MPLS Traffic Engineering and Enhancements

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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. 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.

History for the MPLS Traffic Engineering and Enhancements Feature

Release	Modification
12.0(5)S	This feature was introduced as *MPLS Traffic Engineering*.
12.1(3)T	This feature was updated and integrated into Cisco IOS Release 12.1(3)T. The title of the feature module changed to *MPLS Traffic Engineering and Enhancements*.
12.0(10)ST	This feature was integrated into Cisco IOS Release 12.0(10)ST.
12.0(22)S	This feature was integrated into Cisco IOS Release 12.0(22)S.
12.0(23)S	This feature was updated to support the Cisco 10720 Internet router.
12.2(28)SB	This feature was integrated into Cisco IOS Release 12.2(28)SB.

Finding Support Information for Platforms and Cisco IOS Software Images

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Feature Overview

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 enhances standard Interior Gateway Protocols (IGPs), such as Intermediate System-to-Intermediate System (IS-IS) or Open Shortest Path First (OSPF), to automatically map packets onto the appropriate traffic flows.

- Transports traffic flows across a network using MPLS forwarding.
- Determines the routes for traffic flows across a network based on the resources the traffic flow requires and the resources available in the network.
- 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 traffic flow has bandwidth requirements, media requirements, a priority that is compared to the priority of other flows, and so forth.
- Recovers from link or node failures by adapting to the new constraints presented by the changed topology.
- Transports packets using MPLS forwarding crossing a multihop label-switched path (LSP).
- Uses the routing and signaling capability of LSPs across a backbone topology that
  - Understands the backbone topology and available resources
  - Accounts for link bandwidth and for the size of the traffic flow when determining routes for LSPs across the backbone
  - Has a dynamic adaptation mechanism that enables the backbone to be resilient to failures, even if several primary paths are precalculated off-line
- Includes enhancements to the IGP (IS-IS or OSPF) shortest path first (SPF) calculations to automatically calculate what traffic should be sent over what LSPs.

Why Use MPLS Traffic Engineering?

WAN connections are an expensive item in an ISP budget. Traffic engineering enables ISPs to route network traffic to offer the best service to their users in terms of throughput and delay. By making the service provider more efficient, traffic engineering reduces the cost of the network.

Currently, some ISPs base their services on an overlay model. In the overlay model, transmission facilities are managed by Layer 2 switching. The routers see only a fully meshed virtual topology, making most destinations appear one hop away. If you use the explicit Layer 2 transit layer, you can precisely control how traffic uses available bandwidth. However, the overlay model has numerous disadvantages. MPLS traffic engineering achieves the traffic engineering benefits of the overlay model without running a separate network, and without needing a nonscalable, full mesh of router interconnects.

How MPLS Traffic Engineering Works

MPLS traffic engineering automatically establishes and maintains LSPs across the backbone by using RSVP. The path that an LSP uses is determined by the LSP resource requirements and network resources, such as bandwidth.

Available resources are flooded by means of extensions to a link-state based IGP.

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

MPLS traffic engineering is built on the following Cisco IOS mechanisms:

- IP tunnel interfaces
  - From a Layer 2 standpoint, an MPLS tunnel interface represents the head of an LSP. It is configured with a set of resource requirements, such as bandwidth and media requirements, and priority.
  - From a Layer 3 standpoint, an LSP tunnel interface is the headend of a unidirectional virtual link to the tunnel destination.
- MPLS traffic engineering path calculation module. This calculation module operates at the LSP head. The module determines a path to use for an LSP. The path calculation uses a link-state database containing flooded topology and resource information.
- RSVP with traffic engineering extensions. RSVP operates at each LSP hop and is used to signal and maintain LSPs based on the calculated path.
- MPLS traffic engineering link management module. This module operates at each LSP hop, does link call admission on the RSVP signaling messages, and bookkeeping of topology and resource information to be flooded.
- Link-state IGP (IS-IS or OSPF—each with traffic engineering extensions). These IGPs are used to globally flood topology and resource information from the link management module.
- Enhancements to the SPF calculation used by the link-state IGP (IS-IS or OSPF). The IGP automatically routes traffic onto the appropriate LSP tunnel based on tunnel destination. Static routes can also be used to direct traffic onto LSP tunnels.
- Label switching forwarding. This forwarding mechanism provides routers with a Layer 2-like ability to direct traffic across multiple hops of the LSP established by RSVP signaling.

One approach to engineering a backbone is to define a mesh of tunnels from every ingress device to every egress device. The MPLS traffic engineering path calculation and signaling modules determine the path taken by the LSPs for these tunnels, subject to resource availability and the dynamic state of the network. 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.

A flow from an ingress device to an egress device might be 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 (previously referred to as Tag Switching), see the following Cisco documentation:

- "Multiprotocol Label Switching" chapter in the *Cisco IOS Switching Services Configuration Guide*, Release 12.2.

Mapping Traffic into Tunnels

This section describes how traffic is mapped into tunnels; that is, how conventional hop-by-hop link-state routing protocols interact with MPLS traffic engineering capabilities. In particular, this section describes how the shortest path first (SPF) algorithm, sometimes called a Dijkstra algorithm, has been enhanced so that a link-state IGP can automatically forward traffic over tunnels that MPLS traffic engineering establishes.

Link-state protocols, like integrated IS-IS or OSPF, use an SPF algorithm to compute a shortest path tree from the headend node 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 over a physical interface attached to the router.

New traffic engineering algorithms calculate explicit routes to one or more nodes in the network. The originating router views these explicit routes as logical interfaces. 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 use 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 the 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 headend router. For each of those TE tunnels, the router at the tailend is known to the headend router.

During the SPF computation, the TENT (tentative) list stores paths that are possibly the best paths and the PATH list stores paths that are definitely the best paths. When it is determined that a path is the best possible path, the node is moved from TENT to PATH. PATH is thus the set of nodes for which the best path from the computing router has been found. Each PATH entry consists of ID, path cost, and forwarding direction.

The router must determine the first-hop information. There are several ways to do this:

- Examine the list of tailend routers directly reachable by a TE tunnel. If there is a TE tunnel to this node, use the TE tunnel as the first hop.
- If there is no TE tunnel and the node is directly connected, use the first-hop information from the adjacency database.
- If the node is not directly connected and is not directly reachable by a TE tunnel, copy the first-hop information 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 the TE tunnels. Traffic to nodes that are downstream of the tailend nodes also flows over the 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.

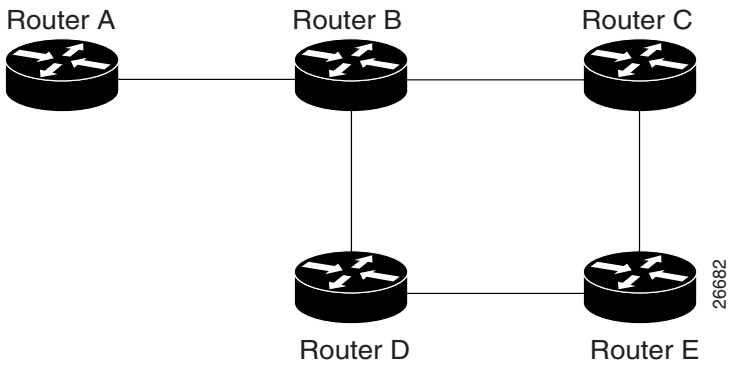
Special Cases and Exceptions

The SPF algorithm finds equal-cost parallel paths to destinations. The enhancement previously described does not change this. Traffic can be forwarded over any of the following:

- One or more native IP paths
- One or more traffic engineering tunnels
- A combination of native IP paths and traffic engineering tunnels

A special situation occurs in the topology shown in Figure 1.

Figure 1 Sample Topology of Parallel Native Paths and Paths over TE Tunnels



If parallel native IP paths and paths over TE tunnels are available, the following implementations allow you to force traffic to flow over TE tunnels only or only over native IP paths. 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 TENT 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 TENT list, it realizes that Router D is the tailend of a TE tunnel. Thus Router A installs a route to Router D by the TE tunnel, and not by Router B.
- When Router A puts Router E on the TENT 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 Router A to Router B to Router C
- The TE tunnel Router A to Router D

Additional Enhancements to SPF Computation Using Configured Tunnel Metrics

When traffic engineering tunnels install an IGP route in a Router Information Base (RIB) 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.

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:

1. Is the TE tunnel installed as one of the next hops to the destination routers?
2. What is the metric value of the routes being installed into the RIB?

You can modify the metrics for determining the first-hop information in one of the following ways:

- 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, the IGP assigns metrics to routes associated with those tailend routers and their downstream routers.

The SPF computation 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.

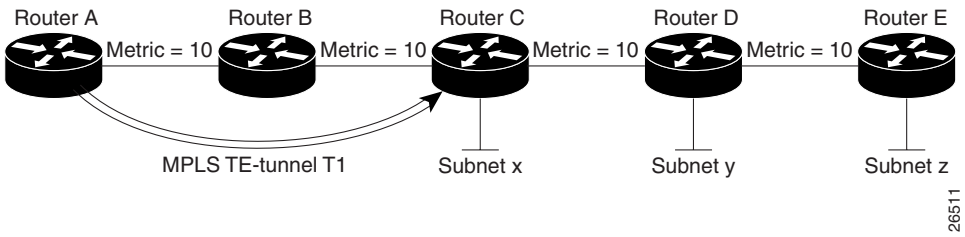
You can represent the TE tunnel metric in two different ways: (1) as an absolute (or fixed) metric or (2) as a relative (or floating) metric.

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 topology shown in Figure 2.

Figure 2 Topology That Has No Traffic Engineering Tunnel



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 metrics 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

A new flavor of IS-IS includes extensions for MPLS traffic engineering and for other purposes. Running MPLS traffic engineering over IS-IS or taking advantage of these other extensions requires transitioning an IS-IS network to this new technology. This section describes these extensions and discusses two ways to migrate an existing IS-IS network from the standard ISO 10589 protocol towards this new flavor of IS-IS.

Note Running MPLS traffic engineering over an existing IS-IS network requires a transition to a new flavor of IS-IS. However, running MPLS traffic engineering over OSPF does not require any similar network transition.

New Extensions for the IS-IS Routing Protocol

New extensions for the IS-IS routing protocol serve the following purposes:

- Remove the 6-bit limit on link metrics.
- Allow interarea IP routes.
- Enable IS-IS to carry different kinds of information for traffic engineering. In the future, more extensions might be needed.

To serve these purposes, two new TLVs (type, length, and value objects) have been defined:

- TLV 22 describes links (or rather adjacencies). It serves the same purpose as the "IS neighbor option" in ISO 10589 (TLV 2).
- TLV 135 describes reachable IP prefixes. It is similar to the IP Neighbor options from RFC 1195 (TLVs 128 and 130).

Note 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."

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 use this ability to add new properties to a link.

The Problem in Theory

Link-state routing protocols compute loop-free routes. This is guaranteed because all routers calculate their routing tables based on the same information from the link-state database (LSPDB).

There is a problem when some routers look at old-style TLVs and some routers look at new-style TLVs because the routers can base their SPF calculations on different information. This can cause routing loops.

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 that you reconfigure all routers during a short period of time, during which service is interrupted. If the implementation of a flag day is not acceptable, a network administrator needs to find a viable solution for modern existing networks.

Network administrators have the following problems related to TLVs:

- They need 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 capable only of advertising and using old-style TLVs.
- They need to test new traffic engineering software in existing networks on a limited number of routers. They cannot upgrade all their routers in their production networks or in their test networks before they start testing.

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

The following sections describe two solutions to the network administrator's problems.

First Solution for Transitioning an IS-IS Network to a New Technology

When you migrate from old-style TLVs towards new-style TLVs, you can advertise the same information twice—once in old-style TLVs and once in new-style TLVs. This ensures that all routers can understand what is advertised.

There are three disadvantages to using that approach:

- Size of the LSPs—During the transition, the LSPs grow to about twice their original size. This might be a problem in networks where the LSPDB is large. An LSPDB might be large because
  - There are many routers, and thus LSPs.
  - There are many neighbors or IP prefixes per router. A router that advertises lots of information causes the LSPs to be fragmented.
- Unpredictable results—In a large network, this solution can produce unpredictable results. A large network in transition pushes the limits regarding LSP flooding and SPF scaling. During the transition
  - You can expect some extra network instability. At this time, you especially do not want to test how far you can push an implementation.
  - Traffic engineering extensions might cause LSPs to be reflooded frequently.
- Ambiguity—If a router encounters different information in the old-style TLVs and the new-style TLVs, it may not be clear what the router should do.

These problems can be largely solved easily 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 to advertising the same information twice is that network administrators can use new-style TLVs before all routers in the network can understand them.

Transition Actions During the First Solution

When transitioning from using IS-IS with old-style TLVs to new-style TLVs, you can perform the following actions:

- If all routers run old software, advertise and use only old-style TLVs.
- Upgrade some routers to newer software.
- 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 continue advertising and using only old-style TLVs.
- Test traffic engineering in parts of your network; however, new-style TLVs cannot be used yet.
- If the whole network needs to migrate, upgrade and configure all remaining routers to advertise and accept both styles of TLVs.
- Configure all routers to advertise and accept only new-style TLVs.
- Configure metrics larger than 63.

For more information about how to perform these actions, see "TLV Configuration Commands" section on page 10.

Second Solution for Transitioning an IS-IS Network to a New Technology

Routers advertise only one style of TLVs at the same time, but can understand both types of TLVs during migration. There are two main benefits to this approach:

- LSPs stay approximately the same size during migration.
- There is no ambiguity when the same information is advertised twice inside one LSP.

This method is useful when you are transitioning the whole network (or a whole area) to use wider metrics (that is, you want a router running IS-IS to generate and accept only new-style TLVs). For more information, see the **metric-style wide** command.

The disadvantage is that all routers must understand the new-style TLVs before any router can start advertising new-style TLVs. It does not help the second problem, where network administrators want to use the new-style TLVs for traffic engineering, while some routers are capable of understanding only old-style TLVs.

Transition Actions During the Second Solution

If you use the second solution, you can perform the following actions:

- If all routers run old software, advertise and use only old-style TLVs.
- Upgrade all routers to newer software.
- Configure all routers one-by-one to advertise old-style TLVs, but to accept both styles of TLVs.
- Configure all routers one-by-one to advertise new-style TLVs, but to accept both styles of TLVs.
- Configure all routers one-by-one to advertise and to accept only new-style TLVs.
- Configure metrics larger than 63.

TLV Configuration Commands

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

- **Metric-style narrow**—Enables the router to generate and accept only old-style TLVs
- **Metric-style transition**—Enables the router to generate and accept both old-style and new-style TLVs
- **Metric-style wide**—Enables the router to generate and accept only new-style TLVs

For more information about the commands, see the "Command Reference" section on page 19 in this document.

You can use either of two transition schemes when you are using the metric-style commands:

- Narrow to transition to wide
- Narrow to narrow transition to wide transition to wide

Implementation in Cisco IOS Software

Cisco IOS software implements both transition solutions. Network administrators can choose the solution that suits them best. For test networks, the first solution is ideal (go to "First Solution for Transitioning an IS-IS Network to a New Technology" section on page 8). For a real transition, both

solutions can be used. The first solution requires fewer steps and less configuration. Only the largest networks that do not want to risk doubling their LSPDB during transition need to use the second solution (go to "Second Solution for Transitioning an IS-IS Network to a New Technology" section on page 10).

Benefits

MPLS traffic engineering has the following benefits:

- Higher return on network backbone infrastructure investment. 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.
- Reduction in operating costs. Costs are reduced because numerous important processes are automated, including setup, configuration, mapping, and selection of MPLS traffic engineered (MPLS TE) tunnels across a Cisco 12000 series backbone.

Restrictions

The following restrictions apply to MPLS traffic engineering:

- MPLS traffic engineering currently supports only a single IS-IS level or OSPF area.
- Currently, MPLS traffic engineering does not support ATM MPLS-controlled subinterfaces.
- The MPLS traffic engineering feature does not support routing and signaling of LSPs over unnumbered IP links. Therefore, do not configure the feature over those links.

Related Features and Technologies

The MPLS traffic engineering feature is related to the IS-IS, OSPF, RSVP, and MPLS features (formerly referred to as tag switching). These features are presented in Cisco product documentation (see the "Related Documents" section on page 18 and "How MPLS Traffic Engineering Works" section on page 3).

Prerequisites

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

- Multiprotocol Label Switching
- IP Cisco Express Forwarding
- Intermediate System-to-Intermediate System (IS-IS) or Open Shortest Path First (OSPF)

Configuration Tasks

Perform the following tasks before you enable MPLS traffic engineering:

- Turn on MPLS tunnels
- Turn on Cisco Express Forwarding
- Turn on IS-IS or OSPF

Perform the following tasks to configure MPLS traffic engineering:

- Configuring a Device to Support Tunnels, page 12
- Configuring an Interface to Support RSVP-Based Tunnel Signaling and IGP Flooding, page 13
- Configuring IS-IS for MPLS Traffic Engineering, page 13
- Configuring OSPF for MPLS Traffic Engineering, page 14
- Configuring an MPLS Traffic Engineering Tunnel, page 14
- Configuring an MPLS Traffic Engineering Tunnel that an IGP Can Use, page 14

Configuring a Device to Support Tunnels

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

	Command	Purpose
Step 1	`Router(config)# ip cef`	Enables standard Cisco Express Forwarding operation. For information about Cisco Express Forwarding configuration and the command syntax, see the *Cisco IOS Switching Services Configuration Guide* and the *Cisco IOS Switching Services Command Reference*.
Step 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 Signaling and IGP Flooding

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

Note You must enable the tunnel feature on interfaces that you want to support MPLS traffic engineering.

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

Configuring IS-IS for MPLS Traffic Engineering

To configure IS-IS for MPLS traffic engineering, perform the steps described below. For a description of the IS-IS commands (excluding the IS-IS traffic engineering commands), see the *Cisco IOS IP Command Reference*, *Volume 2 of 3: Routing Protocols*, Release 12.2

	Command	Purpose
Step 1	`Router(config)# router isis`	Enables IS-IS routing and specifies an IS-IS process for IP. This command places you in router configuration mode.
Step 2	`Router(config-router)# mpls traffic-eng level-1`	Turns on MPLS traffic engineering for IS-IS level 1.
Step 3	`Router(config-router)# mpls traffic-eng router-id loopback0`	Specifies that the traffic engineering router identifier for the node is the IP address associated with interface loopback0.
Step 4	`Router(config-router)# metric-style wide`	Configures a router to generate and accept only new-style TLVs.

Configuring OSPF for MPLS Traffic Engineering

To configure OSPF for MPLS traffic engineering, perform the steps described below. For a description of the OSPF commands (excluding the OSPF traffic engineering commands), see the *Cisco IOS IP Command Reference*, *Volume 2 of 3: Routing Protocols*, Release 12.2.

	Command	Purpose
Step 1	`Router(config)# router ospf process-id`	Configures an OSPF routing process for IP. You are placed in router configuration mode. The *process-id* is an internally used identification parameter for an OSPF routing process. It is locally assigned and can be any positive integer. Assign a unique value for each OSPF routing process.
Step 2	`Router(config-router)# mpls traffic-eng area 0`	Turns on MPLS traffic engineering for OSPF area 0.
Step 3	`Router(config-router)# mpls traffic-eng router-id loopback0`	Specifies that the traffic engineering router identifier for the node is the IP address associated with interface loopback0.

Configuring an MPLS Traffic Engineering Tunnel

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

	Command	Purpose
Step 1	`Router(config)# interface tunnel`	Configures an interface type and enters interface configuration mode.
Step 2	`Router(config)# ip unnumbered loopback0`	Gives the tunnel interface an IP address. An MPLS traffic engineering tunnel interface should be unnumbered because it represents a unidirectional link.
Step 3	`Router(config-if)# tunnel destination A.B.C.D`	Specifies the destination for a tunnel.
Step 4	`Router(config-if)# tunnel mode mpls traffic-eng`	Sets the tunnel encapsulation mode to MPLS traffic engineering.
Step 5	`Router(config-if)# tunnel mpls traffic-eng bandwidth bandwidth`	Configures the bandwidth for the MPLS traffic engineering tunnel.
Step 6	`Router(config-if)# tunnel mpls traffic-eng path-option number {dynamic | explicit {name path-name | path-number}} [lockdown]`	Configures the tunnel to use a named IP explicit path or a path dynamically calculated from the traffic engineering topology database. A dynamic path is used if an explicit path is currently unavailable.

Configuring an MPLS Traffic Engineering Tunnel that an IGP Can Use

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

	Command	Purpose
Step 1	`Router(config-if)# interface tunnel1`	Configures an interface type and enters interface configuration mode.
Step 2	`Router(config-if)# tunnel mpls traffic-eng autoroute announce`	Causes the IGP to use the tunnel in its enhanced SPF calculation.

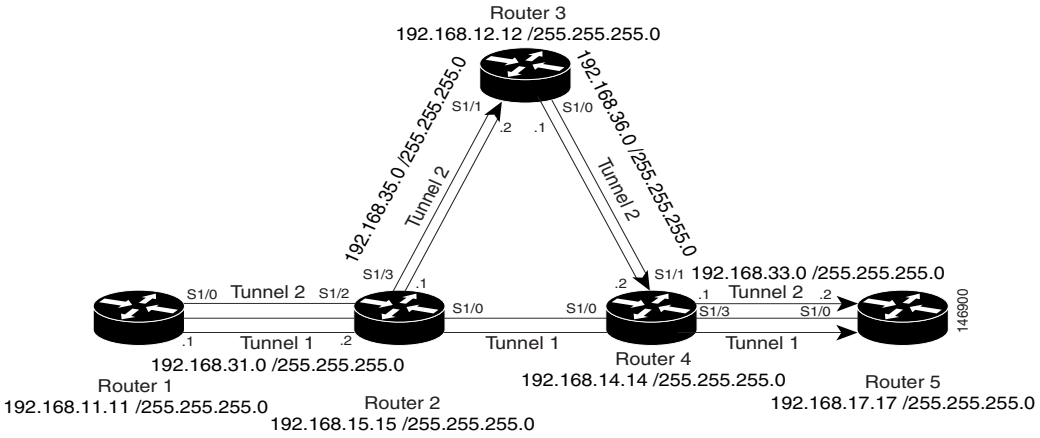
Configuration Examples

This section provides the following configuration examples:

- Configuring MPLS Traffic Engineering Using IS-IS, page 15
- Configuring MPLS Traffic Engineering Using OSPF, page 16
- Configuring an MPLS Traffic Engineering Tunnel, page 17
- Configuring Enhanced SPF Routing Over a Tunnel, page 17

Figure 3 illustrates a sample MPLS topology. This example specifies point-to-point outgoing interfaces. The next sections contain sample configuration commands you enter to implement MPLS traffic engineering and the basic tunnel configuration shown in Figure 3.

Figure 3 Sample MPLS Traffic Engineering Tunnel Configuration



Configuring MPLS Traffic Engineering Using IS-IS

This example lists the commands you enter to configure MPLS traffic engineering with IS-IS routing enabled (see Figure 3).

Note You must enter the following commands on every router in the traffic-engineered portion of your network.

Router 1—MPLS Traffic Engineering Configuration

To configure MPLS traffic engineering, enter the following commands:

```
ip cef
mpls traffic-eng tunnels
interface loopback 0
ip address 192.168.11.11 255.255.255.0
ip router isis

interface s1/0
ip address 192.168.31.0 255.255.255.0.0
ip router isis
mpls traffic-eng tunnels
ip rsvp bandwidth 1000
```

Router 1—IS-IS Configuration

To enable IS-IS routing, enter the following commands:

```
router isis
network 47.0000.0011.0011.00
is-type level-1
metric-style wide
mpls traffic-eng router-id loopback0
mpls traffic-eng level-1
```

Configuring MPLS Traffic Engineering Using OSPF

This example lists the commands you enter to configure MPLS traffic engineering with OSPF routing enabled (see Figure 3).

Note You must enter the following commands on every router in the traffic-engineered portion of your network.

Router 1—MPLS Traffic Engineering Configuration

To configure MPLS traffic engineering, enter the following commands:

```
ip cef
mpls traffic-eng tunnels
interface loopback 0
ip address 192.168.11.11 255.255.255.0

interface s1/0
ip address 192.168.31.0 255.255.255.0.0
mpls traffic-eng tunnels
  ip rsvp bandwidth 1000
```

Router 1—OSPF Configuration

To enable OSPF, enter the following commands:

```
router ospf 0
network 192.168.31.0 255.255.255 area 0
  mpls traffic-eng router-id Loopback0
  mpls traffic-eng area 0
```

Configuring an MPLS Traffic Engineering Tunnel

This example shows you how to configure a dynamic path tunnel and an explicit path in the tunnel. Before you configure MPLS traffic engineering tunnels, you must enter the appropriate global and interface commands on the specified router (in this case, Router 1).

Router 1—Dynamic Path Tunnel Configuration

In this section, a tunnel is configured to use a dynamic path.

```
interface tunnel1
  ip unnumbered loopback 0
  tunnel destination 192.168.17.17 255.255.255.0
  tunnel mode mpls traffic-eng
tunnel mpls traffic-eng bandwidth 100
  tunnel mpls traffic-eng priority 1 1
  tunnel mpls traffic-eng path-option 1 dynamic
```

Router 1—Dynamic Path Tunnel Verification

This section includes the commands you use to verify that the tunnel is up.

```
show mpls traffic-eng tunnels
show ip interface tunnel1
```

Router 1—Explicit Path Configuration

In this section, an explicit path is configured.

```
ip explicit-path identifier 1
 next-address 192.168.131.0 255.255.255.0
 next-address 192.168.135.0 255.255.255.0
 next-address 192.168.136.0 255.255.255.0
 next-address 192.168.133.0 255.255.255.0
```

Router 1—Explicit Path Tunnel Configuration

In this section, a tunnel is configured to use an explicit path.

```
interface tunnel2
  ip unnumbered loopback 0
  tunnel destination 192.168.17.17 255.255.255.0
  tunnel mode mpls traffic-eng
tunnel mpls traffic-eng bandwidth 100
  tunnel mpls traffic-eng priority 1 1
  tunnel mpls traffic-eng path-option 1 explicit identifier 1
```

Router 1—Explicit Path Tunnel Verification

This section includes the commands you use to verify that the tunnel is up.

```
show mpls traffic-eng tunnels
show ip interface tunnel2
```

Configuring Enhanced SPF Routing Over a Tunnel

This section includes the commands that cause the tunnel to be considered by the IGP's enhanced SPF calculation, which installs routes over the tunnel for appropriate network prefixes.

Router 1—IGP Enhanced SPF Consideration Configuration

In this section, you specify that the IGP should use the tunnel (if the tunnel is up) in its enhanced shortest path first (SPF) calculation.

```
interface tunnel1
 tunnel mpls traffic-eng autoroute announce
```

Router 1—Route and Traffic Verification

This section includes the commands you use to verify that the tunnel is up and that the traffic is routed through the tunnel.

```
show traffic-eng tunnels tunnel1 brief
show ip route 192.168.17.17 255.255.255.0
show mpls traffic-eng autoroute
ping 192.168.17.17 255.255.255.0
show interface tunnel1 accounting
show interface s1/0 accounting
```

Additional References

The following sections provide references related to MPLS Traffic Engineering and Enhancements.

Related Documents

Related Topic	Document Title
IP routing protocols	"IP Routing Protocols" chapter in the *Cisco IOS Switching Services Configuration Guide*, Release 12.2
Multiprotocol Label Switching	"Multiprotocol Label Switching" chapter in the *Cisco IOS Switching Services Configuration Guide*, Release 12.2.

Standards

Standard	Title
None	—

MIBs

MIB	MIBs Link
None	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFC	Title
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*
RFC 2328	*OSPF Version 2*
RFC 2370	*The OSPF Opaque LSA Option*

Technical Assistance

Description	Link
The Cisco Technical Support & Documentation website contains thousands of pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/techsupport

Command Reference

This section documents modified commands only.

- **append-after**
- **debug ip ospf mpls traffic-eng advertisements**
- **debug isis mpls traffic-eng advertisements**
- **debug isis mpls traffic-eng events**
- **debug mpls traffic-eng areas**
- **debug mpls traffic-eng autoroute**
- **debug mpls traffic-eng link-management admission-control**
- **debug mpls traffic-eng link-management advertisements**
- **debug mpls traffic-eng link-management bandwidth-allocation**
- **debug mpls traffic-eng link-management errors**
- **debug mpls traffic-eng link-management events**
- **debug mpls traffic-eng link-management igp-neighbors**
- **debug mpls traffic-eng link-management links**
- **debug mpls traffic-eng link-management preemption**
- **debug mpls traffic-eng link-management routing**
- **debug mpls traffic-eng load-balancing**
- **debug mpls traffic-eng path**

- debug mpls traffic-eng topology change
- debug mpls traffic-eng topology lsa
- debug mpls traffic-eng tunnels errors
- debug mpls traffic-eng tunnels events
- debug mpls traffic-eng tunnels labels
- debug mpls traffic-eng tunnels reoptimize
- debug mpls traffic-eng tunnels signalling
- debug mpls traffic-eng tunnels state
- debug mpls traffic-eng tunnels timers
- index
- ip explicit-path
- list
- metric-style narrow
- metric-style transition
- metric-style wide
- mpls traffic-eng
- mpls traffic-eng administrative-weight
- mpls traffic-eng area
- mpls traffic-eng attribute-flags
- mpls traffic-eng flooding thresholds
- mpls traffic-eng link-management timers bandwidth-hold
- mpls traffic-eng link-management timers periodic-flooding
- mpls traffic-eng logging lsp
- mpls traffic-eng logging tunnel
- mpls traffic-eng reoptimize
- mpls traffic-eng reoptimize events
- mpls traffic-eng reoptimize timers frequency
- mpls traffic-eng router-id
- mpls traffic-eng signalling advertise implicit-null
- mpls traffic-eng tunnels (global configuration)
- mpls traffic-eng tunnels (interface configuration)
- next-address
- show ip explicit-paths
- show ip ospf database opaque-area
- show ip ospf mpls traffic-eng
- 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 topology path
- show mpls traffic-eng tunnels
- show mpls traffic-eng tunnels summary
- tunnel mode mpls traffic-eng
- 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

append-after

To insert a path entry after a specified index number, use the **append-after** command in IP explicit path configuration mode.

append-after *index command*

Syntax Description

index	Previous index number. Valid values are from 0 to 65534.
command	An IP explicit path configuration command that creates a path entry. (Use the **next-address** command to specify the next IP address in the explicit path.)

Defaults

No path entry is inserted after a specified index number.

Command Modes

IP explicit path configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

In the following example, the **next-address** command is inserted after index 5:

```
Router(config-ip-expl-path)# append-after 5 next-address 10.3.27.3
```

Related Commands

Command	Description
index	Inserts or modifies a path entry at a specific index.
interface fastethernet	Enters the command mode for IP explicit paths and creates or modifies the specified path.
list	Displays all or part of the explicit paths.
next-address	Specifies the next IP address in the explicit path.
show ip explicit-paths	Displays the configured IP explicit paths.

debug ip ospf mpls traffic-eng advertisements

To print information about traffic engineering advertisements in Open Shortest Path First (OSPF) link state advertisement (LSA) messages, use the **debug ip ospf mpls traffic-eng advertisements** command in privileged EXEC mode. To disable debugging output, use the **no** form of this command.

debug ip ospf mpls traffic-eng advertisements

no debug ip ospf mpls traffic-eng advertisements

Syntax Description

This command has no arguments or keywords

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.0(5)ST	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T.
12.0(22)S	This command was integrated into Cisco IOS Release 12.0(22)S.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

In the following example, information about traffic engineering advertisements is printed in OSPF LSA messages:

```
Router# debug ip ospf mpls traffic-eng advertisements

OSPF:IGP delete router node 10.106.0.6 fragment 0 with 0 links
      TE Router ID 10.106.0.6
OSPF:IGP update router node 10.110.0.10 fragment 0 with 0 links
      TE Router ID 10.110.0.10
OSPF:MPLS announce router node 10.106.0.6 fragment 0 with 1 links
      Link connected to Point-to-Point network
      Link ID :10.110.0.10
      Interface Address :10.1.0.6
      Neighbor Address :10.1.0.10
      Admin Metric :10
      Maximum bandwidth :1250000
      Maximum reservable bandwidth :625000
      Number of Priority :8
      Priority 0 :625000      Priority 1 :625000
      Priority 2 :625000      Priority 3 :625000
      Priority 4 :625000      Priority 5 :625000
      Priority 6 :625000      Priority 7 :625000
      Affinity Bit :0x0
```

Table 1 describes the significant fields shown in the display.

Table 1 debug ip ospf mpls traffic-eng advertisements Field Descriptions

Field	Description
Link ID	Index of the link being described.
Interface Address	Address of the interface.
Neighbor Address	Address of the neighbor.
Admin Metric	Administrative weight associated with this link.
Maximum bandwidth	Bandwidth capacity of the link (kbps).
Maximum reservable bandwidth	Amount of reservable bandwidth on this link.
Number of Priority	Number of priority levels for which bandwidth is advertised.
Priority	Bandwidth available at indicated priority level.
Affinity Bit	Attribute flags of the link that are being flooded.

debug isis mpls traffic-eng advertisements

To print information about traffic engineering advertisements in Intermediate System-to-Intermediate System (IS-IS) link-state advertisement (LSA) messages, use the **debug isis mpls traffic-eng advertisements** command in privileged EXEC mode. To disable debugging output, use the **no** form of this command.

debug isis mpls traffic-eng advertisements

no debug isis mpls traffic-eng advertisements

Syntax Description

This command has no arguments or keywords.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.0(5)ST	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T.
12.0(22)S	This command was integrated into Cisco IOS Release 12.0(22)S.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

In the following example, information about traffic engineering advertisements is printed in IS-IS LSA messages:

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

System ID:Router1.00
  Router ID:10.106.0.6
  Link Count:1
    Link[1]
      Neighbor System ID:Router2.00 (P2P link)
      Interface IP address:10.42.0.6
      Neighbor IP Address:10.42.0.10
      Admin. Weight:10
      Physical BW:155520000 bits/sec
      Reservable BW:5000000 bits/sec
      BW unreserved[0]:2000000 bits/sec, BW unreserved[1]:100000 bits/sec
      BW unreserved[2]:100000 bits/sec, BW unreserved[3]:100000 bits/sec
      BW unreserved[4]:100000 bits/sec, BW unreserved[5]:100000 bits/sec
      BW unreserved[6]:100000 bits/sec, BW unreserved[7]:0 bits/sec
      Affinity Bits:0x00000000
```

Table 2 describes the significant fields shown in the display.

Table 2 debug isis mpls traffic-eng advertisements Field Descriptions

Field	Description
System ID	Identification value for the local system in the area.
Router ID	Multiprotocol Label Switching traffic engineering router ID.
Link Count	Number of links that MPLS traffic engineering advertised.
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	Bandwidth capacity of the link (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	Attribute flags of the link that are being flooded.

debug isis mpls traffic-eng events

To print information about traffic engineering-related Intermediate System-to-Intermediate System (IS-IS) events, use the **debug isis mpls traffic-eng events** command in privileged EXEC mode. To disable debugging output, use the **no** form of this command.

debug isis mpls traffic-eng events

no debug isis mpls traffic-eng events

Syntax Description

This command has no arguments or keywords.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.0(5)ST	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T.
12.0(22)S	This command was integrated into Cisco IOS Release 12.0(22)S.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

In the following example, information is printed about traffic engineering-related IS-IS events:

```
Router# debug isis mpls traffic-eng events

ISIS-RRR:Send MPLS TE Et4/0/1 Router1.02 adjacency down:address 0.0.0.0
ISIS-RRR:Found interface address 10.1.0.6 Router1.02, building subtlv... 58 bytes
ISIS-RRR:Found interface address 10.42.0.6 Router2.00, building subtlv... 64 bytes
ISIS-RRR:Interface address 0.0.0.0 Router1.00 not found, not building subtlv
ISIS-RRR:LSP Router1.02 changed from 0x606BCD30
ISIS-RRR:Mark LSP Router1.02 changed because TLV contents different, code 16
ISIS-RRR:Received 1 MPLS TE links flood info for system id Router1.00
```

debug mpls traffic-eng areas

To print information about traffic engineering area configuration change events, use the **debug mpls traffic-eng areas** command in privileged EXEC mode. To disable debugging output, use the **no** form of this command.

debug mpls traffic-eng areas

no debug mpls traffic-eng areas

Syntax Description

This command has no arguments or keywords.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.0(5)ST	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T.
12.0(22)S	This command was integrated into Cisco IOS Release 12.0(22)S.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

In the following example, information is printed about traffic engineering area configuration change events:

```
Router# debug mpls traffic-eng areas

TE-AREAS:isis level-1:up event
TE-PCALC_LSA:isis level-1
```

debug mpls traffic-eng autoroute

To print information about automatic routing over traffic engineering tunnels, use the **debug mpls traffic-eng autoroute** command in privileged EXEC mode. To disable debugging output, use the **no** form of this command.

debug mpls traffic-eng autoroute

no debug mpls traffic-eng autoroute

Syntax Description

This command has no arguments or keywords.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.0(5)ST	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T.
12.0(22)S	This command was integrated into Cisco IOS Release 12.0(22)S.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

In the following example, information is printed about automatic routing over traffic engineering tunnels:

```
Router# debug mpls traffic-eng autoroute

TE-Auto:announcement that destination 0001.0000.0003.00 has 1 tunnels
    Tunnel1 (traffic share 333, nexthop 10.112.0.12)
```

debug mpls traffic-eng link-management admission-control

To print information about traffic engineering label-switched path (LSP) admission control on traffic engineering interfaces, use the **debug mpls traffic-eng link-management admission-control** command in privileged EXEC mode. To disable debugging output, use the **no** form of this command.

debug mpls traffic-eng link-management admission-control [**detail**] [*acl-number*]

no debug mpls traffic-eng link-management admission-control [**detail**]

Syntax Description

detail	(Optional) Prints detailed debugging information.
acl-number	(Optional) Uses the specified access list to filter the debugging information. Prints information only for those LSPs that match the access list.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T, and the **detail** keyword and the *acl-number* argument were added.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

In the following example, information is printed about traffic engineering LSP admission control on traffic engineering interfaces:

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

TE-LM-ADMIT:tunnel 10.106.0.6 1_10002:created [total 4]
TE-LM-ADMIT:tunnel 10.106.0.6 1_10002: "None" -> "New"
TE-LM-ADMIT:tunnel 10.106.0.6 1_10002: "New" -> "Admitting 2nd Path Leg"
TE-LM-ADMIT:tunnel 10.106.0.6 1_10002: "Admitting 2nd Path Leg" -> "Path Admitted"
TE-LM-ADMIT:Admission control has granted Path query for 10.106.0.6 1_10002 (10.112.0.12)
on link Ethernet4/0/1 [reason 0]
TE-LM-ADMIT:tunnel 10.106.0.6 1_10002: "Path Admitted" -> "Admitting 1st Resv Leg"
TE-LM-ADMIT:tunnel 10.106.0.6 1_10002: "Admitting 1st Resv Leg" -> "Resv Admitted"
TE-LM-ADMIT:Admission control has granted Resv query for 10.106.0.6 1_10002 (10.112.0.12)
on link Ethernet4/0/1 [reason 0]
```

debug mpls traffic-eng link-management advertisements

To print information about resource advertisements for traffic engineering interfaces, use the **debug mpls traffic-eng link-management advertisements** command in privileged EXEC mode. To disable debugging output, use the **no** form of this command.

debug mpls traffic-eng link-management advertisements [**detail**] [*acl-number*]

no debug mpls traffic-eng link-management advertisements [**detail**] [*acl-number*]

Syntax Description

detail	(Optional) Prints detailed debugging information.
acl-number	(Optional) Uses the specified access list to filter the debugging information.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T. The **detail** keyword and the *acl-number* argument were added.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

In the following example, detailed debugging information is printed about resource advertisements for traffic engineering interfaces:

```
Router# debug mpls traffic-eng link-management advertisements detail

TE-LM-ADV:area isis level-1:IGP announcement:link Et4/0/1:info changed
TE-LM-ADV:area isis level-1:IGP msg:link Et4/0/1:includes subnet type (2), described nbrs
(1)
TE-LM-ADV:area isis level-1:IGP announcement:link Et4/0/1:info changed
TE-LM-ADV:area isis level-1:IGP msg:link Et4/0/1:includes subnet type (2), described nbrs
(1)
TE-LM-ADV:LSA:Flooding manager received message:link information change (Et4/0/1)
TE-LM-ADV:area isis level-1:*** Flooding node information ***
  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:     10.1.0.6
    IGP Neighbor:        ID 0001.0000.0001.02
    Admin. Weight:       10
    Physical Bandwidth:  10000 kbits/sec
```

```
    Max Reservable BW:   5000 kbits/sec
    Downstream::
      Reservable Bandwidth[0]:       5000 kbits/sec
      Reservable Bandwidth[1]:       2000 kbits/sec
      Reservable Bandwidth[2]:       2000 kbits/sec
      Reservable Bandwidth[3]:       2000 kbits/sec
      Reservable Bandwidth[4]:       2000 kbits/sec
      Reservable Bandwidth[5]:       2000 kbits/sec
      Reservable Bandwidth[6]:       2000 kbits/sec
Attribute Flags:  0x00000000
```

Table 3 describes the significant fields shown in the display.

Table 3 debug mpls traffic-eng link-management advertisements Field Descriptions

Field	Description
Flooding Protocol	Interior Gateway Protocol (IGB) that is flooding information for this area.
IGP System ID	Identification that IGP flooding uses in this area to identify this node.
MPLS TE Router ID	MPLS traffic engineering router ID.
Flooded Links	Number of links that are flooded in this area.
Link ID	Index of the link that is 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 Bandwidth	Link's bandwidth capacity (in kbps).
Max Reservable BW	Maximum amount of bandwidth that is currently available for reservation at this priority.
Reservable Bandwidth	Amount of bandwidth that is available for reservation.
Attribute Flags	Attribute flags of the link being flooded.

debug mpls traffic-eng link-management bandwidth-allocation

To print detailed information about bandwidth allocation for traffic engineering label-switched paths (LSPs), use the **debug mpls traffic-eng link-management bandwidth-allocation** command in privileged EXEC mode. To disable debugging output, use the **no** form of this command.

debug mpls traffic-eng link-management bandwidth-allocation [**detail**] [*acl-number*]

no debug mpls traffic-eng link-management bandwidth-allocation [**detail**] [*acl-number*]

Syntax Description

detail	(Optional) Prints detailed debugging information.
acl-number	(Optional) Uses the specified access list to filter the debugging information. Prints information only for those LSPs that match the access list.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T. The **detail** keyword and the *acl-number* argument were added.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

In the following example, information is printed about bandwidth allocation for traffic engineering LSPs:

```
Router# debug mpls traffic-eng link-management bandwidth-allocation

TE-LM-BW:tunnel 10.106.0.6 1_10002:requesting Downstream bw hold (3000000 bps [S]) on link
Et4/0/1
TE-LM-BW:tunnel 10.106.0.6 1_10002:Downstream bw hold request succeeded
TE-LM-BW:tunnel 10.106.0.6 1_10002:requesting Downstream bw lock (3000000 bps [S]) on link
Et4/0/1
TE-LM-BW:tunnel 10.106.0.6 1_10002:Downstream bw lock request succeeded×_„Rs
```

Related Commands

Command	Description
debug mpls traffic-eng link-management admission-control	Prints information about traffic engineering LSP admission control on traffic engineering interfaces.
debug mpls traffic-eng link-management errors	Prints information about errors encountered during any traffic engineering link management procedure.

debug mpls traffic-eng link-management errors

To print information about errors encountered during any traffic engineering link management procedure, use the **debug mpls traffic-eng link-management errors** command in privileged EXEC mode. To disable debugging output, use the **no** form of this command.

debug mpls traffic-eng link-management errors [**detail**]

no debug mpls traffic-eng link-management errors [**detail**]

Syntax Description

detail	(Optional) Prints detailed debugging information.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.1(3)T	This command was introduced.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.0(22)S	This command was integrated into Cisco IOS Release 12.0(22)S.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

In the following example, detailed debugging information is printed about errors encountered during a traffic engineering link management procedure:

```
Router# debug mpls traffic-eng link-management errors detail

00:04:48 TE-LM-ROUTING: link Et1/1/1: neighbor 0010.0000.0012.01: add to IP peer db failed
```

Related Commands

Command	Description
debug mpls traffic-eng link-management admission-control	Prints information about traffic engineering LSP admission control on traffic engineering interfaces.
debug mpls traffic-eng link-management advertisements	Prints information about resource advertisements for traffic engineering interfaces.
debug mpls traffic-eng link-management bandwidth-allocation	Prints information about bandwidth allocation for traffic engineering LSPs.
debug mpls traffic-eng link-management events	Prints information about traffic engineering link management system events.

Command	Description
debug mpls traffic-eng link-management igp-neighbors	Prints information about changes to the link management databases of IGP neighbors.
debug mpls traffic-eng link-management links	Prints information about traffic engineering link management interface events.

debug mpls traffic-eng link-management events

To print information about traffic engineering link management system events, use the **debug mpls traffic-eng link-management events** command in privileged EXEC mode. To disable debugging output, use the **no** form of this command.

debug mpls traffic-eng link-management events [**detail**]

no debug mpls traffic-eng link-management events [**detail**]

Syntax Description

detail	(Optional) Prints detailed debugging information.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T and the **detail** keyword was added.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

In the following example, detailed debugging information is printed about traffic engineering link management system events:

```
Router# debug mpls traffic-eng link-management events detail

TE-LM-EVENTS:stopping MPLS TE Link Management process
TE-LM-EVENTS:MPLS TE Link Management process dying now
```

debug mpls traffic-eng link-management igp-neighbors

To print information about changes to the link management database of Interior Gateway Protocol (IGP) neighbors, use the **debug mpls traffic eng link-management igp-neighbors** command in privileged EXEC mode. To disable debugging output, use the **no** form of this command.

debug mpls traffic-eng link-management igp-neighbors [**detail**]

no debug mpls traffic-eng link-management igp-neighbors [**detail**]

Syntax Description

detail	(Optional) Prints detailed debugging information.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T and the **detail** keyword was added.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

In the following example, detailed debugging information is printed about changes to the link management database of IGP neighbors:

```
Router# debug mpls traffic-eng link-management igp-neighbors detail

TE-LM-NBR:link AT0/0.2:neighbor 0001.0000.0002.00:created (isis level-1, 10.42.0.10,
Up)[total 2]
```

Related Commands

Command	Description
debug mpls traffic-eng link-management events	Prints information about traffic engineering-related ISIS events.

debug mpls traffic-eng link-management links

To print information about traffic engineering link management interface events, use the **debug mpls traffic-eng link-management links** command in privileged EXEC mode. To disable debugging output, use the **no** form of this command.

debug mpls traffic-eng link-management links [**detail**]

no debug mpls traffic-eng link-management links [**detail**]

Syntax Description

detail	(Optional) Prints detailed debugging information.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T and the **detail** keyword was added.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

In the following example, detailed debugging information is printed about traffic engineering link management interface events:

```
Router# debug mpls traffic-eng link-management links detail

TE-LM-LINKS:link AT0/0.2:RSVP enabled
TE-LM-LINKS:link AT0/0.2:increasing RSVP bandwidth from 0 to 5000000
TE-LM-LINKS:link AT0/0.2:created [total 2]
TE-LM-LINKS:Binding MPLS TE LM Admission Control as the RSVP Policy Server on ATM0/0.2
TE-LM-LINKS:Bind attempt succeeded
TE-LM-LINKS:link AT0/0.2:LSP tunnels enabled
```

debug mpls traffic-eng link-management preemption

To print information about traffic engineering label-switched path (LSP) preemption, use the **debug mpls traffic-eng link-management preemption** command in privileged EXEC mode. To disable debugging output, use the **no** form of this command.

debug mpls traffic-eng link-management preemption [**detail**]

no debug mpls traffic-eng link-management preemption [**detail**]

Syntax Description

detail	(Optional) Prints detailed debugging information.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.1(3)T	This command was introduced.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

In the following example, detailed debugging information is printed about traffic engineering LSP preemption:

```
Router# debug mpls traffic-eng link-management preemption detail

TE-LM-BW:preempting Downstream bandwidth, 1000000, for tunnel 10.106.0.6 2_2
TE-LM-BW:building preemption list to get bandwidth, 1000000, for tunnel 10.106.0.6 2_2
(priority 0)
TE-LM-BW:added bandwidth, 3000000, from tunnel 10.106.0.6 1_2 (pri 1) to preemption list
TE-LM-BW:preemption list build to get bw, 1000000, succeeded (3000000)
TE-LM-BW:preempting bandwidth, 1000000, using plist with 1 tunnels
TE-LM-BW:tunnel 10.106.0.6 1_2:being preempted on AT0/0.2 by 10.106.0.6 2_2
TE-LM-BW:preemption of Downstream bandwidth, 1000000, succeeded
```

debug mpls traffic-eng link-management routing

To print information about traffic engineering link management routing resolutions that can be performed to help Resource Reservation Protocol (RSVP) interpret explicit route objects, use the **debug mpls traffic-eng link-management routing** command in privileged EXEC mode. To disable debugging output, use the **no** form of this command.

debug mpls traffic-eng link-management routing [**detail**]

no debug mpls traffic-eng link-management routing [**detail**]

Syntax Description

detail	(Optional) Prints detailed debugging information.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T and the **detail** keyword was added.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

In the following example, detailed debugging information is printed about traffic engineering link management routing resolutions that can be performed to help RSVP interpret explicit route objects:

```
Router# debug mpls traffic-eng link-management routing detail

TE-LM-ROUTING:route options to 10.42.0.10:building list (w/ nhop matching)
TE-LM-ROUTING:route options to 10.42.0.10:adding {AT0/0.2, 10.42.0.10}
TE-LM-ROUTING:route options to 10.42.0.10:completed list has 1 links
```

Related Commands

Command	Description
debug ip rsvp	Prints information about RSVP signalling events.

debug mpls traffic-eng load-balancing

To print information about unequal cost load balancing over traffic engineering tunnels, use the **debug mpls traffic-eng load-balancing** command in privileged EXEC mode. To disable debugging output, use the **no** form of this command.

debug mpls traffic-eng load-balancing

no debug mpls traffic-eng load-balancing

Syntax Description

This command has no arguments or keywords.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.0(5)ST	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T.
12.0(22)S	This command was integrated into Cisco IOS Release 12.0(22)S.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

In the following example, information is printed about unequal cost load balancing over traffic engineering tunnels:

```
Router# debug mpls traffic-eng load-balancing

TE-Load:10.210.0.0/16, 2 routes, loadbalancing based on MPLS TE bandwidth
TE-Load:10.200.0.0/16, 2 routes, loadbalancing based on MPLS TE bandwidth
```

debug mpls traffic-eng path

To print information about traffic engineering path calculation, use the **debug mpls traffic-eng path** command in privileged EXEC mode. To disable debugging output, use the **no** form of this command.

debug mpls traffic-eng path {*num* | **lookup** | **spf** | **verify**}

no debug mpls traffic-eng path {*num* | **lookup** | **spf** | **verify**}

Syntax Description

num	Prints path calculation information only for the local tunneling interface with unit number *num*.
lookup	Prints information for path lookups.
spf	Prints information for shortest path first (SPF) calculations.
verify	Prints information for path verifications.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.0(5)ST	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T.
12.0(22)S	This command was integrated into Cisco IOS Release 12.0(22)S.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

In the following example, information is printed about the calculation of the traffic engineering path:

```
Router# debug mpls traffic-eng path lookup

TE-PCALC:Tunnel1000 Path Setup to 10.110.0.10:FULL_PATH
TE-PCALC:bw 0, min_bw 0, metric:0
TE-PCALC:setup_pri 0, hold_pri 0
TE-PCALC:affinity_bits 0x0, affinity_mask 0xFFFF
TE-PCALC_PATH:create_path_hoplist:ip addr 10.42.0.6 unknown.
```

debug mpls traffic-eng topology change

To print information about traffic engineering topology change events, use the **debug mpls traffic-eng topology change** command in privileged EXEC mode. To disable debugging output, use the **no** form of this command.

debug mpls traffic-eng topology change

no debug mpls traffic-eng topology change

Syntax Description

This command has no arguments or keywords.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.0(5)ST	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T.
12.0(22)S	This command was integrated into Cisco IOS Release 12.0(22)S.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

In the following example, information is printed about traffic engineering topology change events:

```
Router# debug mpls traffic-eng topology change

TE-PCALC_LSA:NODE_CHANGE_UPDATE isis level-1
        link flags:LINK_CHANGE_BW
        system_id:0001.0000.0001.00, my_ip_address:10.42.0.6
        nbr_system_id:0001.0000.0002.00, nbr_ip_address 10.42.0.10
```

debug mpls traffic-eng topology lsa

To print information about traffic engineering topology link state advertisement (LSA) events, use the **debug mpls traffic-eng topology lsa** command in privileged EXEC mode. To disable debugging output, use the **no** form of this command.

debug mpls traffic-eng topology lsa

no debug mpls traffic-eng topology lsa

Syntax Description

This command has no arguments or keywords.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.0(5)ST	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T.
12.0(22)S	This command was integrated into Cisco IOS Release 12.0(22)S.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

In the following example, information is printed about traffic engineering topology LSA events:

```
Router# debug mpls traffic-eng topology lsa

TE-PCALC_LSA:node_lsa_add:Received a LSA:flags 0x1 !

IGP Id:0001.0000.0001.00, MPLS TE Id:10.106.0.6 is VALID has 2 links (frag_id 0)
      link[0 ]:Nbr IGP Id:0001.0000.0001.02
          frag_id 0, Intf Address:0.0.0.0
          admin_weight:10, attribute_flags:0x0

      link[1 ]:Nbr IGP Id:0001.0000.0002.00
          frag_id 0, Intf Address:10.42.0.6, Nbr Intf Address:10.42.0.10
          admin_weight:100, attribute_flags:0x0
TE-PCALC_LSA:(isis level-1):Received lsa:

IGP Id:0001.0000.0001.00, MPLS TE Id:10.106.0.6 Router Node  id 8
      link[0 ]:Nbr IGP Id:0001.0000.0002.00, nbr_node_id:9, gen:114
          frag_id 0, Intf Address:10.42.0.6, Nbr Intf Address:10.42.0.10
          admin_weight:100, attribute_flags:0x0
          physical_bw:155520 (kbps), max_reservable_bw:5000 (kbps)
               allocated_bw   reservable_bw      allocated_bw   reservable_bw
               ------------   -------------      ------------   -------------
        bw[0]:0              5000         bw[1]:3000           2000
        bw[2]:0              2000         bw[3]:0              2000
        bw[4]:0              2000         bw[5]:0              2000
        bw[6]:0              2000         bw[7]:0              2000
```

debug mpls traffic-eng tunnels errors

To print information about errors encountered during any traffic engineering tunnel management procedure, use the **debug mpls traffic-eng tunnels errors** command in privileged EXEC mode. To disable debugging output, use the **no** form of this command.

debug mpls traffic-eng tunnels errors [**detail**]

no debug mpls traffic-eng tunnels errors [**detail**]

Syntax Description

detail	(Optional) Prints detailed debugging information.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.1(3)T	This command was introduced.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.0(22)S	This command was integrated into Cisco IOS Release 12.0(22)S.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

In the following example, detailed debugging information is printed about errors encountered during a traffic engineering tunnel management procedure:

```
Router# debug mpls traffic-eng tunnels errors

00:04:14: LSP-TUNNEL-SIG: Tunnel10012[1]: path verification failed (unprotected) [Can't
use link 10.12.4.4 on node 10.0.0.4]
```

debug mpls traffic-eng tunnels events

To print information about traffic engineering tunnel management system events, use the **debug mpls traffic-eng tunnels events** command in privileged EXEC mode. To disable debugging output, use the **no** form of this command.

debug mpls traffic-eng tunnels events [**detail**]

no debug mpls traffic-eng tunnels events [**detail**]

Syntax Description

detail	(Optional) Prints detailed debugging information.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T and the **detail** keyword was added.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

In the following example, detailed debugging information is printed about traffic engineering tunnel management system events:

```
Router# debug mpls traffic-eng tunnels events detail

LSP-TUNNEL:received event:interface admin. down [Ethernet4/0/1]
LSP-TUNNEL:posting action(s) to all-tunnels:
              check static LSPs
LSP-TUNNEL:scheduling pending actions on all-tunnels
LSP-TUNNEL:applying actions to all-tunnels, as follows:
              check static LSPs
```

debug mpls traffic-eng tunnels labels

To print information about Multiprotocol Label Switching (MPLS) label management for traffic engineering tunnels, use the **debug mpls traffic-eng tunnels labels** command in privileged EXEC mode. To disable debugging output, use the **no** form of this command.

debug mpls traffic-eng tunnels labels [**detail**] [*acl-number*]

no debug mpls traffic-eng tunnels labels [**detail**] [*acl-number*]

Syntax Description

detail	(Optional) Prints detailed debugging information.
acl-number	(Optional) Uses the specified access list to filter the debugging information. Prints information only about traffic engineering tunnels that match the access list.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T, and the **detail** keyword and the *acl-number* argument were added.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

In the following example, detailed debugging information is printed about MPLS label management for traffic engineering tunnels:

```
Router# debug mpls traffic-eng tunnels labels detail

LSP-TUNNEL-LABELS:tunnel 10.106.0.6 1 [2]:fabric PROGRAM request
LSP-TUNNEL-LABELS:tunnel 10.106.0.6 1 [2]:programming label 16 on output interface
ATM0/0.2
LSP-TUNNEL-LABELS:descriptor 71FA64:continuing "Program" request
LSP-TUNNEL-LABELS:descriptor 71FA64:set "Interface Point Out State" to, allocated
LSP-TUNNEL-LABELS:# of resource points held for "default" interfaces:2
LSP-TUNNEL-LABELS:descriptor 71FA64:set "Fabric State" to, enabled
LSP-TUNNEL-LABELS:descriptor 71FA64:set "Fabric Kind" to, default (LFIB)
LSP-TUNNEL-LABELS:descriptor 71FA64:set "Fabric State" to, set
LSP-TUNNEL-LABELS:tunnel 10.106.0.6 1 [2]:fabric PROGRAM reply
```

To restrict output to information about a single tunnel, you can configure an access list and supply it to the **debug** command. Configure the access list as follows:

```
Router(config-ext-nacl)# permit udp host scr_address host dst_address eq tun intfc
```

For example, if tunnel 10012 has destination 10.0.0.11 and source 10.0.0.4, as determined by the **show mpls traffic-eng tunnels** command, the following access list could be configured and added to the **debug** command:

```
Router(config-ext-nacl)# permit udp host 10.0.0.4 10.0.0.11 eq 10012
```

debug mpls traffic-eng tunnels reoptimize

To print information about traffic engineering tunnel reoptimizations, use the **debug mpls traffic-eng tunnels reoptimize** command in privileged EXEC mode. To disable debugging output, use the **no** form of this command.

debug mpls traffic-eng tunnels reoptimize [**detail**] [*acl-number*]

no debug mpls traffic-eng tunnels reoptimize [**detail**] [*acl-number*]

Syntax Description

detail	(Optional) Prints detailed debugging information.
acl-number	(Optional) Uses the specified access list to filter the debugging information. Prints information about only those traffic engineering tunnel reoptimizations that match the access list.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T, and the **detail** keyword and the *acl-number* argument were added.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

In the following example, detailed debugging information is printed about traffic engineering tunnel reoptimizations that match access list number 101:

```
Router# debug mpls traffic-eng tunnels reoptimize detail 101

LSP-TUNNEL-REOPT:Tunnel1 curr option 2 (0x6175CF8C), activate new option 2
LSP-TUNNEL-REOPT:Tunnel1 new path:option 2 [10002], weight 20
LSP-TUNNEL-REOPT:Tunnel1 old path:option 2 [2], weight 110
LSP-TUNNEL-REOPT:Tunnel1 [10002] set as reopt
LSP-TUNNEL-REOPT:Tunnel1 path option 2 [10002] installing as current
LSP-TUNNEL-REOPT:Tunnel1 [2] removed as current
LSP-TUNNEL-REOPT:Tunnel1 [2] set to delayed clean
LSP-TUNNEL-REOPT:Tunnel1 [10002] removed as reopt
LSP-TUNNEL-REOPT:Tunnel1 [10002] set to current
```

debug mpls traffic-eng tunnels signalling

To print information about traffic engineering tunnel signalling operations, use the **debug mpls traffic-eng tunnels signalling** command in privileged EXEC mode. To disable debugging output, use the **no** form of this command.

debug mpls traffic-eng tunnels signalling [**detail**] [*acl-number*]

no debug mpls traffic-eng tunnels signalling [**detail**] [*acl-number*]

Syntax Description

detail	(Optional) Prints detailed debugging information.
acl-number	(Optional) Uses the specified access list to filter the debugging information. Prints information about only those traffic engineering tunnel signalling operations that match the access list.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T, and the **detail** keyword and the *acl-number* argument were added.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

In the following example, detailed debugging information is printed about traffic engineering tunnel signalling operations that match access list number 101:

```
Router# debug mpls traffic-eng tunnels signalling detail 101

LSP-TUNNEL-SIG:tunnel Tunnel1 [2]:RSVP head-end open
LSP-TUNNEL-SIG:tunnel Tunnel1 [2]:received Path NHOP CHANGE
LSP-TUNNEL-SIG:Tunnel1 [2]:first hop change:0.0.0.0 --> 10.1.0.10
LSP-TUNNEL-SIG:received ADD RESV request for tunnel 10.106.0.6 1 [2]
LSP-TUNNEL-SIG:tunnel 10.106.0.6 1 [2]:path next hop is 10.1.0.10 (Et4/0/1)
LSP-TUNNEL-SIG:Tunnel1 [2] notified of new label information
LSP-TUNNEL-SIG:sending ADD RESV reply for tunnel 10.106.0.6 1 [2]
```

debug mpls traffic-eng tunnels state

To print information about state maintenance for traffic engineering tunnels, use the **debug mpls traffic-eng tunnels state** command in privileged EXEC mode. To disable debugging output, use the **no** form of this command.

debug mpls traffic-eng tunnels state [**detail**] [*acl-number*]

no debug mpls traffic-eng tunnels state [**detail**] [*acl-number*]

Syntax Description

detail	(Optional) Prints detailed debugging information.
acl-number	(Optional) Uses the specified access list to filter the debugging information. Prints information about state maintenance for traffic engineering tunnels that match the access list.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.1(3)T	This command was introduced.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.0(22)S	This command was integrated into Cisco IOS Release 12.0(22)S.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

In the following example, detailed debugging information is printed about state maintenance for traffic engineering tunnels that match access list number 99:

```
Router# debug mpls traffic-eng tunnels state detail 99

LSP-TUNNEL:tunnel 10.106.0.6 1 [2]: "Connected" -> "Disconnected"
LSP-TUNNEL:Tunnel1 received event:LSP has gone down
LSP-TUNNEL:tunnel 10.106.0.6 1 [2]: "Disconnected" -> "Dead"
LSP-TUNNEL-SIG:Tunnel1:changing state from up to down
LSP-TUNNEL:tunnel 10.106.0.6 1 [2]: "Dead" -> "Connected"
```

debug mpls traffic-eng tunnels timers

To print information about traffic engineering tunnel timer management, use the **debug mpls traffic-eng tunnels timers** command in privileged EXEC mode. To disable debugging output, use the **no** form of this command.

debug mpls traffic-eng tunnels timers [**detail**] [*acl-number*]

no debug mpls traffic-eng tunnels timers [**detail**] [*acl-number*]

Syntax Description

detail	(Optional) Prints detailed debugging information.
acl-number	(Optional) Uses the specified access list to filter the debugging information. Prints information about traffic engineering tunnel timer management that matches the access list.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T, and the **detail** keyword and the *acl-number* argument were added.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

In the following example, detailed debugging information is printed about traffic engineering tunnel timer management:

```
Router# debug mpls traffic-eng tunnels timers detail

LSP-TUNNEL-TIMER:timer fired for Action Scheduler
LSP-TUNNEL-TIMER:timer fired for Tunnel Head Checkup
```

index

To insert or modify a path entry at a specific index, use the **index** command in IP explicit path configuration mode. To remove the path entry at the specified index, use the **no** form of this command.

index *index command*

no index *index*

Syntax Description

index	Index number at which the path entry will be inserted or modified. Valid values are from 0 to 65534.
command	An IP explicit path configuration command that creates or modifies a path entry. (Currently you can use only the **next-address** command.)

Defaults

This command is disabled.

Command Modes

IP explicit path configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

The following example shows how to insert the next address at index 6:

```
Router(cfg-ip-expl-path)# index 6 next-address 10.3.29.3

Explicit Path identifier 6:
    6: next-address 10.3.29.3
```

Related Commands

Command	Description
append-after	Inserts the new path entry after the specified index number. Commands might be renumbered as a result.
interface fastethernet	Enters the command mode for IP explicit paths and creates or modifies the specified path.
list	Displays all or part of the explicit paths.
next-address	Specifies the next IP address in the explicit path.
show ip explicit-paths	Displays the configured IP explicit paths.

ip explicit-path

To enter the command mode for IP explicit paths and create or modify the specified path, use the **ip explicit-path** command in router configuration mode. An IP explicit path is a list of IP addresses, each representing a node or link in the explicit path. To disable this feature, use the **no** form of this command.

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

no explicit-path {**name** *word* | **identifier** *number*}

Syntax Description

name *word*	Name of the explicit path.
identifier *number*	Number of the explicit path. Valid values are from 1 to 65535.
enable	(Optional) Enables the path.
disable	(Optional) Prevents the path from being used for routing while it is being configured.

Command Modes

Router configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

The following example shows how to enter the explicit path command mode for IP explicit paths and creates a path numbered 500:

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

Related Commands

Command	Description
append-after	Inserts the new path entry after the specified index number. Commands might be renumbered as a result.
index	Inserts or modifies a path entry at a specific index.
ip route vrf	Displays all or part of the explicit paths.
next-address	Specifies the next IP address in the explicit path.
show ip explicit-paths	Displays the configured IP explicit paths.

list

To show all or part of the explicit path or paths, use the **list** command in IP explicit path configuration mode.

list [*starting-index-number*]

Syntax Description

starting-index-number	(Optional) Index number at which the explicit path(s) will start to be displayed. Valid values are from 1 to 65535.

Defaults

Explicit paths are not shown.

Command Modes

IP explicit path configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

The following example shows how to list the explicit path:

```
Router(cfg-ip-expl-path)# list

Explicit Path name abc:
    1:next-address 10.0.0.1
    2:next-address 10.0.0.2
```

The following example shows how to list the explicit path starting at index number 2:

```
Router(cfg-ip-expl-path)# list 2

Explicit Path name abc:
    2:next-address 10.0.0.2
Router(cfg-ip-expl-path)#
```

Related Commands

Command	Description
append-after	Inserts the new path entry after the specified index number. Commands might be renumbered as a result.
index	Inserts or modifies a path entry at a specific index.
ip explicit-path	Enters the command mode for IP explicit paths, and creates or modifies the specified path.

Command	Description
next-address	Specifies the next IP address in the explicit path.
show ip explicit-paths	Displays the configured IP explicit paths.

metric-style narrow

To configure a router running Intermediate System-to-Intermediate System (IS-IS) so that it generates and accepts old-style type, length, and value objects (TLVs), use the **metric-style narrow** command in router configuration mode. To disable this function, use the **no** form of this command.

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

no 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	(Optional) Enables this command on routing level 1.
level-2	(Optional) Enables this command on routing level 2.
level-1-2	(Optional) Enables this command on routing levels 1 and 2.

Defaults

The Multiprotocol Label Switching (MPLS) traffic engineering image generates only old-style TLVs. To do MPLS traffic engineering, a router must generate new-style TLVs that have wider metric fields.

Command Modes

Router configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

The following example shows how to configure the router to generate and accept old-style TLVs on router level 1:

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

Related Commands

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

metric-style transition

To configure a router running Intermediate System-to-Intermediate System (IS-IS) so that it generates and accepts both old-style and new-style type, length, and value objects (TLVs), use the **metric-style transition** command in router configuration mode. To disable this function, use the **no** form of this command.

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

no metric-style transition [**level-1** | **level-2** | **level-1-2**]

Syntax Description

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

Defaults

The Multiprotocol Label Switching (MPLS) traffic engineering image generates only old-style TLVs. To do MPLS traffic engineering, a router must generate new-style TLVs that have wider metric fields.

Command Modes

Router configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

The following example shows how to configure a router to generate and accept both old-style and new-style TLVs on router level 2:

```
Router(config-router)# 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 running Intermediate System-to-Intermediate System (IS-IS) so that it generates and accepts only new-style type, length, and value objects (TLVs), use the **metric-style wide** command in router configuration mode. To disable this function, use the **no** form of this command.

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

no 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	(Optional) Enables this command on routing level 1.
level-2	(Optional) Enables this command on routing level 2.
level-1-2	(Optional) Enables this command on routing levels 1 and 2.

Defaults

The Multiprotocol Label Switching (MPLS) traffic engineering image generates only old-style TLVs. To do MPLS traffic engineering, a router must generate new-style TLVs that have wider metric fields.

Command Modes

Router configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Usage Guidelines

If you enter the **metric-style wide** command, a router generates and accepts only new-style TLVs. Therefore, the router uses less memory and other resources than it would if it generated 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 toward traffic engineering deployment. Other commands and models could be appropriate if the new-style TLVs are desired for other reasons. For example, a network might require wider metrics, but might not use traffic engineering.

Examples

The following example shows how to configure a router to generate and accept only new-style TLVs on level 1:

```
Router(config-router)# 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 configure a router running Intermediate System-to-Intermediate System (IS-IS) so that it floods Multiprotocol Label Switching (MPLS) traffic engineering (TE) link information into the indicated IS-IS level, use the **mpls traffic-eng** command in router configuration mode. To disable the flooding of MPLS TE link information into the indicated IS-IS level, use the **no** form of this command.

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

no mpls traffic-eng {**level-1** | **level-2**}

Syntax Description

level-1	Floods MPLS TE link information into IS-IS level 1.
level-2	Floods MPLS TE link information into IS-IS level 2.

Defaults

Flooding is disabled.

Command Modes

Router configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Usage Guidelines

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

Examples

The following example shows how to configure MPLS TE link information flooding for IS-IS level 1:

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

Related Commands

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

mpls traffic-eng administrative-weight

To override the Interior Gateway Protocol (IGP) administrative weight (cost) of the link, use the **mpls traffic-eng administrative-weight** command in interface configuration mode. To disable the override, use the **no** form of this command.

mpls traffic-eng administrative-weight *weight*

no mpls traffic-eng administrative-weight

Syntax Description

weight	Cost of the link.

Defaults

IGP cost of the link.

Command Modes

Interface configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

The following example shows how to override the IGP cost of the link and set 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 area

To configure a router running Open Shortest Path First (OSPF) Multiprotocol Label Switching (MPLS) so that it floods traffic engineering for the indicated OSPF area, use the **mpls traffic-eng area** command in router configuration mode. To disable flooding of traffic engineering for the indicated OSPF area, use the **no** form of this command.

mpls traffic-eng area *number*

no mpls traffic-eng area *number*

Syntax Description

number	The OSPF area on which MPLS traffic engineering is enabled.

Defaults

Flooding is disabled.

Command Modes

Router configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Usage Guidelines

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

Examples

The following example shows how to configure a router running OSPF MPLS to flood traffic engineering for OSPF 0:

```
Router(config-router)# mpls traffic-eng area 0
```

Related Commands

Command	Description
mpls traffic-eng router-id	Specifies that the traffic engineering router identifier for the node is the IP address associated with a given interface.
network area	Defines the interfaces on which OSPF runs and defines the area ID for those interfaces.
router ospf	Configures an OSPF routing process on a router.

mpls traffic-eng attribute-flags

To set the user-specified attribute flags for the interface, use the **mpls traffic-eng attribute-flags** command in interface configuration mode. To disable the user-specified attribute flags for the interface, use the **no** form of this command.

mpls traffic-eng attribute-flags *attributes*

no mpls traffic-eng attribute-flags

Syntax Description

attributes	Links attributes that will be compared to a tunnel's affinity bits during selection of a path. Valid values are from 0x0 to 0xFFFFFFFF, representing 32 attributes (bits) where the value of an attribute is 0 or 1.

Defaults

0x0

Command Modes

Interface configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Usage Guidelines

This command assigns attributes to a link so that tunnels with matching attributes (represented by their affinity bits) prefer this link instead of others that do not match.

The interface is flooded globally so that it can be used as a tunnel head-end path selection criterion.

Examples

The following example shows how to set the attribute flags to 0x0101:

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

Related Commands

Command	Description
mpls traffic-eng administrative-weight	Overrides the IGP administrative weight of the link.
tunnel mpls traffic-eng affinity	Configures affinity (the properties that the tunnel requires in its links) for an MPLS traffic engineering tunnel.

mpls traffic-eng flooding thresholds

To set a reserved bandwidth thresholds for a link, use the **mpls traffic-eng flooding thresholds** command in interface configuration mode. 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**}

Syntax Description

down	Sets the thresholds for decreased reserved bandwidth.
up	Sets the thresholds for increased reserved bandwidth.
percent [*percent*]	Bandwidth threshold level. For the **down** keyword, valid values are from 0 through 99. For the **up** keyword, valid values are from 1 through 100.

Defaults

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 Modes

Interface configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Usage Guidelines

When a threshold is crossed, Multiprotocol Label Switching (MPLS) traffic engineering link management advertises updated link information. If no thresholds are crossed, changes can be flooded periodically unless periodic flooding was disabled.

Examples

The following example shows how to set the reserved bandwidth of the link for decreased (down) and for increased (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	Displays 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	Displays current local link information.

mpls traffic-eng link-management timers bandwidth-hold

To set the length of time that bandwidth is held for an RSVP path (setup) message while you wait for the corresponding RSVP Resv message to come back, use the **mpls traffic-eng link-management timers bandwidth-hold** command in global configuration mode. To disable this function, use the **no** form of this command.

mpls traffic-eng link-management timers bandwidth-hold *seconds*

no mpls traffic-eng link-management timers bandwidth-hold

Syntax Description

seconds	Length of time that bandwidth can be held. Valid values are from 1 to 300 seconds.

Defaults

15 seconds

Command Modes

Global configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

In the following example, bandwidth is set to be held for 10 seconds:

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

Related Commands

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

mpls traffic-eng link-management timers periodic-flooding

To set the length of the interval for periodic flooding, use the **mpls traffic-eng link-management timers periodic-flooding** command in global configuration mode. To disable the specified interval length for periodic flooding, use the **no** form of this command.

mpls traffic-eng link-management timers periodic-flooding *seconds*

no mpls traffic-eng link-management timers periodic-flooding

Syntax Description

seconds	Length of the interval (in seconds) for periodic flooding. Valid values are from 0 to 3600. A value of 0 turns off periodic flooding. If you set this value from 1 to 29, it is treated as 30.

Defaults

180 seconds (3 minutes)

Command Modes

Global configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Usage Guidelines

Use this command to advertise link state information changes that do not trigger immediate action. For example, a change to the amount of allocated bandwidth that does not cross a threshold.

Examples

The following example shows how to set the interval length for periodic flooding to 120 seconds:

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

Related Commands

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

mpls traffic-eng logging lsp

To log certain traffic engineering label switched path (LSP) events, use the **mpls traffic-eng logging lsp** command in global configuration mode. To disable logging of LSP events, use the **no** form of this command.

mpls traffic-eng logging lsp {**path-errors** | **reservation-errors** | **preemption** | **setups** | **teardowns**} [*acl-number*]

no mpls traffic-eng logging lsp {**path-errors** | **reservation-errors** | **preemption** | **setups** | **teardowns**} [*acl-number*]

Syntax Description

path-errors	Logs RSVP path errors for traffic engineering LSPs.
reservation-errors	Logs RSVP reservation errors for traffic engineering LSPs.
preemption	Logs events related to the preemption of traffic engineering LSPs.
setups	Logs events related to the establishment of traffic engineering LSPs.
teardowns	Logs events related to the removal of traffic engineering LSPs.
acl-number	(Optional) Uses the specified access list to filter the events that are logged. Logs events only for LSPs that match the access list.

Defaults

Logging of LSP events is disabled.

Command Modes

Global configuration

Command History

Release	Modification
12.1(3)T	This command was introduced.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.0(22)S	This command was integrated into Cisco IOS Release 12.0(22)S.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

The following example shows how to log path errors for LSPs that match access list 3:

```
Router(config)# mpls traffic-eng logging lsp path-errors 3
```

Related Commands

Command	Description
access-list (extended)	Defines an extended IP access list.
logging console	Limits the number of messages logged to the console.
mpls traffic-eng logging tunnel	Logs certain traffic engineering tunnel events.
show logging	Displays the messages that are logged in the buffer.

mpls traffic-eng logging tunnel

To log certain traffic engineering tunnel events, use the **mpls traffic-eng logging tunnel** command in global configuration mode. To disable logging of traffic engineering tunnel events, use the **no** form of this command.

mpls traffic-eng logging tunnel lsp-selection [*acl-number*]

no mpls traffic-eng logging tunnel lsp-selection [*acl-number*]

Syntax Description

lsp-selection	Logs events related to the selection of a label switched path (LSP) for a traffic engineering tunnel.
acl-number	(Optional) Uses the specified access list to filter the events that are logged. Logs events only for tunnels that match the access list.

Defaults

Logging of tunnel events is disabled.

Command Modes

Global configuration

Command History

Release	Modification
12.1(3)T	This command was introduced.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.0(22)S	This command was integrated into Cisco IOS Release 12.0(22)S.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

The following example shows how to log traffic engineering tunnel events associated with access list 3:

```
Router(config)# mpls traffic-eng logging tunnel lsp-selection 3
```

Related Commands

Command	Description
access-list (extended)	Creates an extended access list.
logging console	Limits the number of messages logged to the console.
mpls traffic-eng logging lsp	Logs certain traffic engineering LSP events.
show logging	Displays the messages that are logged in the buffer.

mpls traffic-eng reoptimize

To force immediate reoptimization of all traffic engineering tunnels, use the **mpls traffic-eng reoptimize** command in privileged EXEC mode.

mpls traffic-eng reoptimize

Syntax Description

This command has no arguments or keywords.

Command Modes

Privileged EXEC

Command History

Release	Modification
12.0(5)ST	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T.
12.0(22)S	This command was integrated into Cisco IOS Release 12.0(22)S.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

The following example shows how to reoptimize all traffic engineering tunnels immediately:

```
Router# mpls traffic-eng reoptimize
```

mpls traffic-eng reoptimize events

To turn on automatic reoptimization of Multiprotocol Label Switching (MPLS) traffic engineering when certain events occur, such as when an interface becomes operational, use the **mpls traffic-eng reoptimize events** command in global configuration mode. To disable automatic reoptimization, use the **no** form of this command.

mpls traffic-eng reoptimize events link-up

no mpls traffic-eng reoptimize events link-up

Syntax Description

link-up	Triggers automatic reoptimization whenever an interface becomes operational.

Defaults

Event-based reoptimization is disabled.

Command Modes

Global configuration

Command History

Release	Modification
12.1(3)T	This command was introduced.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.0(22)S	This command was integrated into Cisco IOS Release 12.0(22)S.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

The following example shows how to turn on automatic reoptimization whenever an interface becomes operational:

```
Router(config)# mpls traffic-eng reoptimize events link-up
```

Related Commands

Command	Description
mpls traffic-eng logging lsp	Controls the frequency with which tunnels with established LSPs are checked for better LSPs.
mpls traffic-eng reoptimize	Reoptimizes all traffic engineering tunnels immediately.

mpls traffic-eng reoptimize timers frequency

To control the frequency with which tunnels with established label switched paths (LSPs) are checked for better LSPs, use the **mpls traffic-eng reoptimize timers frequency** command in global configuration mode. To disable this function, use the **no** form of this command.

mpls traffic-eng reoptimize timers frequency *seconds*

no mpls traffic-eng reoptimize timers frequency

Syntax Description

seconds	Sets the frequency of reoptimization (in seconds). A value of 0 disables reoptimization. The range of values is 0 to 604800 seconds (1 week)

Defaults

3600 seconds (1 hour)

Command Modes

Global configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Usage Guidelines

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

Note If the **lockdown** keyword is specified with the **tunnel mpls traffic-eng path-option** command, then a reoptimize check is not done on the tunnel.

Examples

The following example shows how to set the reoptimization frequency to 1 day:

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

Related Commands

Command	Description
mpls traffic-eng reoptimize	Reoptimizes all traffic engineering tunnels immediately.
tunnel mpls traffic-eng path-option	Configures a path option for an MPLS traffic engineering tunnel.

mpls traffic-eng router-id

To specify that the traffic engineering router identifier for the node is the IP address associated with a given interface, use the **mpls traffic-eng router-id** command in router configuration mode. To remove the traffic engineering router identifier, use the **no** form of this command.

mpls traffic-eng router-id *interface-name*

no mpls traffic-eng router-id

Syntax Description

interface-name	Interface whose primary IP address is the router's identifier.

Defaults

No traffic engineering router identifier is specified.

Command Modes

Router configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Usage Guidelines

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

Examples

The following example shows how to specify the traffic engineering router identifier as the IP address associated with interface Loopback0:

```
Router(config-router)# mpls traffic-eng router-id Loopback0
```

Related Commands

Command	Description
mpls atm control-vc	Turns on flooding of MPLS traffic engineering link information in the indicated IGP level/area.

mpls traffic-eng signalling advertise implicit-null

To use the Multiprotocol Label Switching (MPLS) encoding for the implicit-null label in signaling messages sent to neighbors that match the specified access list, use the **mpls traffic-eng signalling advertise implicit-null** command in router configuration mode. To disable this feature, use the **no** form of this command.

mpls traffic-eng signalling advertise implicit-null [*acl-name* | *acl-number*]

no mpls traffic-eng sicgnalling advertise implicit-null

Syntax Description

acl-name	Name of the access list.
acl-number	Number of the access list.

Defaults

Use the Cisco encoding for the implicit-null label in signaling messages.

Command Modes

Router configuration

Command History

Release	Modification
12.0(5)ST	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T.
12.0(22)S	This command was integrated into Cisco IOS Release 12.0(22)S.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

The following example shows how to configure the router to use MPLS encoding for the implicit-null label when it sends signaling messages to certain peers:

```
Router(config-router)# mpls traffic-eng signalling advertise implicit-null
```

mpls traffic-eng tunnels (global configuration)

To enable Multiprotocol Label Switching (MPLS) traffic engineering tunnel signaling on a device, use the **mpls traffic-eng tunnels** command in global configuration mode. To disable MPLS traffic engineering tunnel signaling, use the **no** form of this command.

mpls traffic-eng tunnels

no mpls traffic-eng tunnels

Syntax Description

This command has no arguments or keywords.

Defaults

The command is disabled.

Command Modes

Global configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Usage Guidelines

This command enables MPLS traffic engineering on a device. For you to use the feature, MPLS traffic engineering must also be enabled on the desired interfaces.

Examples

The following example shows how to turn on MPLS traffic engineering tunnel signaling:

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

Related Commands

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

mpls traffic-eng tunnels (interface configuration)

To enable Multiprotocol Label Switching (MPLS) traffic engineering tunnel signaling on an interface (assuming that it is enabled on the device), use the **mpls traffic-eng tunnels** command in interface configuration mode. To disable MPLS traffic engineering tunnel signaling on the interface, use the **no** form of this command.

mpls traffic-eng tunnels

no mpls traffic-eng tunnels

Syntax Description

This command has no arguments or keywords.

Defaults

The command is disabled on all interfaces.

Command Modes

Interface configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Usage Guidelines

To enable MPLS traffic engineering on the interface, 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.

Examples

The following example shows how to enable MPLS traffic engineering on Ethernet interface 0/0:

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

Related Commands

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

next-address

To specify the next IP address in the explicit path, use the **next-address** command in IP explicit path configuration mode. To remove the specified next IP address in the explicit path, use the **no** form of this command.

next-address *ip-address*

no next-address *ip-address*

Syntax Description

ip-address	Next IP address in the explicit path.

Defaults

Next IP address in the explicit path is not specified.

Command Modes

IP explicit path configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.0(19)ST1	The **loose** keyword was added.
12.0(21)ST	The command was implemented on the Cisco GSR 12000 series platform.
12.2(18)S	The command was integrated into Cisco IOS Release 12.2(18)S.
12.2(18)SXD	This command was integrated into Cisco IOS Release 12.2(18)SXD.
12.2(27)SBC	This command was integrated into Cisco IOS Release 12.2(27)SBC.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

The following example shows how to assign the number 60 to the IP explicit path, enable the path, and specify 10.3.27.3 as the next IP address in the list of IP addresses:

```
Router(config)# ip explicit-path identifier 60 enable
Router(cfg-ip-expl-path)# next-address 10.3.27.3

Explicit Path identifier 60:
    1: next-address 10.3.27.3
Router(cfg-ip-exp1-path)#
```

Related Commands

Command	Description
append-after	Inserts the new path entry after the specified index number.
index	Inserts or modifies a path entry at a specified index.
ip explicit-path	Enters the subcommand mode for IP explicit paths and creates or modifies the specified path.

Command	Description
list	Displays all or part of the explicit paths.
show ip explicit-paths	Displays configured IP explicit paths.

show ip explicit-paths

To display the configured IP explicit paths, use the **show ip explicit-paths** command in user EXEC or privileged EXEC mode.

show ip explicit-paths [**name** *word* | **identifier** *number*] [**detail**]

Syntax Description

name *word*	(Optional) Name of the explicit path.
identifier *number*	(Optional) Number of the explicit path. Valid values are from 1 to 65535.
detail	(Optional) Displays, in the long form, information about the configured IP explicit paths.

Defaults

No default behavior or values.

Command Modes

User EXEC
Privileged EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Usage Guidelines

An IP explicit path is a list of IP addresses, each representing a node or link in the explicit path.

Examples

The following is sample 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 10.3.28.3
    2: next-address 10.3.27.3
```

Table 4 describes the significant fields shown in the display.

Table 4 show ip explicit-paths Field Descriptions

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

Related Commands

Command	Description
append-after	Inserts a path entry after a specific index number. Commands might be renumbered as a result.
index	Inserts or modifies a path entry at a specific index.
ip explicit-path	Enters the subcommand mode for IP explicit paths so that you can create or modify the named path.
list	Displays all or part of the explicit paths.
next-address	Specifies the next IP address in the explicit path.

show ip ospf database opaque-area

To display lists of information related to traffic engineering opaque link-state advertisements (LSAs), also known as Type-10 opaque link area link states, use the **show ip ospf database opaque-area** command in user EXEC or privileged EXEC mode.

show ip ospf database opaque-area

Syntax Description

This command has no arguments or keywords.

Command Modes

User EXEC
Privileged EXEC

Command History

Release	Modification
12.0(8)S	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

The following is sample output from the **show ip ospf database opaque-area** command:

```
Router# show ip ospf database opaque-area

OSPF Router with ID (10.3.3.3) (Process ID 1)

                Type-10 Opaque Link Area Link States (Area 0)

  LS age: 12
  Options: (No TOS-capability, DC)
  LS Type: Opaque Area Link
  Link State ID: 10.0.0.0
  Opaque Type: 1
  Opaque ID: 0
  Advertising Router: 172.16.8.8
  LS Seq Number: 80000004
  Checksum: 0xD423
  Length: 132
  Fragment number : 0

    MPLS TE router ID: 172.16.8.8

    Link connected to Point-to-Point network
      Link ID : 10.2.2.2

      Interface Address : 192.168.1.1
```

Table 5 describes the significant fields shown in the display.

Table 5 show ip ospf database opaque-area Field Descriptions

Field	Description
LS age	Link-state age.
Options	Type of service options.
LS Type	Type of the link state.
Link State ID	Router ID number.
Opaque Type	Opaque link-state type.
Opaque ID	Opaque LSA ID number.
Advertising Router	Advertising router ID.
LS Seq Number	Link-state sequence number that detects old or duplicate link state advertisements (LSAs).
Checksum	Fletcher checksum of the complete contents of the LSA.
Length	Length (in bytes) of the LSA.
Fragment number	Arbitrary value used to maintain multiple traffic engineering LSAs.
MPLS TE router ID	Unique MPLS traffic engineering ID.
Link ID	Index of the link being described.
Interface Address	Address of the interface.

Related Commands

Command	Description
mpls traffic-eng area	Configures a router running OSPF MPLS to flood traffic engineering for an indicated OSPF area.
mpls traffic-eng router-id	Specifies that the traffic engineering router identifier for the node is the IP address associated with a given interface.
show ip ospf mpls traffic-eng	Provides information about the links available on the local router for traffic engineering.

show ip ospf mpls traffic-eng

To display information about the links available on the local router for traffic engineering, use the **show ip ospf mpls traffic-eng** command in user EXEC or privileged EXEC mode.

show ip ospf [**process-id** [**area-id**] **mpls traffic-eng** [**link**] | **fragment**]

Syntax Description

process-id	(Optional) Internal identification number that is assigned locally when the OSPF routing process is enabled. The value can be any positive integer.
area-id	(Optional) Area number associated with OSPF.
link	(Optional) Provides detailed information about the links over which traffic engineering is supported on the local router.
fragment	(Optional) Provides detailed information about the traffic engineering fragments on the local router.

Defaults

No default behavior or values.

Command Modes

User EXEC
Privileged EXEC

Command History

Release	Modification
12.0S	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

The following is sample output from the **show ip ospf mpls traffic-eng** command:

```
Router# show ip ospf mpls traffic-eng link

OSPF Router with ID (10.0.0.1) (Process ID 1)

  Area 0 has 2 MPLS TE links. Area instance is 14.

  Links in hash bucket 8.
    Link is associated with fragment 1. Link instance is 14
      Link connected to Point-to-Point network
      Link ID :197.0.0.1
      Interface Address :172.16.0.1
      Neighbor Address :172.16.0.2
      Admin Metric :97
      Maximum bandwidth :128000
      Maximum reservable bandwidth :250000
      Number of Priority :8
      Priority 0 :250000      Priority 1 :250000
      Priority 2 :250000      Priority 3 :250000
```

```
    Priority 4 :250000      Priority 5 :250000
    Priority 6 :250000      Priority 7 :212500
    Affinity Bit :0x0
  Link is associated with fragment 0. Link instance is 14
    Link connected to Broadcast network
    Link ID :192.168.1.2
    Interface Address :192.168.1.1
    Neighbor Address :192.168.1.2
    Admin Metric :10
    Maximum bandwidth :1250000
    Maximum reservable bandwidth :2500000
    Number of Priority :8
    Priority 0 :2500000     Priority 1 :2500000
    Priority 2 :2500000     Priority 3 :2500000
    Priority 4 :2500000     Priority 5 :2500000
    Priority 6 :2500000     Priority 7 :2500000
    Affinity Bit :0x0
```

Table 6 describes the significant fields shown in the display.

Table 6 show ip ospf mpls traffic-eng Field Descriptions

Field	Description
OSPF Router with ID	Router identification number.
Process ID	OSPF process identification.
Area instance	Number of times traffic engineering information or any link changed.
Link instance	Number of times any link changed.
Link ID	Link-state ID.
Interface Address	Local IP address on the link.
Neighbor Address	IP address that is on the remote end of the link.
Admin Metric	Traffic engineering link metric.
Maximum bandwidth	Bandwidth set by the **bandwidth interface** command in the interface configuration mode.
Maximum reservable bandwidth	Bandwidth available for traffic engineering on this link. This value is set in the **ip rsvp** command in the interface configuration mode.
Number of priority	Number of priorities that are supported.
Priority	Bandwidth (in bytes per second) that is available for traffic engineering at certain priorities.
Affinity Bit	Affinity bits (color) assigned to the link.

show ip rsvp host

To display Resource Reservation Protocol (RSVP) terminal point information for receivers or senders, use the **show ip rsvp host** command in user EXEC or privileged EXEC mode.

show ip rsvp host {**senders** | **receivers**} [*hostname* | *ip-address*]

Syntax Description

senders	Displays information for senders.
receivers	Displays information for receivers.
hostname	(Optional) Restricts the display to sessions with *hostname* as their destination.
ip-address	(Optional) Restricts the display to sessions with the specified IP address as their destination.

Command Modes

User EXEC
Privileged EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

The following is sample output from the **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 7 describes the significant fields shown in the display.

Table 7 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, shared explicit, or fixed).
Serv	Service (RATE or LOAD).

Table 7 show ip rsvp host Field Descriptions (continued)

Field	Description
BPS	Reservation rate (in bits per second).
Bytes	Bytes of requested burst size.

Related Commands

Command	Description
show ip rsvp request	Displays the RSVP reservations currently being requested upstream for a specified interface or all interfaces.
show ip rsvp reservation	Displays RSVP-related receiver information currently in the database.
show ip rsvp sender	Displays RSVP-related sender information currently in the database.

show isis database verbose

To display additional information about the Intermediate System-to-Intermediate System (IS-IS) database, use the **show isis database verbose** command in user EXEC or privileged EXEC mode.

show isis database verbose

Syntax Description

This command has no arguments or keywords.

Command Modes

User EXEC
Privileged EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.2(27)SBC	This command was integrated into Cisco IOS Release 12.2(27)SBC.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

The following is sample 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:   10.5.5.5
  IP Address:  172.16.39.5
  Metric:10         IP 172.16.39.0/24
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 8 describes the significant fields shown in the display.

Table 8 show isis database verbose Field Descriptions

Field	Description
LSPID	Link-state packet (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 pseudonode LSP. This is similar to a router LSA in Open Shortest Path First (OSPF); the LSP describes the state of the originating router. For each LAN, the designated router for that LAN creates and floods a pseudonode LSP that describes all systems attached to that LAN. The last octet is the LSP number. If all the data cannot fit into a single LSP, the LSP is divided into multiple LSP fragments. Each fragment has a different LSP number. An asterisk (*) indicates that the system issuing this command originated the LSP.
LSP Seq Num	LSP sequence number that allows other systems to determine if they received the latest information from the source.
LSP Checksum	Checksum of the entire LSP packet.
LSP Holdtime	Amount of time that the LSP remains valid (in seconds). An LSP hold time of zero indicates that this LSP was purged and is being removed from all routers' link-state databases (LSDBs). The value indicates how long the purged LSP will stay in the LSDB before it is completely removed.
ATT	Attach bit. This bit indicates that the router is also a Level 2 router, and it can reach other areas. Level 1 routers use the Attach bit to find the closest Level 2 router. They install a default route to the closest Level 2 router.
P	P bit. This bit detects if the IS can repair area partitions. Cisco and other vendors do not support area partition repair.
OL	Overload bit. This bit determines if the IS is congested. If the overload bit is set, other routers do not use this system as a transit router when they calculate routes. Only packets for destinations directly connected to the overloaded router are sent to this router.
Area Address	Reachable area addresses from the router. For Level 1 LSPs, these are the area addresses configured manually on the originating router. For Level 2 LSPs, these are all the area addresses for the area to which this router belongs.
NLPID	Network Layer Protocol identifier.
Hostname	Host name of the node.
Router ID	Traffic engineering router identifier for the node.
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 end system (ES), or a connectionless network service [CLNS] prefix).
Affinity	Link attribute flags that are being flooded.
Physical BW	Link bandwidth capacity (in bits per second).

Table 8 show isis database verbose Field Descriptions (continued)

Field	Description
Reservable BW	Amount of reservable bandwidth on this link.
BW Unreserved	Amount of bandwidth that is available for reservation.

The following example includes a route tag:

```
Router# show isis database verbose

IS-IS Level-1 Link State Database:
LSPID                 LSP Seq Num    LSP Checksum    LSP Holdtime    ATT/P/OL
dasher.00-00          0x000000F8     0xE57B          518             1/0/0
  Area Address: 49.0002
  NSPID:        0xCC
  Hostname: dasher
  IP Address: 10.3.0.1
  Metric: 10     IP 172.16.170.0/24
  Metric: 10     IP 10.0.3.0/24
  Metric: 10     IP 10.0.3.3/30
  Metric: 10     IS-Extended dasher.02172.19.170.0/24
  Metric: 20     IP-Interarea 10.1.1.1/32
    Route Admin Tag: 60
  Metric: 20     IP-Interarea 192.168.0.6/32
    Route Admin Tag: 50
```

Related Commands

Command	Description
show isis mpls traffic-eng adjacency-log	Displays a log of 20 entries of MPLS traffic engineering IS-IS adjacency changes.
show isis mpls traffic-eng advertisements	Displays the last flooded record from MPLS traffic engineering.
show isis mpls traffic-eng tunnel	Displays information about tunnels considered in the IS-IS next hop calculation.

show isis mpls traffic-eng adjacency-log

To display a log of 20 entries of Multiprotocol Label Switching (MPLS) traffic engineering Intermediate System-to-Intermediate System (IS-IS) adjacency changes, use the **show isis mpls traffic-eng adjacency-log** command in user EXEC or privileged EXEC mode.

show isis mpls traffic-eng adjacency-log

Syntax Description

This command has no arguments or keywords.

Command Modes

User EXEC
Privileged EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

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  172.16.1.2        PO1/0/0   Up     level-1
04:52:37  0000.0024.0004.02  10.0.0.0          Et0/2     Up     level-1
```

Table 9 describes the significant fields shown in the display.

Table 9 show isis mpls traffic-eng adjacency-log Field Descriptions

Field	Description
When	Amount of time since the entry was recorded in the log.
Neighbor ID	Identification value of the neighbor.
IP Address	Neighbor IPv4 address.
Interface	Interface from which a neighbor is learned.
Status	Up (active) or Down (disconnected).
Level	Routing level.

Related Commands

Command	Description
show isis mpls traffic-eng advertisements	Displays the last flooded record from MPLS traffic engineering.

show isis mpls traffic-eng advertisements

To display the last flooded record from Multiprotocol Label Switching (MPLS) traffic engineering, use the **show isis mpls traffic-eng advertisements** command in user EXEC or privileged EXEC mode.

show isis mpls traffic-eng advertisements

Syntax Description

This command has no arguments or keywords.

Command Modes

User EXEC
Privileged EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

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

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

System ID:dtp-5.00
  Router ID:10.5.5.5
  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 10 describes the significant fields shown in the display.

Table 10 show isis 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 that MPLS traffic engineering advertised.

Table 10 show isis mpls traffic-eng advertisements Field Descriptions (continued)

Field	Description
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 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 attribute flags being flooded.

Related Commands

Command	Description
show isis mpls traffic-eng adjacency-log	Displays a log of 20 entries of MPLS traffic engineering IS-IS adjacency changes.

show isis mpls traffic-eng tunnel

To display information about tunnels considered in the Intermediate System-to-Intermediate System (IS-IS) next hop calculation, use the **show isis mpls traffic-eng tunnel** command in privileged EXEC mode.

show isis mpls traffic-eng tunnel

Syntax Description

This command has no arguments or keywords.

Command Modes

Privileged EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	This command was integrated into Cisco IOS Release 12.1(3)T.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

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

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

Station Id          Tunnel Name   Bandwidth    Nexthop       Metric   Mode
kangpa-router1.00   Tunnel1022    3333         10.2.2.2       -3       Relative
                    Tunnel1021    10000        10.2.2.2       11       Absolute
tomklong-route.00   Tunnel1031    10000        172.17.3.3       -1       Relative
                    Tunnel1032    10000        172.17.3.3
```

Table 11 describes the significant fields shown in the display.

Table 11 show isis mpls traffic-eng tunnel Field Descriptions

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

Related Commands

Command	Description
show mpls traffic-eng autoroute	Displays tunnels that are announced to IGP, including interface, destination, and bandwidth.

show mpls traffic-eng autoroute

To display tunnels announced to the Interior Gateway Protocol (IGP), including interface, destination, and bandwidth, use the **show mpls traffic-eng autoroute** command in user EXEC or privileged EXEC mode.

show mpls traffic-eng autoroute

Defaults

No default behavior or values

Command Modes

User EXEC
Privileged EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Usage Guidelines

The enhanced shortest path first (SPF) calculation of the IGP has been modified so that it uses traffic engineering tunnels. This command shows which tunnels IGP is currently using in its enhanced SPF calculation (that is, which tunnels are up and have autoroute configured).

Examples

The following is sample output from the **show mpls traffic-eng autoroute** command.

Note that the tunnels are organized by destination. All tunnels to a destination 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 10.2.2.2, absolute metric 11)
    Tunnel1022 (traffic share 3333, nexthop 10.2.2.2, relative metric -3)
  destination 0003.0003.0003.00 has 2 tunnels
    Tunnel1032 (traffic share 10000, nexthop 172.16.3.3)
    Tunnel1031 (traffic share 10000, nexthop 172.16.3.3, relative metric -1)
```

Table 12 describes the significant fields shown in the display.

Table 12 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.

Table 12 show mpls traffic-eng autoroute Field Descriptions (continued)

Field	Description
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	MPLS traffic engineering tailend IP address of the tunnel.
absolute metric	MPLS traffic engineering metric with mode absolute of the tunnel.
relative metric	MPLS traffic engineering metric with mode relative of the tunnel.

Related Commands

Command	Description
show isis mpls traffic-eng tunnel	Displays information about tunnels considered in the IS-IS next hop calculation.
tunnel mpls traffic-eng autoroute announce	Causes the IGP to use the tunnel (if it is up) in its enhanced SPF calculation.
tunnel mpls traffic-eng autoroute metric	Specifies the MPLS traffic engineering tunnel metric that the IGP enhanced SPF calculation will use.

show mpls traffic-eng link-management admission-control

To show which tunnels were 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** command in user EXEC or privileged EXEC mode.

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

Syntax Description

interface-name	(Optional) Displays only tunnels that were admitted on the specified interface.

Command Modes

User EXEC
Privileged EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	The command output changed. The BW field now shows bandwidth in kBps, and it is followed by the status (reserved or held) of the bandwidth.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

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

```
Router2# show mpls traffic-eng link-management admission-control

System Information::
    Tunnels Count:       4
    Tunnels Selected:    4
TUNNEL ID              UP IF     DOWN IF  PRIORITY STATE           BW (kbps)
10.106.0.6 1000_1      AT1/0.2   -        0/0      Resv Admitted   0
10.106.0.6 2000_1      Et4/0/1   -        1/1      Resv Admitted   0
10.106.0.6 1_2         Et4/0/1   Et4/0/2  1/1      Resv Admitted   3000       R
10.106.0.6 2_2         AT1/0.2   AT0/0.2  1/1      Resv Admitted   3000       R
```

Table 13 describes the significant fields shown in the display.

Table 13 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 that the tunnel used.
DOWN IF	Downstream interface that the tunnel used.
PRIORITY	Setup priority of the tunnel followed by the hold priority.

Table 13 show mpls traffic-eng link-management admission-control Field Descriptions

Field	Description
STATE	Admission status of the tunnel.
BW (kbps)	Bandwidth of the tunnel (in kBps). If an "R" follows the bandwidth number, the bandwidth is reserved. If an "H" follows the bandwidth number, the bandwidth is temporarily being held for a path message.

Related Commands

Command	Description
show mpls traffic-eng link-management advertisements	Displays local link information that MPLS traffic engineering link management is currently flooding into the global traffic engineering topology.
show mpls traffic-eng link-management bandwidth-allocation	Displays current local link information.
show mpls traffic-eng link-management igp-neighbors	Displays IGP neighbors.
show mpls traffic-eng link-management interfaces	Displays per-interface resource and configuration information.
show mpls traffic-eng link-management summary	Displays a summary of link management information.

show mpls traffic-eng link-management advertisements

To show local link information that MPLS traffic engineering link management is currently flooding into the global traffic engineering topology, use the **show mpls traffic-eng link-management advertisements** command in user EXEC or privileged EXEC mode.

show mpls traffic-eng link-management advertisements

Syntax Description

This command has no arguments or keywords.

Command Modes

User EXEC
Privileged EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	The command output was modified.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

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

```
Router1# 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:     10.1.0.6
    IGP Neighbor:        ID 0001.0000.0001.02
    Admin. Weight:       10
    Physical Bandwidth:  10000 kbits/sec
    Max Reservable BW:   5000 kbits/sec
    Downstream::
      Reservable Bandwidth[0]:       5000 kbits/sec
      Reservable Bandwidth[1]:       2000 kbits/sec
      Reservable Bandwidth[2]:       2000 kbits/sec
      Reservable Bandwidth[3]:       2000 kbits/sec
      Reservable Bandwidth[4]:       2000 kbits/sec
      Reservable Bandwidth[5]:       2000 kbits/sec
      Reservable Bandwidth[6]:       2000 kbits/sec
      Reservable Bandwidth[7]:       2000 kbits/sec
    Attribute Flags:     0x00000000
```

Table 14 describes the significant fields shown in the display.

Table 14 show mpls traffic-eng link-management advertisements Field Descriptions

Field	Description
Flooding Status	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 that is flooding information for this area.
IGP System ID	Identification that IGP flooding uses in this area to identify this node.
MPLS TE Router ID	MPLS traffic engineering router ID.
Flooded Links	Number of links that are flooded in this area.
Link ID	Index of the link that is 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 Bandwidth	Link bandwidth capacity (in kBps).
Max Reservable BW	Amount of reservable bandwidth on this link.
Reservable Bandwidth	Amount of bandwidth that is available for reservation.
Attribute Flags	Attribute flags of the link are being flooded.

Related Commands

Command	Description
show mpls traffic-eng link-management bandwidth-allocation	Displays current local link information.
show mpls traffic-eng link-management igp-neighbors	Displays IGP neighbors.
show mpls traffic-eng link-management interfaces	Displays per-interface resource and configuration information.
show mpls traffic-eng link-management summary	Displays a 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** command in user EXEC or privileged EXEC mode.

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

Syntax Description

interface-name	(Optional) Displays only tunnels that were admitted on the specified interface.

Command Modes

User EXEC
Privileged EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	The command output was modified.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Usage Guidelines

Advertised information might differ from the current information, depending on how flooding was configured.

Examples

The following is sample output from the **show mpls traffic-eng link-management bandwidth-allocation** command:

```
Router1# show mpls traffic-eng link-management bandwidth-allocation Et4/0/1

System Information::
    Links Count:         2
    Bandwidth Hold Time: max. 15 seconds
Link ID:: Et4/0/1 (10.1.0.6)
    Link Status:
      Physical Bandwidth:  10000 kbits/sec
      Max Reservable BW:   5000 kbits/sec (reserved:0% in, 60% out)
      BW Descriptors:      1
      MPLS TE Link State:  MPLS TE on, RSVP on, admin-up, flooded
      Inbound Admission:   reject-huge
      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)
    Downstream Bandwidth Information (kbits/sec):
      KEEP PRIORITY     BW HELD  BW TOTAL HELD   BW LOCKED  BW TOTAL LOCKED
                  0           0              0           0                0
                  1           0              0        3000             3000
                  2           0              0           0             3000
                  3           0              0           0             3000
                  4           0              0           0             3000
                  5           0              0           0             3000
```

```
6               0               0               0               3000
7               0               0               0               3000
```

Table 15 describes the significant fields shown in the display.

Table 15 show mpls traffic-eng link-management bandwidth-allocation Field Descriptions

Field	Description
Links Count	Number of links configured for MPLS traffic engineering.
Bandwidth Hold Time	Amount of time that bandwidth can be held.
Link ID	Interface name and IP address of the link being described.
Physical Bandwidth	Link bandwidth capacity (in bits per second).
Max Reservable BW	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 admission policy for incoming tunnels.
Outbound Admission	Link admission policy for outgoing tunnels.
Admin. Weight	Link administrative weight.
IGP Neighbor Count	List of the IGP neighbors directly reachable over this link.
Up Thresholds	Link's bandwidth thresholds for allocations.
Down Thresholds	Link's bandwidth thresholds for deallocations.
KEEP PRIORITY	Priority levels for the link's bandwidth allocations.
BW HELD	Amount of bandwidth (in kBps) 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 locked at this priority and those above it.

Related Commands

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

show mpls traffic-eng link-management igp-neighbors

To show Interior Gateway Protocol (IGP) neighbors, use the **show mpls traffic-eng link-management igp-neighbors** command in user EXEC or privileged EXEC mode.

show mpls traffic-eng link-management igp-neighbors [*igp-id* [**isis** *isis-address* | **ospf** *ospf-id*] | **ip** *ip-address*]

Syntax Description

igp-id	(Optional) Displays the IGP neighbors that are using a specified IGP identification.
isis *isis-address*	(Optional) Displays the specified IS-IS neighbor when you display neighbors by IGP ID.
ospf *ospf-id*	(Optional) Displays the specified OSPF neighbor when you display neighbors by IGP ID.
ip *ip-address*	(Optional) Displays the IGP neighbors that are using a specified IGP IP address.

Command Modes

User EXEC
Privileged EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

The following is sample 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: 10.0.0.0)
Link ID::  PO1/0/0
    Neighbor ID:  0000.0026.0001.00 (area: isis level-1, IP: 172.16.1.2)
```

Table 16 describes the significant fields shown in the display.

Table 16 show mpls traffic-eng link-management igp-neighbors Field Descriptions

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

Related Commands

Command	Description
show mpls traffic-eng link-management advertisements	Displays 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	Displays current local link information.
show mpls traffic-eng link-management interfaces	Displays per-interface resource and configuration information.
show mpls traffic-eng link-management summary	Displays a summary of link management information.

show mpls traffic-eng link-management interfaces

To show interface resource and configuration information, use the **show mpls traffic-eng link-management interfaces** command in user EXEC or privileged EXEC mode.

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

Syntax Description

interface-name	(Optional) Displays information only for the specified interface.

Command Modes

User EXEC
Privileged EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	The command output was modified.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Usage Guidelines

Displays resource and configuration information for all configured interfaces.

Examples

The following is sample output from the **show mpls traffic-eng link-management interfaces** command:

```
Router1# show mpls traffic-eng link-management interfaces Et4/0/1

System Information::
    Links Count:         2
Link ID:: Et4/0/1 (10.1.0.6)
    Link Status:
      Physical Bandwidth:  10000 kbits/sec
      Max Reservable BW:   5000 kbits/sec (reserved:0% in, 60% out)
      MPLS TE Link State:  MPLS TE on, RSVP on, admin-up, flooded
      Inbound Admission:   reject-huge
      Outbound Admission:  allow-if-room
      Admin. Weight:       10 (IGP)
      IGP Neighbor Count:  1
      IGP Neighbor:        ID 0001.0000.0001.02, IP 10.0.0.0 (Up)
    Flooding Status for each configured area [1]:
      IGP Area[1]: isis level-1: flooded
```

Table 17 describes the significant fields shown in the display.

Table 17 show mpls traffic-eng link management interfaces Field Descriptions

Field	Description
Links Count	Number of links that were enabled for use with Multiprotocol Label Switching (MPLS) traffic engineering.
Link ID	Index of the link.
Physical Bandwidth	Link's bandwidth capacity (in kbps).
Max Reservable BW	Amount of reservable bandwidth on this link.
MPLS TE Link State	The status of the MPLS link.
Inbound Admission	Link admission policy for inbound tunnels.
Outbound Admission	Link admission policy for outbound tunnels.
Admin. Weight	Administrative weight associated with this link.
IGP Neighbor Count	Number of Interior Gateway Protocol (IGP) neighbors directly reachable over this link.
IGP Neighbor	IGP neighbor on this link.
Flooding Status for each configured area	Flooding status for the specified configured area.

Related Commands

Command	Description
show mpls traffic-eng link-management advertisements	Displays 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	Displays current local link information.
show mpls traffic-eng link-management igp-neighbors	Displays IGP neighbors.
show mpls traffic-eng link-management summary	Displays a summary of link management information.

show mpls traffic-eng link-management summary

To show a summary of link management information, use the **show mpls traffic-eng link-management summary** command in user EXEC or privileged EXEC mode.

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

Syntax Description

interface-name	(Optional) Displays information only for the specified interface.

Command Modes

User EXEC
Privileged EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	The command output was modified.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

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

```
Router1# show mpls traffic-eng link-management summary

System Information::
    Links Count:         2
    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:       1
Link ID:: Et4/0/1 (10.1.0.6)
    Link Status:
      Physical Bandwidth:  10000 kbits/sec
      Max Reservable BW:   5000 kbits/sec (reserved:0% in, 60% out)
      MPLS TE Link State:  MPLS TE on, RSVP on, admin-up, flooded
      Inbound Admission:   reject-huge
      Outbound Admission:  allow-if-room
      Admin. Weight:       10 (IGP)
      IGP Neighbor Count:  1
Link ID:: AT0/0.2 (10.42.0.6)
    Link Status:
      Physical Bandwidth:  155520 kbits/sec
      Max Reservable BW:   5000 kbits/sec (reserved:0% in, 0% out)
      MPLS TE Link State:  MPLS TE on, RSVP on
      Inbound Admission:   allow-all
      Outbound Admission:  allow-if-room
      Admin. Weight:       10 (IGP)
      IGP Neighbor Count:  0
```

Table 18 describes the significant fields shown in the display.

Table 18 show mpls traffic-eng link-management summary Field Descriptions

Field	Description
Links Count	Number of links configured for MPLS traffic engineering.
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 that were 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 bandwidth capacity (in kbps).
Max Reservable BW	Amount of reservable bandwidth on this link.
MPLS TE Link State	Status of the link's MPLS traffic engineering-related functions.
Inbound Admission	Link admission policy for incoming tunnels.
Outbound Admission	Link admission policy for outgoing tunnels.
Admin. Weight	Link 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	Displays 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	Displays current local link information.
show mpls traffic-eng link-management igp-neighbors	Displays IGP neighbors.
show mpls traffic-eng link-management interfaces	Displays per-interface resource and configuration 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** command in privileged EXEC mode.

show mpls traffic-eng topology {*ip-address* | **igp-id** {**isis** *nsap-address* | **ospf** *ip-address*}}[**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 *nsap-address*	Specifies the node by router identification (*nsap-address*) if using IS-IS.
ospf *ip-address*	Specifies the node by router identifier if using OSPF.
brief	(Optional) Provides a less detailed version of the topology.

Command Modes

Privileged EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.0(11)ST	The single “Reservable” column was replaced by two columns: one each for “global pool” and for “subpool.”
12.2(8)T	This command was integrated into Cisco IOS Release 12.2(8)T.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

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:172.16.4.4 Router Node
      link[0 ]:Intf Address: 10.1.1.4
                  Nbr IGP Id: 0000.0024.0004.02,
                admin_weight:10, affinity_bits:0x0
                max_link_bw:10000 max_link_reservable: 10000
        globalpoolsubpool
                total allocatedreservable reservable
                --------------- ---------- ----------
    bw[0]: 0 1000500
    bw[1]:10 990490
    bw[2]: 600 390390
    bw[3]: 0 390390
    bw[4]: 0 390390
    bw[5]: 0 390390
```

Table 19 describes the significant fields shown in the display.

Table 19 show mpls traffic-eng topology Field Descriptions

Field	Description
My-System_id	Unique identifier of the IGP.
IGP Id	Identification of advertising router.
MPLS TE Id	Unique MPLS traffic engineering identification.
Intf Address	The interface address of the link.
Nbr IGP Id	Neighbor IGP router identifier.
admin_weight	Cost of the link.
affinity_bits	Requirements on the attributes of the links that the traffic crosses.
max_link_bw	Physical line rate.
max_link_reservable	Maximum amount of bandwidth that can be reserved on a link.
total allocated	Amount of bandwidth allocated at that priority.
reservable	Amount of available bandwidth reservable at that priority for each of the two pools: global and sub.

Related Commands

Command	Description
show mpls traffic-eng tunnels	Displays information about tunnels.

show mpls traffic-eng topology path

To show the properties of the best available path to a specified destination that satisfies certain constraints, use the **show mpls traffic-eng topology path** command in user EXEC or privileged EXEC mode.

show mpls traffic-eng topology path {*tunnel-interface* [**destination** *address*] | **destination** *address*} [**bandwidth** *value*] [**priority** *value* [*value*]] [**affinity** *value* [**mask** *mask*]]

Syntax Description

tunnel-interface	Name of an MPLS traffic engineering interface (for example, Tunnel1) from which default constraints should be copied.
destination *address*	(Optional) IP address specifying the path's destination.
bandwidth *value*	(Optional) Bandwidth constraint. The amount of available bandwidth that a suitable path requires. This overrides the bandwidth constraint obtained from the specified tunnel interface. You can specify any positive number.
priority *value* [*value*]	(Optional) Priority constraints. The setup and hold priorities used to acquire bandwidth along the path. If specified, this overrides the priority constraints obtained from the tunnel interface. Valid values are from 0 to 7.
affinity *value*	(Optional) Affinity constraints. The link attributes for which the path has an affinity. If specified, this overrides the affinity constraints obtained from the tunnel interface.
mask *mask*	(Optional) Affinity constraints. The mask associated with the affinity specification.

Command Modes

User EXEC
Privileged EXEC

Command History

Release	Modification
12.1(3)T	This command was introduced.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.0(22)S	This command was integrated into Cisco IOS Release 12.0(22)S.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Usage Guidelines

The specified constraints override any constraints obtained from a reference tunnel.

Examples

The following is sample output from the **show mpls traffic-eng topology path** command:

```
Router1# show mpls traffic-eng topology path Tunnel1 bandwidth 1000

Query Parameters:
  Destination:10.112.0.12
    Bandwidth:1000
```

```
   Priorities:1 (setup), 1 (hold)
     Affinity:0x0 (value), 0xFFFF (mask)
Query Results:
  Min Bandwidth Along Path:2000 (kbps)
  Max Bandwidth Along Path:5000 (kbps)
  Hop  0:10.1.0.6       :affinity 00000000, bandwidth 2000 (kbps)
  Hop  1:10.1.0.10      :affinity 00000000, bandwidth 5000 (kbps)
  Hop  2:10.43.0.10     :affinity 00000000, bandwidth 2000 (kbps)
  Hop  3:10.112.0.12
```

Table 20 describes the significant fields shown in the display.

Table 20 show mpls traffic-eng topology path Field Descriptions

Field	Description
Destination	IP address of the path's destination.
Bandwidth	Amount of available bandwidth that a suitable path requires.
Priorities	Setup and hold priorities used to acquire bandwidth.
Affinity	Link attributes for which the path has an affinity.
Min Bandwidth Along Path	Minimum amount of bandwidth configured for a path.
Max Bandwidth Along Path	Maximum amount of bandwidth configured for a path.
Hop	Information about each link in the path.

show mpls traffic-eng tunnels

To show information about tunnels, use the **show mpls traffic-eng tunnels** command in user EXEC or privileged EXEC mode.

show mpls traffic-eng tunnels *tunnel-interface* [**brief**] **protect**

show mpls traffic-eng tunnels *tunnel-interface*
[**destination** *address*]
[**source-id** {*number* | *ip-address* | *ip-address number*}]
[**role** {**all** | **head** | **middle** | **tail** | **remote**}]
[**up** | **down**]
[**name** *string*]
[**suboptimal constraints** {**none** | **current** | **max**}]
[**interface in** *physical-interface*] [**interface out** *physical-interface*] | **interface** *physical-interface* [**brief**] **protect**

Syntax Description

tunnel-interface	Displays information for the specified tunneling interface.
brief	(Optional) Displays the information in brief format.
protect	Displays the status of the protected path.
destination *address*	(Optional) Restricts the display to tunnels destined to the specified IP address.
source-id	(Optional) Restricts the display to tunnels with a matching source IP address or tunnel number.
number	(Optional) Tunnel number.
ip-address	(Optional) Source IP address.
ip-address number	(Optional) Source IP address and tunnel number.
role	(Optional) Restricts the display to tunnels with the indicated role (all, head, middle, tail, or remote).
all	(Optional) Displays all tunnels.
head	(Optional) Displays tunnels with their heads at this router.
middle	(Optional) Displays tunnels with their midpoints at this router.
tail	(Optional) Displays tunnels with their tails at this router.
remote	(Optional) Displays tunnels with their heads at another router; this is a combination of the **middle** and **tail** keyword values.
up	(Optional) Displays tunnels if the tunnel interface is up. Tunnel midpoints and tails are typically up or not present.
down	(Optional) Displays tunnels that are down.
name *string*	(Optional) Displays tunnels with the specified 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.
suboptimal constraints none	(Optional) Displays tunnels whose path metric is greater than the shortest unconstrained path. Selected tunnels have a longer path than the IGP's shortest path.

suboptimal constraints current	(Optional) Displays tunnels whose path metric is greater than the current shortest path, constrained by the tunnel's configured options. Selected tunnels would have a shorter path if they were reoptimized immediately.
suboptimal constraints max	(Optional) Displays tunnels whose path metric is greater than the current shortest path, constrained by the tunnel's configured options, and considering only the network's capacity. Selected tunnels would have a shorter path if no other tunnels were consuming network resources.
interface in *physical-interface*	(Optional) Displays tunnels that use the specified input interface.
interface out *physical-interface*	(Optional) Displays tunnels that use the specified output interface.
interface *physical-interface*	(Optional) Displays tunnels that use the specified interface as an input or output interface.

Command Modes

User EXEC
Privileged EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	The new **brief** format includes input and output interface information. The **suboptimal** and **interface** keywords were added to the nonbrief format. The nonbrief, nonsummary formats each include the history of LSP selection.
12.0(30)S	The **protect** keyword was added.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

The following is sample output from the **show mpls traffic-eng tunnels brief** command:

```
Router1# show mpls traffic-eng tunnels brief

Signalling Summary:
    LSP Tunnels Process:           running
    RSVP Process:                  running
    Forwarding:                    enabled
    Periodic reoptimization:       every 3600 seconds, next in 1706 seconds
TUNNEL NAME                      DESTINATION      UP IF     DOWN IF   STATE/PROT
Router1_t1                       10.112.0.12      -         Et4/0/1   up/up
tagsw-r11_t2                     10.112.0.12      -         unknown   up/down
tagsw-r11_t3                     10.112.0.12      -         unknown   admin-down
tagsw-r11_t1000                  10.110.0.10      -         unknown   up/down
tagsw-r11_t2000                  10.110.0.10      -         Et4/0/1   up/up
Displayed 5 (of 5) heads, 0 (of 0) midpoints, 0 (of 0) tails
```

The following is sample output from the **show mpls traffic-eng tunnels protect brief** command:

```
Router# show mpls traffic-eng tunnels 500 protect brief

Router#_t500
  LSP Head, Tunnel500, Admin: up, Oper: up
  Src 172.16.0.5, Dest 172.16.0.8, Instance 17
```

```
Fast Reroute Protection: None
Path Protection: 1 Common Link(s) , 1 Common Node(s)
  Primary lsp path:192.168.6.6 192.168.7.7
                   192.168.8.8 192.168.0.8

  Protect lsp path:172.16.7.7 192.168.8.8
                   10.0.0.8
  Path Protect Parameters:
    Bandwidth: 50       kbps (Global)  Priority: 7  7   Affinity: 0x0/0xFFFF
    Metric Type: TE (default)
  InLabel  :  -
  OutLabel : Serial5/3, 46
  RSVP Signalling Info:
       Src 172.16.0.5, Dst 172.16.0.8, Tun_Id 500, Tun_Instance 18
    RSVP Path Info:
      My Address: 172.16.0.5
      Explicit Route: 192.168.7.7 192.168.8.8
      Record   Route:   NONE
      Tspec: ave rate=50 kbits, burst=1000 bytes, peak rate=50 kbits
    RSVP Resv Info:
      Record   Route:   NONE
      Fspec: ave rate=50 kbits, burst=1000 bytes, peak rate=50 kbits
```

Table 21 describes the significant fields shown in the display.

Table 21 show mpls traffic-eng tunnels Field Descriptions

Field	Description
LSP Tunnels Process	Status of the LSP tunnels process.
RSVP Process	Status of the RSVP process.
Forwarding	Status of forwarding (enabled or disabled).
Periodic reoptimization	Schedule for periodic reoptimization.
TUNNEL NAME	Name of the interface that is configured at the tunnel head.
DESTINATION	Identifier of the tailend router.
UP IF	Upstream interface that the tunnel used.
DOWN IF	Downstream interface that the tunnel used.
STATE/PROT	For tunnel heads, admin-down or up. For nonheads, signalled.

Related Commands

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

show mpls traffic-eng tunnels summary

To show summary information about tunnels, use the **show mpls traffic-eng tunnels summary** command in user EXEC or privileged EXEC mode.

show mpls traffic-eng tunnels summary

Syntax Description

This command has no arguments or keywords.

Command Modes

User EXEC
Privileged EXEC

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.1(3)T	This command was introduced.
12.0(10)ST	This command was integrated into Cisco IOS Release 12.0(10)ST.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

The following is sample output from the **show mpls traffic-eng tunnels summary** command**:**

```
Router# show mpls traffic-eng tunnels 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 22 describes the significant fields shown in the display.

Table 22 show mpls traffic-eng tunnels summary Field Descriptions

Field	Description
LSP Tunnels Process	MPLS traffic engineering has or has not been enabled.
RSVP Process	RSVP has or has not been enabled. (This feature is enabled as a consequence of MPLS traffic engineering being enabled.)
Forwarding	Indicates whether appropriate forwarding is 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 successfully signalled or being signalled.
Established	LSPs currently signalled.

Table 22 show mpls traffic-eng tunnels summary Field Descriptions (continued)

Field	Description
activations	Signalling attempts initiated.
deactivations	Signalling attempts terminated.
Periodic reoptimization	Frequency of periodic reoptimization and time until the next periodic reoptimization.

Related Commands

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

tunnel mode mpls traffic-eng

To set the mode of a tunnel to Multiprotocol Label Switching (MPLS) for traffic engineering, use the **tunnel mode mpls traffic-eng** command in interface configuration mode. To disable this feature, use the **no** form of this command.

tunnel mode mpls traffic-eng

no tunnel mode mpls traffic-eng

Syntax Description

This command has no arguments or keywords.

Defaults

Disabled.

Command Modes

Interface configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Usage Guidelines

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

Examples

The following example shows how to set the mode of the tunnel to MPLS traffic engineering:

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

Related Commands

Command	Description
tunnel mpls traffic-eng affinity	Configures an affinity for an MPLS traffic engineering tunnel.
tunnel mpls traffic-eng autoroute announce	Instructs the IGP to use the tunnel in its enhanced SPF algorithm calculation (if the tunnel is up).
tunnel mpls traffic-eng bandwidth	Configures the 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 an MPLS traffic engineering tunnel.

tunnel mpls traffic-eng affinity

To configure an affinity (the properties the tunnel requires in its links) for a Multiprotocol Label Switching (MPLS) traffic engineering tunnel, use the **tunnel mpls traffic-eng affinity** command in interface configuration mode. To disable the MPLS traffic engineering tunnel affinity, use the **no** form of this command.

tunnel mpls traffic-eng affinity *properties* [**mask** *mask-value*]

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

Syntax Description

properties	Attribute values required for links carrying this tunnel. A 32-bit decimal number. Valid values are from 0x0 to 0xFFFFFFFF, representing 32 attributes (bits), where the value of an attribute is 0 or 1.
mask *mask-value*	(Optional) Link attribute to be checked. A 32-bit decimal number. Valid values are from 0x0 to 0xFFFFFFFF, representing 32 attributes (bits), where the value of an attribute is 0 or 1.

Defaults

properties: 0X00000000
mask value: 0X0000FFFF

Command Modes

Interface configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Usage Guidelines

The affinity determines the attributes of the links that this tunnel will use (that is, the attributes for which the tunnel has an affinity). The attribute mask determines which link attribute the router should check. If a bit in the mask is 0, an attribute value of a link or that bit is irrelevant. If a bit in the mask is 1, the attribute value of a link and the required affinity of the tunnel for that bit must match.

A tunnel can use a link if the tunnel affinity equals the link attributes and the tunnel affinity mask.

Any properties set to 1 in the affinity should also be 1 in the mask. In other words, affinity and mask should be set as follows:

```
tunnel_affinity = (tunnel_affinity and tunnel_affinity_mask)
```

Examples

The following example shows how to set the affinity of the tunnel to 0x0101 mask 0x303:

```
Router(config-if)# tunnel mpls traffic-eng affinity 0x0101 mask 0x303
```

Related Commands

Command	Description
mpls traffic-eng attribute-flags	Sets the attributes 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 specify that the Interior Gateway Protocol (IGP) should use the tunnel (if the tunnel is up) in its enhanced shortest path first (SPF) calculation, use the **tunnel mpls traffic-eng autoroute announce** command in interface configuration mode. 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.

Defaults

The IGP does not use the tunnel in its enhanced SPF calculation.

Command Modes

Interface configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Usage Guidelines

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

Examples

The following example shows how to specify that the IGP should use the tunnel in its enhanced SPF calculation if the tunnel is up:

```
Router(config-if)# tunnel mpls traffic-eng autoroute announce
```

The following example shows how to specify that if the IGP is using this tunnel in its enhanced SPF calculation, the IGP should give it an absolute metric of 10:

```
Router(config-if)# tunnel mpls traffic-eng autoroute announce metric absolute 10
```

Related Commands

Command	Description
ip route	Establishes static routes.
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 Multiprotocol Label Switching (MPLS) traffic engineering tunnel metric that the Interior Gateway Protocol (IGP) enhanced shortest path first (SPF) calculation uses, use the **tunnel mpls traffic-eng autoroute metric** command in interface configuration mode. To disable the specified MPLS traffic engineering tunnel metric, 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

absolute	Absolute metric mode; you can enter a positive metric value.
relative	Relative metric mode; you can enter a positive, negative, or zero value.
value	The metric that the IGP enhanced SPF calculation uses. The **relative** value can be from –10 to 10. **Note** Even though the value for a relative metric can be from –10 to 10, configuring a tunnel metric with a negative value is considered a misconfiguration. If from the routing table the metric to the tunnel tail appears to be 4, then the cost to the tunnel tail router is actually 3 because 1 is added to the cost for getting to the loopback address. In this instance, the lowest value that you can configure for the relative metric is–3.

Defaults

The default is metric relative 0.

Command Modes

Interface configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Examples

The following example shows how to specify the use of MPLS traffic engineering tunnel metric negative 1 for the IGP enhanced SPF calculation:

```
Router(config-if)# tunnel mpls traffic-eng autoroute metric relative -1
```

Related Commands

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

tunnel mpls traffic-eng bandwidth

To configure bandwidth required for a Multiprotocol Label Switching (MPLS) traffic engineering tunnel, use the **tunnel mpls traffic-eng bandwidth** command in interface configuration mode. To disable this bandwidth configuration, use the **no** form of this command.

tunnel mpls traffic-eng bandwidth [**sub-pool** | **global**] *kbps*

no tunnel mpls traffic-eng bandwidth [**sub-pool** | **global**] *kbps*

Syntax Description

sub-pool	(Optional) Indicates a subpool tunnel.
global	(Optional) Indicates a global pool tunnel. Entering this keyword is not necessary, for all tunnels are global pool in the absence of the **sub-pool** keyword. But if users of pre-DiffServ-aware Traffic Engineering (DS-TE) images enter this keyword, it is accepted.
kbps	Bandwidth, in kilobits per second, set aside for the MPLS traffic engineering tunnel. Range is between 1 and 4294967295.

Defaults

Default bandwidth is 0.
Default is a global pool tunnel.

Command Modes

Interface configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.0(11)ST	The **sub-pool** keyword was added.
12.2(8)T	This command was integrated into Cisco IOS Release 12.2(8)T.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Usage Guidelines

Enter the bandwidth for either a global pool or subpool tunnel, not both. Only the **ip rsvp bandwidth** command specifies the two bandwidths within one command.

To set up only a global pool tunnel, leave out the keyword **sub-pool**. If you enter **global** as a keyword, the system will accept it, but will not write it to NVRAM. This is to avoid the problem of having your configuration not understood if you upgrade to an image that contains the DS-TE capability and then return to a non-DS-TE image.

Examples

The following example shows how to configure 100 kbps of bandwidth for the MPLS traffic engineering tunnel:

```
Router(config-if)# tunnel mpls traffic-eng bandwidth 100
```

Related Commands

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

tunnel mpls traffic-eng path-option

To configure a path option for a Multiprotocol Label Switching (MPLS) traffic engineering (TE) tunnel, use the **tunnel mpls traffic-eng path-option** command in interface configuration mode. To disable the specified path option, use the **no** form of this command.

tunnel mpls traffic-eng path-option [**protect**] *number* {**dynamic** | **explicit** | {**name** *path-name* | *path-number*}} [**lockdown**]

no tunnel mpls traffic-eng path-option [**protect**] *number* {**dynamic** | **explicit** | {**name** *path-name* | *path-number*}} [**lockdown**]

Syntax Description

protect	(Optional) Backup label-switched path (LSP.)
number	When multiple path options are configured, lower numbered options are preferred.
dynamic	Part of the LSP is dynamically calculated.
explicit	Part of the LSP is an IP explicit path.
name *path-name*	Path name of the IP explicit path that the tunnel uses with this option.
path-number	Path number of the IP explicit path that the tunnel uses with this option.
lockdown	(Optional) The LSP cannot be reoptimized.

Defaults

Disabled.

Command Modes

Interface configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.0(30)S	The **protect** keyword was added.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Usage Guidelines

You can configure multiple path options for a single tunnel. For example, there can be several explicit path options and a dynamic option for one tunnel. Path setup preference is for lower (not higher) numbers, so option 1 is preferred.

Dynamic path protection is not recommended.

You should not configure the **lockdown** option with protected paths.

Examples

The following example shows how to configure the tunnel to use a named IP explicit path:

```
Router(config-if)# tunnel mpls traffic-eng path-option protect 10 explicit path750
```

In the following example, tunnel 10 is protected with path3441:

```
Router(config-if)# tunnel mpls traffic-eng path-option protect 10 explicit path3441
```

Related Commands

Command	Description
ip explicit-path	Enters the subcommand mode for IP explicit paths and creates or modifies the specified path.
show ip explicit-paths	Displays the configured IP explicit paths.
tunnel mpls traffic-eng priority	Configures the setup and reservation priority for an MPLS traffic engineering tunnel.

tunnel mpls traffic-eng priority

To configure the setup and reservation priority for an Multiprotocol Label Switching (MPLS) traffic engineering (TE) tunnel, use the **tunnel mpls traffic-eng priority** command in interface configuration mode. To remove the specified setup and reservation priority, use the **no** form of this command.

tunnel mpls traffic-eng priority *setup-priority* [*hold-priority*]

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

Syntax Description

setup-priority	The priority used when signalling an LSP for this tunnel to determine which existing tunnels can be preempted. Valid values are from 0 to 7, where a lower number indicates a higher priority. Therefore, an LSP with a setup priority of 0 can preempt any LSP with a non-0 priority.
hold-priority	(Optional) The priority associated with an LSP for this tunnel to determine if it should be preempted by other LSPs that are being signalled. Valid values are from 0 to 7, where a lower number indicates a higher priority.

Defaults

setup-priority: 7
hold-priority: The same value as the setup-priority

Command Modes

Interface configuration

Command History

Release	Modification
12.0(5)S	This command was introduced.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Usage Guidelines

When a label switched path (LSP) is being signaled and an interface does not currently have enough bandwidth available for that LSP, the call admission software preempts lower-priority LSPs so that the new LSP can be admitted. (LSPs are preempted if that allows the new LSP to be admitted.)

In the described determination, the new LSP's priority is its setup priority and the existing LSP's priority is its hold priority. The two priorities make it possible to signal an LSP with a low setup priority (so that the LSP does not preempt other LSPs on setup) but a high hold priority (so that the LSP is not preempted after it is established).

Setup priority and hold priority are typically configured to be equal, and setup priority cannot be better (numerically smaller) than the hold priority.

Examples

The following example shows how to configure a tunnel with a setup and hold priority of 1:

```
Router(config-if)# tunnel mpls traffic-eng priority 1
```

Related Commands

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

Glossary

affinity—An MPLS traffic engineering tunnel's requirements on the attributes of the links it will cross. The tunnel's affinity bits and affinity mask bits must match the attribute bits 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. Tunnels that are harder to route are expected to have a higher priority and to be able to preempt tunnels that are easier to route. The assumption is that lower-priority tunnels will be able to find another path.

constraint-based routing—Procedures and protocols that determine a route across a backbone take 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 is 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. The Internet protocol used to exchange routing information within an autonomous system. Examples of common IGPs include IGRP, OSPF, and RIP.

ip explicit path—A list of IP addresses, each representing a node or link in the explicit path.

IS-IS—Intermediate System-to-Intermediate System. OSI link-state hierarchical routing protocol that calls for intermediate system (IS) routers to exchange routing information based on a single metric to determine network topology.

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

label-switched path (LSP) tunnel—A configured connection between two routers, in which label switching is used to carry the packets.

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, receiving routers use LSAs to maintain their routing tables.

LSP—See label-switched path.

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

reoptimization—Reevaluation of the most suitable path for a tunnel to use, given the specified constraints.

RSVP—Resource Reservation Protocol. A protocol for reserving network resources to provide quality of service guarantees to application flows.

tailend—The downstream, receive end of a tunnel.

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

Note See *Internetworking Terms and Acronyms* for terms not included in this glossary.