from the system. When it is nonzero,the LSP is a so called non-pseudonode LSP. This is similar to a router LSA in OSPF. The LSP will describe the state of the originating router. For each LAN, the designated router for that LAN will create and flood a pseudonode LSP, describing all systems attached to that LAN. The last octet is the LSP number. If there is more data than can fit in a single LSP, the LSP will be divided into multiple LSP fragments. Each fragment will have a different LSP number. An asterisk (*) indicates that the LSP was originated by the system on which this command is issued.
LSP Seq Num	Sequence number for the LSP that allows other systems to determine if they have received the latest information from the source.
LSP Checksum	Checksum of the entire LSP packet.
LSP Holdtime	Amount of time the LSP remains valid, in seconds. An LSP holdtime of zero indicates that this LSP was purged and is being removed from all routers' LSDB. The value between brackets indicates how long the purged LSP will stay in the LSDB before being completely removed.
ATT	The Attach bit. This indicates that the router is also a Level 2 router, and it can reach other areas. L1-only routers and L1L2 routers that have lost connection to other L2 routers will use the attached bit to find the closest L2 router. They will point a default route to the closest L2 router.
P	The P bit. Detects if the IS is area partition repair capable. Cisco and other vendors do not support area partition repair.
OL	The Overload bit. Determines if the IS is congested. If the Overload bit is set, other routers will not use this system as a transit router when calculating routers. Only packets for destinations directly connected to the overloaded router will be sent to this router.
Area Address	Reachable area addresses from the router. For L1 LSPs, these are the area addresses configured manually on the originating router. For L2 LSPs, these are all the area addresses for the area this route belongs to.
NLPID	
Hostname	
IP Address	IPv4 address for the interface

Metric	IS-IS metric for the cost of the adjacency between the originating router and the advertised neighbor, or the metric of the cost to get from the advertising router to the advertised destination (which can be an IP address, an ES or a CLNS prefix).
Affinity	Link's attribute flags being flooded.
Interface IP Address	
Physical BW	Link's bandwidth capacity (in bits per second).
Reservable BW	Amount of reservable bandwidth on this link.
BW Unreserved	Amount of bandwidth that is available for reservation.

show isis mpls traffic-eng adjacency-log

To display a log of 20 entries of MPLS traffic engineering IS-IS adjacency changes, use the **show isis mpls traffic-eng adjacency-log** EXEC command.

show isis mpls traffic-eng adjacency-log

Syntax Description

This command has no arguments or keywords.

Default

No default behavior or values.

Command Mode

EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.

Sample Display

The following is sample output from the **show isis mpls traffic-eng adjacency-log** command:

```
Router# show isis mpls traffic-eng adjacency-log

IS-IS RRR log
When      Neighbor ID        IP Address       Interface Status Level
04:52:52  0000.0024.0004.02  0.0.0.0          Et0/2     Up     level-1
04:52:50  0000.0026.0001.00  170.1.1.2        PO1/0/0   Up     level-1
04:52:37  0000.0024.0004.02  0.0.0.0          Et0/2     Up     level-1
```

Table 4 lists the fields displayed in this example.

Table 4 Show IS-IS MPLS Traffic-Eng Adjacency-Log Field Descriptions

Field	Description
When	The amount of time since the entry of the log has been recorded.
Neighbor ID	Identification value of the neighbor.
IP Address	Neighbor’s IPv4 address.
Interface	Interface from which a neighbor is learned.
Status	Up (active) or Down (disconnected)
Level	Indication of routing level.

show isis mpls traffic-eng advertisements

To display the last flooded record from MPLS traffic engineering, use the **show isis mpls traffic-eng advertisements** EXEC command.

show isis mpls traffic-eng advertisements

Syntax Description

This command has no arguments or keywords.

Default

No default behavior or values.

Command Mode

EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.

Sample Display

The following is output from the **show isis mpls traffic-eng advertisements** command:

```
Router# show isis mpls traffic-eng advertisements

System ID:dtp-5.00
  Router ID:5.5.5.5
  Link Count:1
    Link[1]
      Neighbor System ID:dtp-5.01 (broadcast link)
      Interface IP address:172.21.39.5
      Neighbor IP Address:0.0.0.0
      Admin. Weight:10
      Physical BW:10000000 bits/sec
      Reservable BW:1166000 bits/sec
      BW unreserved[0]:1166000 bits/sec, BW unreserved[1]:1166000 bits/sec
      BW unreserved[2]:1166000 bits/sec, BW unreserved[3]:1166000 bits/sec
      BW unreserved[4]:1166000 bits/sec, BW unreserved[5]:1166000 bits/sec
      BW unreserved[6]:1166000 bits/sec, BW unreserved[7]:1153000 bits/sec
      Affinity Bits:0x00000000
```

Table 5 lists the fields displayed in this example.

Table 5 Show IS-IS MPLS Traffic-Eng Advertisements Field Descriptions

Field	Description
System ID	Identification value for the local system in the area.
Router ID	MPLS traffic engineering router ID.
Link Count	Number of links advertised by MPLS traffic engineering.
Neighbor System ID	Identification value for the remote system in an area.
Interface IP address	IPv4 address of the interface.
Neighbor IP Address	IPv4 address of the neighbor.
Admin. Weight	Administrative weight associated with this link.
Physical BW	Link’s bandwidth capacity (in bits per second).
Reservable BW	Amount of reservable bandwidth on this link.
BW unreserved	Amount of bandwidth that is available for reservation.
Affinity Bits	Link’s attribute flags being flooded.

show isis mpls traffic-eng tunnel

To display information about tunnels considered in IS-IS next hop calculation, use the **show isis mpls traffic-eng tunnel** EXEC command.

show isis mpls traffic-eng tunnel

Syntax Description

This command has no arguments or keywords.

Default

No default behavior or values.

Command Mode

EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.

Sample Display

The following example shows output from this command:

```
Router# show isis mpls traffic-eng tunnel

Station Id          Tunnel Name   Bandwidth    Nexthop       Metric   Mode
kangpa-router1.00   Tunnel1022    3333         2.2.2.2       -3       Relative
                    Tunnel1021    10000        2.2.2.2       11       Absolute
tomklong-route.00   Tunnel1031    10000        3.3.3.3       -1       Relative
                    Tunnel1032    10000        3.3.3.3
```

Table 6 lists the fields displayed in this example.

Table 6 Show ISIS MPLS Traffic-Eng Tunnel Field Descriptions

Field	Description
Station Id	The name or system ID of the MPLS traffic engineering tailend router.
Tunnel Name	The name of the MPLS traffic engineering tunnel interface.
Bandwidth	The MPLS traffic engineering tunnel bandwidth specified.
Nexthop	The MPLS traffic engineering tunnel destination IP address.
Metric	The MPLS traffic engineering tunnel metric.
Mode	The MPLS traffic engineering tunnel metric mode. It can be relative or absolute.

show mpls traffic-eng autoroute

To show tunnels that are announced to IGP, including interface, destination, and bandwidth, use the **show mpls traffic-eng autoroute** privileged EXEC command.

show mpls traffic-eng autoroute

Syntax Description

This command has no arguments or keywords.

Default

No default behavior or values.

Command Mode

Privileged EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.

Usage Guidelines

The IGP's SPF/nexthop calculation has been modified to understand TE tunnels. This command shows which tunnels are currently being used by the IGP in its SPF/nexthop calculation (tunnels that are up and have autoroute configured)

Example

The following example shows output from the **show mpls traffic-eng autoroute** command:

Note that the list of tunnels is organized by destination. All tunnels to a destination will carry a share of the traffic tunneled to that destination.

```
Router# show mpls traffic-eng autoroute

MPLS TE autorouting enabled
  destination 0002.0002.0002.00 has 2 tunnels
    Tunnel1021 (traffic share 10000, nexthop 2.2.2.2, absolute metric 11)
    Tunnel1022 (traffic share 3333, nexthop 2.2.2.2, relative metric -3)
  destination 0003.0003.0003.00 has 2 tunnels
    Tunnel1032 (traffic share 10000, nexthop 3.3.3.3)
    Tunnel1031 (traffic share 10000, nexthop 3.3.3.3, relative metric -1)
```

Table 7 lists the fields displayed in this example.

Table 7 Show MPLS Traffic-Eng Autoroute Field Descriptions

Field	Description
MPLS TE autorouting enabled	IGP automatically routes traffic into tunnels.

destination	MPLS traffic engineering tailend router system ID.
traffic share	A factor based on bandwidth, indicating how much traffic this tunnel should carry relative to other tunnels to the same destination. If two tunnels go to a single destination, one with a traffic share of 200 and the other with a traffic share of 100, the first tunnel carries two thirds of the traffic.
nexthop	The MPLS traffic engineering tunnel tailend IP address.
absolute metric	The MPLS traffic engineering tunnel metric with mode absolute.
relative metric	The MPLS traffic engineering tunnel metric with mode relative.

show mpls traffic-eng link-management admission-control

To show which tunnels have been admitted locally, and their parameters (such as, priority, bandwidth, incoming and outgoing interface, and state), use the **show mpls traffic-eng link-management admission-control** EXEC command.

show mpls traffic-eng link-management admission-control [**interface name**]

Syntax Description

interface name	(Optional) Shows only those tunnels that have been admitted on the specified interface.

Default

No default behavior or values.

Command Mode

EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.

Sample Display

The following example shows output from the show **mpls traffic-eng link-management admission-control** command:

```
Router# show mpls traffic-eng link-management admission-control

System Information::
    Tunnels Count:        1
    Tunnels Selected:     1
TUNNEL ID              UP IF     DOWN IF  PRIORITY STATE           BANDWIDTH
3.3.25.3 1_1           -         PO1/0/0  1/1      Resv Admitted   10000      R
```

Table 8 lists the fields displayed in this example.

Table 8 Show MPLS Traffic-Eng Link-Management Admission-Control Field Descriptions

Field	Description
Tunnels Count	Total number of tunnels admitted.
Tunnels Selected	Number of tunnels to be displayed.
TUNNEL ID	Tunnel identification.
UP IF	Upstream interface used by the tunnel.
DOWN IF	Downstream interface used by the tunnel.

PRIORITY	Tunnel’s setup priority followed by the hold priority.
STATE	Tunnel’s admission status.
BANDWIDTH	Bandwidth is bits per second. If an “R” appears after the bandwidth number, it means the bandwidth has been reserved. If an “H” appears after the bandwidth number, it means the bandwidth has been temporarily held for a path message.

Related Commands

Command	Description
show mpls traffic-eng link-management advertisements	Shows local link information currently being flooded by MPLS traffic engineering link management into the global traffic engineering topology.
show mpls traffic-eng link-management bandwidth-allocation	Shows current local link information.
show mpls traffic-eng link-management igp-neighbors	Shows IGP neighbors.
show mpls traffic-eng link-management interfaces	Shows per-interface resource and configuration information.
show mpls traffic-eng link-management summary	Shows summary of link management information.

show mpls traffic-eng link-management advertisements

To show local link information currently being flooded by MPLS traffic engineering link management into the global traffic engineering topology, use the **show mpls traffic-eng link-management advertisements** EXEC command.

show mpls traffic-eng link-management advertisements

Syntax Description

This command has no arguments or keywords.

Default

No default behavior or values.

Command Mode

EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.

Sample Display

The following example shows output from the **show mpls traffic-eng link-management advertisements** command:

```
Router# show mpls traffic-eng link-management advertisements

Flooding Status:     ready
Configured Areas:    1
IGP Area[1] ID:: isis level-1
  System Information::
    Flooding Protocol:   ISIS
  Header Information::
    IGP System ID:       0001.0000.0001.00
    MPLS TE Router ID:   10.106.0.6
    Flooded Links:       1
  Link ID:: 0
    Link IP Address:     10.32.0.6
    IGP Neighbor:        ID 0001.0000.0002.00, IP 10.32.0.10
    Admin. Weight:       10
    Physical BW:         155520000 bits/sec
    Reservable BW:       5000000 bits/sec
    Output Bandwidth::
      BW Unreserved[0]:    5000000 bits/sec
      BW Unreserved[1]:    1000000 bits/sec
      BW Unreserved[2]:    1000000 bits/sec
      BW Unreserved[3]:    1000000 bits/sec
      BW Unreserved[4]:    1000000 bits/sec
      BW Unreserved[5]:    1000000 bits/sec
      BW Unreserved[6]:    1000000 bits/sec
      BW Unreserved[7]:    1000000 bits/sec
    Affinity Bits         0x00000000
```

Table 9 lists the fields displayed in this example.

Table 9 Show MPLS Traffic-Eng Link-Management Advertisements Field Descriptions

Field	Description
Flooding Status	Enable status of the link management flooding system.
Configured Areas	Number of the IGP areas configured.
IGP Area [1] ID	Name of the first IGP area.
Flooding Protocol	IGP being used to flood information for this area.
IGP System ID	Identification used by IGP flooding this area to identify this node.
MPLS TE Router ID	MPLS traffic engineering router ID.
Flooded Links	Number of links flooded for this area.
Link ID	Index of the link being described.
Link IP Address	Local IP address of this link.
IGP Neighbor	IGP neighbor on this link.
Admin. Weight	Administrative weight associated with this link.
Physical BW	Link's bandwidth capacity (in bits per second).
Reservable BW	Amount of reservable bandwidth on this link.
BW unreserved	Amount of bandwidth that is available for reservation.
Affinity Bits	Link's attribute flags being flooded.

Related Commands

Command	Description
show mpls traffic-eng link-management advertisements	Shows local link information currently being flooded by MPLS traffic engineering link management into the global traffic engineering topology.
show mpls traffic-eng link-management bandwidth-allocation	Shows current local link information.
show mpls traffic-eng link-management igp-neighbors	Shows IGP neighbors.
show mpls traffic-eng link-management interfaces	Shows per-interface resource and configuration information.
show mpls traffic-eng link-management summary	Shows summary of link management information.

show mpls traffic-eng link-management bandwidth-allocation

To show current local link information, use the **show mpls traffic-eng link-management bandwidth-allocation** EXEC command.

show mpls traffic-eng link-management bandwidth-allocation [**interface name**]

Syntax Description

interface name	(Optional) Shows only those tunnels that have been admitted on the specified interface.

Default

No default behavior or values.

Command Mode

EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.

Usage Guidelines

Advertised information may differ from current information depending on how flooding has been configured.

Sample Display

The following example shows output from this command:

```
Router# show mpls traffic-eng link-management bandwidth-allocation atm0/0.1

System Information::
    Links Count:         3
    Bandwidth Hold Time: max. 15 seconds
Link ID:: AT0/0.1 (10.32.0.6)
    Link Status:
      Physical Bandwidth:  155520000 bits/sec
      MPLS TE Bandwidth:   5000000 bits/sec (reserved:0% in, 80% out)
      BW Descriptors:      1
      MPLS TE Link State:  MPLS TE on, RSVP on, admin-up, flooded
      Inbound Admission:   allow-all
      Outbound Admission:  allow-if-room
      Admin. Weight:       10 (IGP)
      IGP Neighbor Count:  1
      Up Thresholds:       15 30 45 60 75 80 85 90 95 96 97 98 99 100 (default)
      Down Thresholds:     100 99 98 97 96 95 90 85 80 75 60 45 30 15 (default)
    Outbound Bandwidth Information (bits/second):
      KEEP PRIORITY     BW HELD  BW TOTAL HELD   BW LOCKED  BW TOTAL LOCKED
                  0           0              0           0                0
                  1           0              0     4000000          4000000
```

```
                   2           0              0           0          4000000
                   3           0              0           0          4000000
                   4           0              0           0          4000000
                   5           0              0           0          4000000
                   6           0              0           0          4000000
                   7           0              0           0          4000000
```

Table 10 lists the fields displayed in this example.

Table 10 Show MPLS Traffic-Eng Link-Management Bandwidth-Allocation Field Descriptions

Field	Description
Links Count	Number of links configured for MPLS traffic engineering.
Bandwidth Holdtime	
Link ID	Interface name and IP address of the link being described.
Physical Bandwidth	Link's bandwidth capacity (in bits per second).
MPLS TE Bandwidth	Amount of reservable bandwidth on this link.
BW Descriptors	Number of bandwidth allocations on this link.
MPLS TE Link State	Status of the link's MPLS traffic engineering-related functions.
Inbound Admission	Link's admission policy for incoming tunnels.
Outbound Admission	Link's admission policy for outgoing tunnels.
Admin. Weight	Administrative weight associated with this link.
Up Thresholds	Link's bandwidth thresholds for allocations.
Down Thresholds	Link's bandwidth thresholds for deallocations.
IGP Neighbor	List of the IGP neighbors directly reachable over this link.
KEEP PRIORITY	Priority levels for the link's bandwidth allocations.
BW HELD	Amount of bandwidth (in bits per seconds) temporarily held at this priority for path messages.
BW TOTAL HELD	Bandwidth held at this priority and those above it.
BW LOCKED	Amount of bandwidth reserved at this priority.
BW TOTAL LOCKED	Bandwidth reserved at this priority and those above.

Related Commands

Command	Description
show mpls traffic-eng link-management advertisements	Shows local link information currently being flooded by MPLS traffic engineering link management into the global traffic engineering topology.
show mpls traffic-eng link-management bandwidth-allocation	Shows current local link information.
show mpls traffic-eng link-management igp-neighbors	Shows IGP neighbors.

show mpls traffic-eng link-management interfaces	Shows per-interface resource and configuration information.
show mpls traffic-eng link-management summary	Shows summary of link management information.

show mpls traffic-eng link-management igp-neighbors

To show IGP neighbors, use the **show mpls traffic-eng link-management igp-neighbors** privileged EXEC command.

show mpls traffic-eng link-management igp-neighbors [{**igp-id** {**isis** *isis-address* | **ospf** *ospf-id*} | **ip** *A.B.C.D*}]

Syntax Description

igp-id	Shows the IGP neighbors using a specified IGP identification.
isis *isis-address*	Specifies an IS-IS neighbor to display when displaying neighbors by IGP ID.
ospf *ospf-id*	Specifies an OSPF neighbor to display when displaying neighbors by IGP ID.
ip *A.B.C.D.*	Shows the IGP neighbors using a specified IGP IP address.

Default

No default behavior or values.

Command Mode

EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.

Sample Display

The following example shows output from the **show mpls traffic-eng link-management igp-neighbors** command

```
Router# show mpls traffic-eng line-management igp-neighbors

Link ID::  Et0/2
    Neighbor ID:  0000.0024.0004.02 (area: isis level-1, IP: 0.0.0.0)
Link ID::  PO1/0/0
    Neighbor ID:  0000.0026.0001.00 (area: isis level-1, IP: 170.1.1.2)
```

Table 11 lists the fields displayed in this example.

Table 11 Show MPLS Traffic-Eng Link-Management IGP-Neighbors Field Descriptions

Field	Description
Link ID	Link by which the neighbor is reached.
Neighbor ID	IGP’s identification information for the neighbor.

Related Commands

Command	Description
show mpls traffic-eng link-management advertisements	Shows local link information currently being flooded by MPLS traffic engineering link management into the global traffic engineering topology.
show mpls traffic-eng link-management bandwidth-allocation	Shows current local link information.
show mpls traffic-eng link-management igp-neighbors	Shows IGP neighbors.
show mpls traffic-eng link-management interfaces	Shows per-interface resource and configuration information.
show mpls traffic-eng link-management summary	Shows summary of link management information.

show mpls traffic-eng link-management interfaces

To show per-interface resource and configuration information, use the **show mpls traffic-eng link-management interfaces** EXEC command.

show mpls traffic-eng link-management interfaces [*interface*]

Syntax Description

interface	(Optional) Specifies the name of a single interface for which information is to be displayed.

Default

No default behavior or values.

Command Mode

EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.

Sample Display

```
Router# show mpls traffic-eng link-management interfaces
System Information::
Links Count:        3
Link ID:: Et1/1/1 (10.1.0.6)
    Link Status:
      Physical Bandwidth:  10000000 bits/sec
      MPLS TE Bandwidth:   5000000 bits/sec (reserved:0% in, 0% out)
      MPLS TE Link State:  MPLS TE on, RSVP on
      Inbound Admission:   reject-huge
      Outbound Admission:  allow-if-room
      Admin. Weight:       10 (IGP)
      IGP Neighbor Count:  2
      IGP Neighbor:        ID 0000.0000.0000.02, IP 0.0.0.0 (Up)
      IGP Neighbor:        ID 0001.0000.0001.02, IP 0.0.0.0 (Down)
    Flooding Status for each configured area [1]:
      IGP Area[1  isis level-1: not flooded
                  (Reason:Interface has been administratively disabled)
Link ID:: AT0/0.1 (10.32.0.6)
    Link Status:
      Physical Bandwidth:  155520000 bits/sec
      MPLS TE Bandwidth:   5000000 bits/sec (reserved:0% in, 80% out)
      MPLS TE Link State:  MPLS TE on, RSVP on, admin-up, flooded
      Inbound Admission:   allow-all
      Outbound Admission:  allow-if-room
      Admin. Weight:       10 (IGP)
      IGP Neighbor Count:  1
      IGP Neighbor:        ID 0001.0000.0002.00, IP 10.32.0.10 (Up)
    Flooding Status for each configured area [1]:
      IGP Area[1  isis level-1: flooded
```

Table 12 lists the fields displayed in this example.

Table 12 Show MPLS Traffic-Eng Link-Management Interfaces Field Descriptions

Field	Description
Links Count	Number of links that have been enabled for use with MPLS traffic engineering.
Physical Bandwidth	Link’s bandwidth capacity (in bits per second).
MPLS TE Bandwidth	Amount of reservable bandwidth on this link.
MPLS TE Link State	The status of the MPLS link.
Inbound Admission	Link’s admission policy for inbound tunnels.
Outbound Admission	Link’s admission policy for outbound tunnels.
Admin. Weight	Administrative weight associated with this link.
IGP Neighbor Count	Number of IGP neighbors directly reachable over this link.
IGP Area [1]	Flooding status for the specified configured area.

Related Commands

Command	Description
show mpls traffic-eng link-management advertisements	Shows local link information currently being flooded by MPLS traffic engineering link management into the global traffic engineering topology
show mpls traffic-eng link-management bandwidth-allocation	Shows current local link information
show mpls traffic-eng link-management igp-neighbors	Shows IGP neighbors
show mpls traffic-eng link-management interfaces	Shows per-interface resource and configuration information
show mpls traffic-eng link-management summary	Shows summary of link management information

show mpls traffic-eng link-management summary

To show summary of link management information, use the **show mpls traffic-eng link-management summary** EXEC command.

show mpls traffic-eng link-management summary [*interface name*]

Syntax Description

interface name	(Optional) Specifies the name of a single interface for which information is to be displayed.

Default

No default behavior or values.

Command Mode

EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.

Sample Display

The following example shows output from the **show mpls traffic-eng link-management summary** command:

```
Router# show mpls traffic-eng link-management summary atm0/0.1

System Information::
    Links Count:         3
    Flooding System:     enabled
IGP Area ID:: isis level-1
    Flooding Protocol:   ISIS
    Flooding Status:     data flooded
    Periodic Flooding:   enabled (every 180 seconds)
    Flooded Links:       1
    IGP System ID:       0001.0000.0001.00
    MPLS TE Router ID:   10.106.0.6
    IGP Neighbors:       3
Link ID:: AT0/0.1 (10.32.0.6)
    Link Status:
      Physical Bandwidth:  155520000 bits/sec
      MPLS TE Bandwidth:   5000000 bits/sec (reserved:0% in, 80% out)
      MPLS TE Link State:  MPLS TE on, RSVP on, admin-up, flooded
      Inbound Admission:   allow-all
      Outbound Admission:  allow-if-room
      Admin. Weight:       10 (IGP)
      IGP Neighbor Count:  1
```

Table 13 lists the fields displayed in this example.

Table 13 Show MPLS Traffic-Eng Link-Management Summary Field Descriptions

Field	Description
Flooding System	Enable status of the MPLS traffic engineering flooding system.
IGP Area ID	Name of the IGP area being described.
Flooding Protocol	IGP being used to flood information for this area.
Flooding Status	Status of flooding for this area.
Periodic Flooding	Status of periodic flooding for this area.
Flooded Links	Number of links flooded.
IGP System ID	IGP for this node associated with this area.
MPLS TE Router ID	MPLS traffic engineering router ID for this node.
IGP Neighbors	Number of reachable IGP neighbors associated with this area.
Link ID	Interface name and IP address of the link being described.
Physical Bandwidth	Link’s bandwidth capacity (in bits per second).
MPLS TE Bandwidth	Amount of reservable bandwidth on this link.
MPLS TE Link State	Status of the link’s MPLS traffic engineering -related functions.
Inbound Admission	Link’s admission policy for incoming tunnels.
Outbound Admission	Link’s admission policy for outgoing tunnels.
Admin. Weight	Link’s administrative weight.
IGP Neighbor Count	List of the IGP neighbors directly reachable over this link.

Related Commands

Command	Description
show mpls traffic-eng link-management advertisements	Shows local link information currently being flooded by MPLS traffic engineering link management into the global traffic engineering topology.
show mpls traffic-eng link-management bandwidth-allocation	Shows current local link information.
show mpls traffic-eng link-management igp-neighbors	Shows IGP neighbors.
show mpls traffic-eng link-management interfaces	Shows per-interface resource and configuration information.
show mpls traffic-eng link-management summary	Shows summary of link management information.

show mpls traffic-eng topology

To show the MPLS traffic engineering global topology as currently known at this node, use the **show mpls traffic-eng topology** privileged EXEC command.

show mpls traffic-eng topology [{*A.B.C.D* **| igp-id** {**isis** *nsapaddr* **| ospf** *A.B.C.D*}] [**brief**]

Syntax Description

A.B.C.D	Specifies the node by the IP address (router identifier to interface address).
igp-id	Specifies the node by IGP router identifier.
isis ***nsapaddr***	Specifies the node by router identification (nsapaddr) if using IS-IS.
ospf *A.B.C.D*	Specifies the node by router identifier if using OSPF.
brief	(Optional) The brief form of the output gives a less detailed version of the topology.

Default

No default behavior or values.

Command Mode

EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.

Sample Display

The following example shows output from the **show mpls traffic-eng topology** command:

```
Router# show mpls traffic-eng topology

My_System_id: 0000.0025.0003.00

IGP Id: 0000.0024.0004.00, MPLS TE Id:24.4.4.4 Router Node
      link[0 ]:Intf Address: 150.1.1.4
                  Nbr IGP Id: 0000.0024.0004.02,
                admin_weight:10, affinity_bits:0x0
                max_link_bw:10000 max_link_reservable: 10000
               allocated   reservable      allocated   reservable
               ---------   ----------      ---------   ----------
        bw[0]: 0           10000      bw[1]: 0           10000
        bw[2]: 0           10000      bw[3]: 0           10000
        bw[4]: 0           10000      bw[5]: 0           10000
        bw[6]: 0           10000      bw[7]: 0           10000
```

Table 14 lists the fields displayed in this example.

Table 14 Show MPLS Traffic-Eng Topology Field Descriptions

Field	Description
My-System_id	IGP's unique identifier.
IGP Id	Identification of advertising router.
MPLS TE Id	Unique MPLS traffic engineering identification.
Intf Address	This link's interface address.
Nbr IGP Id	Neighbor IGP router identifier.
admin_weight	Cost of the link.
affinity_bits	The requirements on the attributes of the links that the traffic crosses.
max_link_bw	Physical line rate.
max_link_reservable	The maximum amount of bandwidth you can reserve on a link.
allocated	Amount of bandwidth allocated at that priority.
reservable	Amount of available bandwidth reservable at that priority.

show mpls traffic-eng tunnel

To show information about tunnels, use the **show mpls traffic-eng tunnel** command.

show mpls traffic-eng tunnel [{**tunnel_interface | destination** *address* **| source-id** [{*ipaddress* **|** *0-MAX* | **name** *name* **role {all | head | middle | tail | remote} | {up | down}}] [brief]**

Syntax Description

tunnel_interface	Shows tunnel interface.
destination *address*	Displays brief summary of tunnel status and configuration.
source-id *ipaddress*	Restricts the display to tunnels originating at that IP address.
0-MAX	
name *name*	Restricts the display to tunnels with that value as their name. The tunnel name is derived from the interface description, if specified; otherwise, it is the interface name. The tunnel name is included in the signalling message so it is available at all hops.
role	Restrict the display to tunnels with the indicated role.
all	Displays all tunnels.
head	Displays tunnels with their head at this router.
middle	Displays tunnels with a midpoint at this router.
tail	Displays tunnels with a tail at this router.
remote	Displays tunnels with their head at some other router—the combination of middle and tail.
up	Restricts the display to tunnels that are up. When you specify "up," a tunnel head is shown if the tunnel interface is up. Tunnel midpoints and tails are typically either up or not present.
down	Restricts the display to tunnels that are down.
brief	Specifies a format with one line per tunnel.

Default

No default behavior or values.

Command Mode

EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.

Sample Display

The following example shows output from the **show mpls traffic-eng tunnel brief** command:

```
(Router)# show mpls traffic-eng tunnel brief

Signalling Summary:
    LSP Tunnels Process:           running
    RSVP Process:                  running
    Forwarding:                    enabled
    Periodic reoptimization:       every 180 seconds, next in 108 seconds
TUNNEL NAME                          DESTINATION      STATUS      STATE
tagsw-r4_t1                          10.0.0.11        admin-down  down
tagsw-r4_t10011                      10.0.0.11        up          up
...
al7500-sw12_t20004                   10.0.0.4         signalled   up
Displayed 16 (of 16) heads, 0 (of 0) midpoints, 1 (of 1) tails
```

Table 15 lists the fields displayed in this example.

Table 15 Show MPLS Traffic-Eng Field Descriptions

Field	Description
TUNNEL NAME	Name of the interface that is configured at the tunnel head.
DESTINATION	Tailend router identifier.
STATUS	For tunnel heads, admin-down or up. For non-heads, signalled.
STATE	Up or down.

Related Commands

Command	Description
mpls traffic-eng tunnels (configuration)	Enables MPLS traffic engineering tunneling signalling on a device
mpls traffic-eng tunnels (interface)	Enables MPLS traffic engineering tunnel signalling on an, interface.
mpls traffic-eng reoptimization timers frequency	Control the frequency at which tunnels with established LSPs are checked for better LSPs

show mpls traffic-eng tunnel summary

To show summary information about tunnels, use the **show mpls traffic-eng tunnel summary** command.

show mpls traffic-eng tunnel summary

Syntax Description

This command has no arguments or keywords.

Default

No default behavior or values.

Command Mode

Privileged EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.

Sample Display

The following example shows output from the **show mpls traffic-eng tunnel summary** command:

```
Router# show mpls traffic-eng tunnel summary

Signalling Summary:
    LSP Tunnels Process:            running
    RSVP Process:                   running
    Forwarding:                     enabled
    Head: 1 interfaces, 1 active signalling attempts, 1 established
          1 activations, 0 deactivations
    Midpoints: 0, Tails: 0
    Periodic reoptimization:        every 3600 seconds, next in 3436 seconds
```

Table 16 lists the fields displayed in this example.

Table 16 Show MPLS Traffic-Eng Tunnel Summary Field Descriptions

Field	Description
LSP Tunnels Process	Has the MPLS traffic engineering feature been enabled?
RSVP Process	Has the RSVP feature been enabled? (This is enabled as a consequence of enabling the MPLS traffic engineering feature.)
Forwarding	Is appropriate forwarding enabled? (Appropriate forwarding on a router is CEF switching.
Head	Summary information about tunnel heads at this device.
Interfaces	Number of MPLS traffic engineering tunnel interfaces.

Active signalling attempts	LSPs currently either successfully signalled or in the process of being signalled.
Established	LSPs currently signalled.
Activations	Signalling attempts initiated.
Deactivations	Signalling attempts terminated.
Periodic reoptimization	Frequency of periodic reoptimization and time until next periodic reoptimization.

Related Commands

Command	Description
mpls traffic-eng tunnels (configuration)	Enables MPLS traffic engineering tunneling signalling on a device
mpls traffic-eng tunnels (interface)	Enables MPLS traffic engineering tunnel signalling on an, interface.
mpls traffic-eng reoptimization timers frequency	Controls the frequency at which tunnels with established LSPs are checked for better LSPs

tunnel mpls traffic-eng affinity

To configure tunnel affinity (the properties the tunnel requires in its links), use the **tunnel mpls traffic-eng affinity** command. To disable this feature, use the **no** form of this command.

tunnel mpls traffic-eng affinity *properties* [**mask** *mask*]
no tunnel mpls traffic-eng affinity *properties* [**mask** *mask*]

Syntax Description

properties	Attribute values required for links carrying this tunnel (values of bits are either 0 or 1).
mask *mask*	Which attribute values should be checked. If a bit in the mask is 0, a link's attribute value or that bit is irrelevant. If a bit in the masks 1, the link's attribute value and the tunnel's required affinity for that bit must match.

Default

properties: 0X00000000
mask: 0X0000FFFF

Command Mode

Interface configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.

Example

Related Commands

Command	Description
mpls traffic-eng attribute-flags	Sets the user-specified attribute-flags for the interface.
tunnel mode mpls traffic-eng	Sets the mode of a tunnel to MPLS for traffic engineering.

tunnel mpls traffic-eng autoroute announce

To instruct the IGP to use the tunnel in its SPF/next hop calculation (if the tunnel is up), use the **tunnel mpls traffic-eng autoroute announce** command. To disable this feature, use the **no** form of this command.

tunnel mpls traffic-eng autoroute announce
no tunnel mpls traffic-eng autoroute announce

Syntax Description

This command has no arguments or keywords.

Default

The tunnel is not used by the IGP in its SPF/next hop calculation.

Command Mode

Interface configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.

Usage Guidelines

Currently, the only way to cause traffic to be forwarded onto a tunnel is by enabling this feature or by configuring forwarding explicitly with an interface static route, for example.

Related Commands

Command	Description
ip route	Defines a static host name-to-address mapping in the host cache..
tunnel mode mpls traffic-eng	Sets the mode of a tunnel to MPLS for traffic engineering.

tunnel mpls traffic-eng autoroute metric

To specify the MPLS traffic-engineering tunnel metric used by IGP autoroute, use the **tunnel mpls traffic-eng autoroute metric** command. To disable this feature, use the **no** form of this command.

tunnel mpls traffic-eng autoroute metric {**absolute**|**relative**} *value*
no tunnel mpls traffic-eng autoroute metric

Syntax Description

metric	The MPLS traffic engineering tunnel metric
absolute	The MPLS traffic-engineering tunnel metric mode absolute: a positive metric value can be supplied
relative	The MPLS traffic-engineering tunnel metric mode relative: a positive, negative or zero value can be supplied

Default

The default is metric relative 0.

Command Mode

Interface configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.

Usage Guidelines

Example

Related Commands

Command	Description
show mpls traffic-eng autoroute	Shows tunnels announced to IGP, including interface, destination, and bandwidth.
tunnel mpls traffic-eng autoroute	Instructs the IGP to use the tunnel in its SPF/next hop calculation (if the tunnel is up).

tunnel mpls traffic-eng bandwidth

To configure bandwidth required for an MPLS traffic engineering tunnel, use the **tunnel mpls traffic-eng bandwidth** command. To disable this feature, use the **no** form of this command.

tunnel mpls traffic-eng bandwidth *bandwidth*
no tunnel mpls traffic-eng bandwidth *bandwidth*

Syntax Description

bandwidth	The bandwidth required for an MPLS traffic engineering tunnel. Bandwidth is specified in kilobits per seconds.

Default

Default bandwidth required is 0.

Command Mode

Configuration interface

Command History

Release	Modification
12.0(5)S	This command was introduced.

Usage Guidelines

Example

Related Commands

Command	Description
show mpls traffic-eng tunnel	Displays tunnel information.

tunnel mpls traffic-eng path-option

To configure a path option, use the **tunnel mpls traffic-eng path-option** command. To disable this feature, use the **no** form of this command.

tunnel mpls traffic-eng path-option identifier ***path-number*** **name** ***path-name***
no tunnel mpls traffic-eng path-option identifier ***path-number*** **name** ***path-name***

Syntax Description

identifier *path-number*	Uses the IP explicit path with the indicated path number.
name *path-name*	Uses the IP explicit path with the indicated path name.

Default

No default behavior or values.

Command Mode

Interface configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.

Usage Guidelines

Multiple path setup options may be configured for a single tunnel. For example, you can configure several explicit paths and a dynamic option for one tunnel. Path setup prefers options with lower numbers to options with higher numbers, so option 1 is the most preferred option.

Example

Related Commands

Command	Description
ip explicit-path	Enter the subcommand mode for IP explicit paths to create or modify the named path.
show ip explicit-paths	Shows configured IP explict paths.
tunnel mode mpls traffic-eng priority	Configures setup and reservation priority for a tunnel.

tunnel mpls traffic-eng priority

To configure setup and reservation priority for a tunnel, use the **tunnel mpls traffic-eng priority** command. To disable this feature, use the **no** form of this command.

tunnel mpls traffic-eng priority *setup-priority* [*hold-priority*]
no tunnel traffic-eng priority *setup-priority* [*hold-priority*]

Syntax Description

setup-priority	The priority used when signalling an LSP for this tunnel to figure out what existing tunnels are eligible to be preempted. The range is 0 to 7, where a lower numeric value indicates a higher priority. Therefore, an LSP with a setup priority of 0 can preempt any LSP with a non-0 priority.
hold-priority	The priority associated with an LSP for this tunnel once established to figure out if it should be preempted by other LSPs that are being signalled. The range is 0 to 7, where a lower numeric value indicates a higher priority.

Default

setup-priority: 7
hold-priority: setup priority

Command Mode

Interface configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.

Usage Guidelines

The priority mechanism allows a hard-to-fit LSP to preempt easy-to-fit LSPs so that the easy-to fit LSPs can be re-established once the hard-to-fit LSP has been placed.

Typically, setup and hold priorities are equal. However, a separate hold priority allows a subset on tunnels to not preempt on setup, but to not be preempted once established.

Setup priority may not be better than (numerically smaller than) hold priority.

Example

Related Commands

Command	Description
tunnel mode mpls traffic-eng	Sets the mode of a tunnel to MPLS for traffic engineering.

tunnel mode mpls traffic-eng

To set the mode of a tunnel to MPLS for traffic engineering, use the **tunnel mode mpls traffic-eng** command. To disable this feature, use the **no** form of this command.

tunnel mode mpls traffic-eng [gre-ip]
no tunnel mode mpls traffic-eng [gre-ip]

Syntax Description

gre-ip	(Optional)

Default

No default behavior or values.

Command Mode

Interface configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.

Usage Guidelines

This command specifies that the tunnel interface is for an MPLS traffic engineering tunnel, and enables the various tunnel MPLS configuration options.

Example

Related Commands

Command	Description
tunnel mpls traffic-eng affinity	Configures tunnel affinity (the properties the tunnel requires in its links).
tunnel mpls traffic-eng autoroute announce	Instructs the IGP to use the tunnel in its SPF/next hop calculation (if the tunnel is up).
tunnel mpls traffic-eng bandwidth	Configures bandwidth required for an MPLS traffic engineering tunnel.
tunnel mpls traffic-eng path-option	Configures a path option.
tunnel mpls traffic-eng priority	Configures setup and reservation priority for a tunnel.