MPLS Traffic Engineering—Automatic Bandwidth Adjustment for TE Tunnels

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The MPLS Traffic Engineering—Automatic Bandwidth Adjustment for TE Tunnels feature provides the means to automatically adjust the bandwidth allocation for traffic engineering tunnels based on their measured traffic load.

History for the MPLS Traffic Engineering—Automatic Bandwidth Adjustment for TE Tunnels Feature

Release	Modification
12.0(14)ST	This feature was introduced.
12.2(4)T	This feature was integrated into Release 12.2(4)T.
12.2(4)T2	Support for the Cisco 7500 series routers was added.
12.2(14)S	This feature was integrated into Cisco IOS Release 12.2(14)S.
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 autobandwidth samples the average output rate for each tunnel marked for automatic bandwidth adjustment. For each marked tunnel, it periodically (for example, once per day) adjusts the tunnel's allocated bandwidth to be the largest sample for the tunnel since the last adjustment.

The frequency with which tunnel bandwidth is adjusted and the allowable range of adjustments is configurable on a per-tunnel basis. In addition, the sampling interval and the interval over which to average tunnel traffic to obtain the average output rate is user-configurable on a per-tunnel basis.

Benefits

The automatic bandwidth feature makes it easy to configure and monitor the bandwidth for Multiprotocol Label Switching (MPLS) traffic engineering tunnels. If automatic bandwidth is configured for a tunnel, traffic engineering automatically adjusts the the tunnel's bandwidth.

Restrictions

The automatic bandwidth adjustment feature treats each tunnel for which it has been enabled independently. That is, it adjusts the bandwidth for each such tunnel according to the adjustment frequency configured for the tunnel and the sampled output rate for the tunnel since the last adjustment without regard for any adjustments previously made or pending for other tunnels.

Related Features and Technologies

The automatic bandwidth feature is related to:

- MPLS traffic engineering
- Resource Reservation Protocol (RSVP)

Prerequisites

Your network must support the following:

- MPLS traffic engineering tunnels
- IP Cisco Express Forwarding

Configuration Tasks

Perform the following tasks before you enable automatic bandwidth adjustment:

- Configure MPLS tunnels.
- Configure Cisco Express Forwarding.

Perform the following tasks to configure automatic bandwidth adjustment:

- Configuring a Platform to Support Traffic Engineering Tunnels, page 3
- Configuring IS-IS for MPLS Traffic Engineering, page 4
- Configuring OSPF for MPLS Traffic Engineering, page 4
- Configuring an MPLS Traffic Engineering Tunnel, page 5
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- Configuring a Platform to Support Automatic Bandwidth Adjustment, page 6
- Configuring Automatic Bandwidth Adjustment for a Tunnel, page 7
- Configuring the Interval for Computing Tunnel Average Output Rate, page 7

Configuring a Platform to Support Traffic Engineering Tunnels

To configure a platform to support traffic engineering 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 Command Reference*.
Step 2	`Router(config)# mpls traffic-eng tunnels`	Enables the MPLS traffic engineering tunnel feature on a device.

Configuring IS-IS for MPLS Traffic Engineering

To configure Intermediate System-to-Intermediate System (IS-IS) for MPLS traffic engineering, perform the steps described below. For a description of the IS-IS commands, see the *Cisco IOS Switching Services Command Reference* and see *Cisco IOS IP Command Reference, Volume 2 of 3: Routing Protocols*.

	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 type, length, value objects (TLVs).

Configuring OSPF for MPLS Traffic Engineering

To configure Open Shortest Path First (OSPF) for MPLS traffic engineering, perform the steps described below. For a description of the OSPF commands, see the *Cisco IOS Switching Command Reference* and see *Cisco IOS IP Command Reference, Volume 2 of 3*: *Routing Protocols*.

	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. For more detailed descriptions of the commands and their arguments, see the *Cisco IOS Switching Services Configuration Guide*.

	Command	Purpose
Step 1	`Router(config)# interface tunnel-interface`	Configures an interface type and enters interface configuration mode.
Step 2	`Router(config-if)# 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. The destination must be the MPLS traffic engineering router ID of the destination device.
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. If automatic bandwidth is configured for the tunnel, the **tunnel mpls traffic-eng bandwidth** command configures the initial tunnel bandwidth, which will be adjusted by the autobandwidth mechanism.
Step 6	`Router(config-if)# tunnel mpls traffic-eng path-option number {dynamic | explicit {name path-name | id 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 Bandwidth on Each Link That the Tunnels Cross

To configure bandwidth on each link that the tunnels cross, perform the following steps:

	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` *interface-kbps single-flow-kbps* [**sub-pool** *kbps*]	Enables RSVP for IP on an interface and specifies the amount of interface bandwidth (in kbps) allocated for RSVP flows (for example, traffic engineering tunnels).

Configuring a Platform to Support Automatic Bandwidth Adjustment

To enable automatic bandwidth adjustment on a platform and initiate sampling the output rate for tunnels configured for bandwidth adjustment, enter the following global configuration command:

Command	Description
`Router(config)# mpls traffic-eng auto-bw timers frequency` [*sec*]	Enables automatic bandwidth adjustment on a platform and begins sampling the output rate for tunnels that have been configured for automatic bandwidth adjustment. The *sec* option can be used to specify the sampling interval, in seconds.

To disable automatic bandwidth adjustment on a platform, use the **no** version of the command, which terminates output rate sampling and bandwidth adjustment for tunnels. In addition, the **no** form of the command restores the configured bandwidth for each tunnel where “configured bandwidth” is determined as follows:

- If the tunnel bandwidth was explicitly configured via the **tunnel mpls traffic-eng bandwidth** command after the running configuration was written (if at all) to the startup configuration, the “configured bandwidth” is the bandwidth specified by that command.
- Otherwise, the “configured bandwidth” is the bandwidth specified for the tunnel in the startup configuration.

Configuring Automatic Bandwidth Adjustment for a Tunnel

To enable automatic bandwidth adjustment for a tunnel and constrain the range of automatic bandwidth adjustments applied to the tunnel, perform these steps in interface configuration mode:

	Command	Purpose
Step 1	`Router(config)# interface tunnel-interface`	Configures an interface type and enters interface configuration mode.
Step 2	`Router(config-if)# tunnel mpls traffic-eng auto-bw max-bw seconds min-bw seconds`	Enables automatic bandwidth adjustment for the tunnel. Specifies the minimum and maximum automatic bandwidth allocations, in kilobits per second, that can be applied to the tunnel by automatic adjustment.

Configuring the Interval for Computing Tunnel Average Output Rate

To specify the interval for computing the average output rate for an MPLS traffic engineering tunnel, use the **load-interval** command shown below.

Command	Purpose
`Router(config)# interface tunnel-interface`	Configures an interface type and enters interface configuration mode.
`Router(config-if)# load-interval sec`	Configures the interval over which the input and output rates for the interface are averaged.

Verifying the Configuration

To verify that automatic bandwidth has been configured, enter the command shown below. For a detailed description of the command, see the *Cisco IOS Switching Command Reference*.

Command	Purpose
`Router(config)# show mpls traffic-eng tunnels tunnel-interface`	Shows information about tunnels, including automatic bandwidth information for tunnels that have the feature enabled.

Example:

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

- The auto-bw line indicates that automatic bandwidth adjustment is enabled for the tunnel.
- 86400 is the time, in seconds, between bandwidth adjustments.
- 85477 is the time, in seconds, remaining until the next bandwidth adjustment.
- 5347 is the largest bandwidth sample since the last bandwidth adjustment.
- 5000 is the last bandwidth adjustment and the bandwidth currently requested for the tunnel.

```
Router# show mpls traffic-eng tunnels

Name:tagsw4500-9_t1                       (Tunnel1) Destination:10.0.0.11
  Status:
    Admin:up         Oper:up     Path:valid       Signalling:connected

    path option 1, type explicit pbr_south (Basis for Setup, path weight 30)
    path option 2, type dynamic

  Config Parameters:
    Bandwidth:5000     kbps (Global)  Priority:7  7   Affinity:0x0/0xFFFF
    AutoRoute: disabled  LockDown:disabled  Loadshare:5000     bw-based
    auto-bw:(86400/85477) 5347 Bandwidth Requested:5000
```

Troubleshooting Tips

Each **tunnel mpls traffic-eng auto-bw** command supersedes the previous one. Therefore, if you want to specify multiple options for a tunnel, you must specify them all in a single **tunnel mpls traffic-eng auto-bw** command.

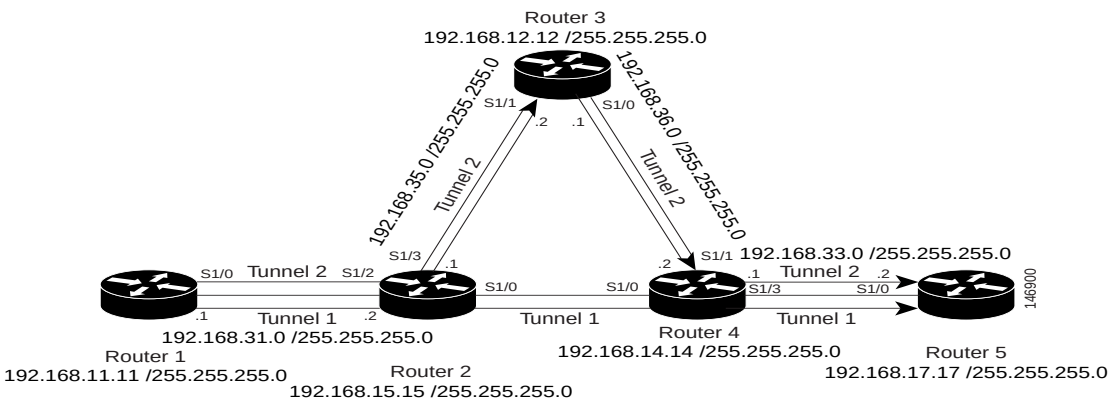
Configuration Examples

This section provides the following configuration examples:

- MPLS Traffic Engineering Configuration for Automatic Bandwidth, page 9
- Tunnel Configuration for Automatic Bandwidth, page 9

Figure 1 illustrates a sample MPLS topology. The next sections contain sample configuration commands to configure automatic bandwidth adjustment for MPLS traffic engineering tunnels originating on Router 1 and to enable it for Tunnel1. The examples omit some configuration required for MPLS traffic engineering, such as the required RSVP and Interior Gateway Protocol (IGP) (IS-IS or OSPF) configuration, because the purpose of these examples is to illustrate the configuration for automatic bandwidth adjustment. For information about configuring MPLS traffic engineering see the *Cisco IOS Switching Services Configuration Guide*.

Figure 1 Sample MPLS Traffic Engineering Tunnel Configuration



MPLS Traffic Engineering Configuration for Automatic Bandwidth

The following illustrates how to use the **mpls traffic-eng auto-bw timers** command to enable automatic bandwidth adjustment for Router 1. The command specifies that the output rate is to be sampled every 10 minutes for tunnels configured for automatic bandwidth.

```
ip cef
mpls traffic-eng tunnels
mpls traffic-eng auto-bw timers frequency 600  !Enable automatic bandwidth adjustment
interface loopback 0
ip address 192.168.11.11 255.255.255.0
```

Tunnel Configuration for Automatic Bandwidth

The following example illustrates how to use the **tunnel mpls traffic-eng auto-bw** command to enable automatic bandwidth adjustment for Tunnel1. The command specifies a maximum allowable bandwidth of 2000 kbps, a minimum allowable bandwidth of 1000 kbps, and that the default automatic bandwidth adjustment frequency of once a day be used.

```
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 1500
  tunnel mpls traffic-eng priority 1 1
  tunnel mpls traffic-eng path-option 1 dynamic
  tunnel mpls traffic-eng auto bw max-bw 2000 min-bw 1000   !Enable automatic bandwidth
                                                            !adjustment for Tunnel1
```

Additional References

The following sections provide references related to MPLS Traffic Engineering—Automatic Bandwidth Adjustment for TE Tunnels.

Related Documents

Related Topic	Document Title
IP commands	*Cisco IOS IP Command Reference, Volume 2 of 3: Routing Protocols*, Release 12.2
Quality of service solutions commands	*Cisco IOS Quality of Service Solutions Command Reference*, Release 12.4T
Quality of service solutions	*Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.4
Switching services commands	*Cisco IOS Switching Command Reference*, Release 12.4T
Switching services	*Cisco IOS Switching Services Configuration Guide*, Release 12.2

Standards

Standard	Title
None	—

MIBs

MIB	MIBs Link
MPLS Traffic Engineering MIB	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
None	—

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.

- **clear mpls traffic-eng auto-bw timers**
- **mpls traffic-eng auto-bw timers**
- **tunnel mpls traffic-eng auto-bw**

clear mpls traffic-eng auto-bw timers

To reinitialize the automatic bandwidth adjustment feature on a platform, use the **clear mpls traffic-eng auto-bw timers** command in user EXEC mode.

clear mpls traffic-eng auto-bw timers

Syntax Description

This command has no arguments or keywords.

Defaults

None.

Command Modes

User EXEC

Command History

Release	Modification
12.2(4)T	This command was introduced.
12.2(14)S	This command was integrated into Cisco IOS Release 12.2(14)S.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Usage Guidelines

For each tunnel for which automatic bandwidth adjustment is enabled, the platform maintains information about sampled output rates and the time remaining until the next bandwidth adjustment. The **clear mpls traffic-eng auto-bw timers** command clears this information for all such tunnels. The effect is as if automatic bandwidth adjustment had just been enabled for the tunnels.

Examples

The following example shows how to clear information about sampled output rates and the time remaining until the next bandwidth adjustment:

```
Router> clear mpls traffic-eng auto-bw timers
Clear mpls traffic engineering auto-bw timers [confirm]
```

Related Commands

Command	Description
mpls traffic-eng auto-bw timers	Enables automatic bandwidth adjustment on a platform for tunnels configured for bandwidth adjustment.
tunnel mpls traffic-eng auto-bw	Enables automatic bandwidth adjustment for a tunnel, specifies the frequency with which tunnel bandwidth can be automatically adjusted, and designates the allowable range of bandwidth adjustments.

mpls traffic-eng auto-bw timers

To enable automatic bandwidth adjustment for a platform and to start output rate sampling for tunnels configured for automatic bandwidth adjustment, use the **mpls traffic-eng auto-bw timers** command in global configuration mode. To disable automatic bandwidth adjustment for the platform, use the **no** form of this command.

mpls traffic-eng auto-bw timers [**frequency** *sec*]

no mpls traffic-eng auto-bw timers

Syntax Description

frequency *sec*	(Optional) Interval, in seconds, for sampling the output rate of each tunnel configured for automatic bandwidth. The value must be from 1 through 604800. The recommended value is 300.

Defaults

When the optional **frequency** keyword is not specified, the sampling interval is 300 seconds (5 minutes).

Command Modes

Global configuration

Command History

Release	Modification
12.2(4)T	This command was introduced.
12.2(14)S	This command was integrated into Cisco IOS Release 12.2(14)S.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Usage Guidelines

The **mpls traffic-eng auto-bw timers** command enables automatic bandwidth adjustment on a platform by causing traffic engineering to periodically sample the output rate for each tunnel configured for bandwidth adjustment.

The **no mpls traffic-eng auto-bw timers** command disables automatic bandwidth adjustment for a platform by terminating the output rate sampling and bandwidth adjustment for tunnels configured for adjustment. In addition, the **no** form of the command restores the configured bandwidth for each tunnel where "configured bandwidth" is determined as follows:

- If the tunnel bandwidth was explicitly configured via the **tunnel mpls traffic-eng bandwidth** command after the running configuration was written (if at all) to the startup configuration, the "configured bandwidth" is the bandwidth specified by that command.
- Otherwise, the "configured bandwidth" is the bandwidth specified for the tunnel in the startup configuration.

Examples

The following example shows how to designate that for each Multiprotocol Label Switching (MPLS) traffic engineering tunnel, the output rate is sampled once every 10 minutes (every 600 seconds):

```
Router(config)# mpls traffic-eng auto-bw timers frequency 600
```

Related Commands

Command	Description
tunnel mpls traffic-eng auto-bw	Enables automatic bandwidth adjustment for a tunnel, specifies the frequency with which tunnel bandwidth can be automatically adjusted, and designates the allowable range of bandwidth adjustments.

tunnel mpls traffic-eng auto-bw

To configure a tunnel for automatic bandwidth adjustment and to control the manner in which the bandwidth for a tunnel is adjusted, use the **tunnel mpls traffic-eng auto-bw** command in interface configuration mode. To disable automatic bandwidth adjustment for a tunnel, use the **no** form of this command.

tunnel mpls traffic-eng auto-bw [**collect-bw**] [**frequency** *seconds*] [**max-bw** *seconds*] [**min-bw** *seconds*]

no tunnel mpls traffic-eng auto-bw

Syntax Description

collect-bw	(Optional) Collects output rate information for the tunnel, but does not adjust the tunnel's bandwidth.
frequency *seconds*	(Optional) The interval between bandwidth adjustments. The specified interval can be from 300 to 604800 seconds. Do not specify a value lower than the output rate sampling interval specified in the **mpls traffic-eng auto-bw** command.
max-bw *seconds*	(Optional) Maximum automatic bandwidth, in kbps, for this tunnel. The value is from 0 to 4294967295.
min-bw *seconds*	(Optional) Minimum automatic bandwidth, in kbps, for this tunnel. The value is from 0 to 4294967295.

Defaults

If the command is entered with no optional keywords or arguments, automatic bandwidth adjustment for the tunnel is enabled, with adjustments made every 24 hours and with no constraints on the bandwidth adjustments made.

If the **collect-bw** keyword is entered, the tunnel's bandwidth is sampled but not adjusted, and the other keywords, if any, are ignored.

If the **collect-bw** keyword is not entered and some, but not all of the other keywords are entered, the defaults for the options not entered are: **frequency**, every 24 hours; **min-bw**, unconstrained (0); **max-bw**, unconstrained.

Command Modes

Interface configuration

Command History

Release	Modification
12.2(4)T	This command was introduced.
12.2(14)S	This command was integrated into Cisco IOS Release 12.2(14)S.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Usage Guidelines

To sample the bandwidth used by a tunnel without automatically adjusting it, specify the **collect-bw** keyword in the **tunnel mpls traffic-eng auto-bw** command.

If you enter the **tunnel mpls traffic-eng auto-bw** command without the **collect-bw** keyword, the tunnel's bandwidth is adjusted to the largest average output rate sampled for the tunnel since the last bandwidth adjustment for the tunnel was made.

To constrain the bandwidth adjustment that can be made to a tunnel, use the **max-bw** and **min-bw** keywords and specify the permitted maximum allowable bandwidth and minimum allowable bandwidth, respectively.

The **no** form of the **tunnel mpls traffic-eng auto-bw** command disables bandwidth adjustment for the tunnel and restores the configured bandwidth for the tunnel bandwidth where "configured bandwidth" is determined as follows:

- If the tunnel bandwidth was explicitly configured via the **tunnel mpls traffic-eng bandwidth** command after the running configuration was written (if at all) to the startup configuration, the "configured bandwidth" is the bandwidth specified by that command.
- Otherwise, the "configured bandwidth" is the bandwidth specified for the tunnel in the startup configuration.

Note When you save the router configuration, the current bandwidth (not the originally configured bandwidth) is saved for tunnels with automatic bandwidth enabled.

Note Each **tunnel mpls traffic-eng auto-bw** command supersedes the previous one. Therefore, if you want to specify multiple arguments for a tunnel, you must specify them all in a single **tunnel mpls traffic-eng auto-bw** command.

Note Keywords for the **tunnel mpls traffic-eng auto-bw** command are order-dependent; you must enter them in the order in which they are listed in the command format.

Examples

The following example shows how to enable automatic bandwidth adjustment for tunnel102 and specify that the adjustments are to occur every hour:

```
Router(config)# interface tunnel102
Router(config-if)# tunnel mpls traffic-eng auto-bw frequency 3600
```

Related Commands

Command	Description
mpls traffic-eng auto-bw timers	Enables automatic bandwidth adjustment on a platform for tunnels configured for bandwidth adjustment.
tunnel mode mpls traffic-eng	Sets the mode of a tunnel to MPLS for traffic engineering.
tunnel mpls traffic-eng bandwidth	Configures bandwidth required for a MPLS traffic engineering tunnel.