



# MPLS Traffic Engineering (TE)—Automatic Bandwidth Adjustment for TE Tunnels

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## Feature History

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.

This feature module describes Multiprotocol Label Switching (MPLS) automatic bandwidth adjustment for Release 12.2(4)T2. Automatic bandwidth adjustment is a feature of traffic engineering.

This document contains the following sections:

- Feature Overview
- Supported Platforms
- Supported Standards, MIBs, and RFCs
- Prerequisites
- Configuration Tasks
- Configuration Examples
- Command Reference

## Feature Overview

Traffic engineering automatic bandwidth adjustment provides the means to automatically adjust the bandwidth allocation for traffic engineering tunnels based on their measured traffic load.

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 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
- RSVP (Resource Reservation Protocol)

## Related Documents

- *Cisco IOS IP Command Reference, Volume 2 of 3*, Release 12.2
- *Cisco IOS Quality of Service Solutions Command Reference*, Release 12.2
- *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2
- *Cisco IOS Switching Services Configuration Guide*, Release 12.2
- *Cisco IOS Switching Services Command Reference*, Release 12.2

## Supported Platforms

Automatic bandwidth is supported on the following platforms:

- Cisco 3600 series (including the Cisco 3620, Cisco 3640, and Cisco 3660)
- Cisco 4000 series (including the Cisco 4000 and Cisco 4500)
- Cisco 7200 series (including the Cisco 7202, Cisco 7204, Cisco 7204 VXR, Cisco 7206, and Cisco 7206 VXR)
- Cisco 7500 series (including the Cisco 7505, Cisco 7507, Cisco 7513, and Cisco 7576)

**Note**

The Cisco 7500 series platform is supported in Release 12.2(4)T2 and later.

### Platform Support Through Feature Navigator

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

Feature Navigator is a web-based tool that enables you to quickly determine which Cisco IOS software images support a specific set of features and which features are supported in a specific Cisco IOS image.

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

Feature Navigator is updated when major Cisco IOS software releases and technology releases occur. As of May 2001, Feature Navigator supports M, T, E, S, and ST releases. You can access Feature Navigator at the following URL:

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

## Supported Standards, MIBs, and RFCs

### Standards

No new or modified standard are supported by this feature.

### MIBs

This feature supports the *MPLS Traffic Engineering MIB*.

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

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

### RFCs

No new or modified RFCs are supported by this feature.

## Prerequisites

Your network must support the following:

- MPLS traffic engineering tunnels
- IP Cisco Express Forwarding (CEF)

## Configuration Tasks

Perform the following tasks before you enable automatic bandwidth adjustment:

- Configure MPLS tunnels.
- Configure CEF.

Perform the following tasks to configure automatic bandwidth adjustment:

- Configuring a Platform to Support Traffic Engineering Tunnels
- Configuring IS-IS for MPLS Traffic Engineering
- Configuring OSPF for MPLS Traffic Engineering
- Configuring an MPLS Traffic Engineering Tunnel
- Configuring Bandwidth on Each Link That the Tunnels Cross
- Configuring a Platform to Support Automatic Bandwidth Adjustment
- Configuring Automatic Bandwidth Adjustment for a Tunnel
- Configuring the Interval for Computing Tunnel Average Output Rate

### 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)# <b>ip cef</b>	Enables standard CEF operation.  For information about CEF configuration and the command syntax, see the <i>Cisco IOS Switching Services Configuration Guide</i> and the <i>Cisco IOS Switching Services Command Reference</i> .
Step 2	Router(config)# <b>mpls traffic-eng tunnels</b>	Enables the MPLS traffic engineering tunnel feature on a device.

### 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, 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)# <b>router isis</b>	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)# <b>mpls traffic-eng level-1</b>	Turns on MPLS traffic engineering for IS-IS level 1.

	Command	Purpose
Step 3	Router(config-router)# <b>mpls traffic-eng router-id loopback0</b>	Specifies that the traffic engineering router identifier for the node is the IP address associated with interface loopback0.
Step 4	Router(config-router)# <b>metric-style wide</b>	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, 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)# <b>router ospf process-id</b>	Configures an OSPF routing process for IP. You are placed in router configuration mode.  The <i>process-id</i> 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)# <b>mpls traffic-eng area 0</b>	Turns on MPLS traffic engineering for OSPF area 0.
Step 3	Router(config-router)# <b>mpls traffic-eng router-id loopback0</b>	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)# <b>interface</b> <i>tunnel-interface</i>	Configures an interface type and enters interface configuration mode.
Step 2	Router(config-if)# <b>ip unnumbered loopback0</b>	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)# <b>tunnel destination</b> <i>A.B.C.D</i>	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)# <b>tunnel mode mpls traffic-eng</b>	Sets the tunnel encapsulation mode to MPLS traffic engineering.
Step 5	Router(config-if)# <b>tunnel mpls traffic-eng bandwidth</b> <i>bandwidth</i>	Configures the bandwidth for the MPLS traffic engineering tunnel. If automatic bandwidth is configured for the tunnel, the <b>tunnel mpls traffic-eng bandwidth</b> command configures the initial tunnel bandwidth, which will be adjusted by the auto-bandwidth mechanism.
Step 6	Router(config-if)# <b>tunnel mpls traffic-eng path-option</b> <i>number</i> { <b>dynamic</b>   <b>explicit</b> { <i>name path-name</i>   <i>id path-number</i> }} [ <b>lockdown</b> ]	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)# <b>mpls traffic-eng tunnels</b>	Enables MPLS traffic engineering tunnels on an interface.
Step 2	Router(config-if)# <b>ip rsvp bandwidth</b> <i>interface-kbps</i> <i>single-flow-kbps</i> [ <b>sub-pool</b> <i>kbps</i> ]	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)# <b>mpls traffic-eng auto-bw timers frequency</b> [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 <b>frequency</b> <i>sec</i> 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; that 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
<b>Step 1</b>	Router(config)# <b>interface</b> <i>tunnel-interface</i>	Configures an interface type and enters interface configuration mode.
<b>Step 2</b>	Router(config-if)# <b>tunnel mpls traffic-eng auto-bw max-bw</b> <i>n</i> <b>min-bw</b> <i>n</i>	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)# <b>interface</b> <i>tunnel-interface</i>	Configures an interface type and enters interface configuration mode.
Router(config-if)# <b>load-interval</b> <i>sec</i>	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 Services Command Reference*.

Command	Purpose
Router(config)# <b>show mpls traffic-eng tunnels</b> <i>tunnel_interface</i>	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-1# show mpls traffic-eng tunnels

```
Name:tagsw4500-9_t1                               (Tunnell) 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.

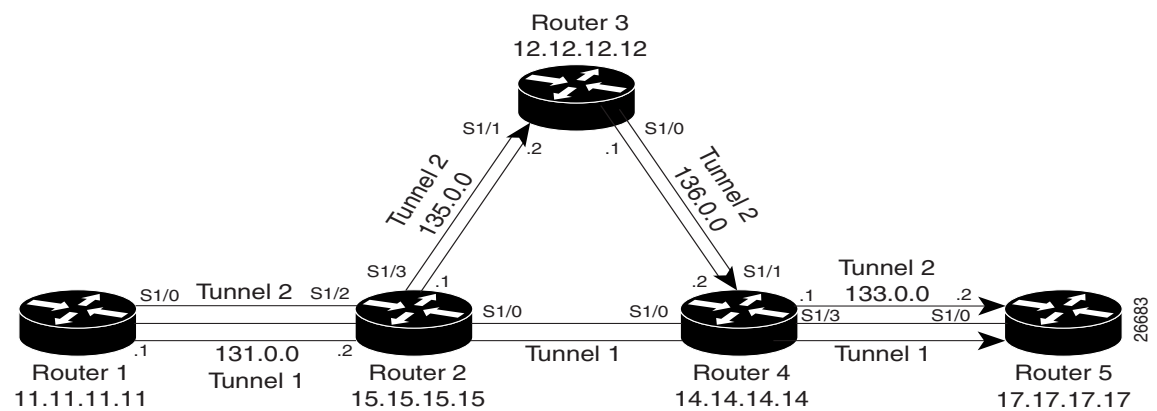
## Configuration Examples

This section provides the following configuration examples:

- MPLS Traffic Engineering Configuration for Automatic Bandwidth
- Tunnel Configuration for Automatic Bandwidth

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 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 11.11.11.11 255.255.255.255
```

## 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 17.17.17.17
  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
```

# Command Reference

This section documents the following new commands:

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

All other commands used with this feature are documented in the Cisco IOS Release 12.2 command reference publications.

# 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 EXEC** command.

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

**Syntax Description** This command has no arguments or keywords.

**Defaults** None.

**Command Modes** EXEC

Command History	Release	Modification
	Release 12.2(4)T	This command was introduced.

**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 command clears information about sampled output rates and the time remaining until the next bandwidth adjustment:

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

Related Commands	Command	Description
	<b>mpls traffic-eng auto-bw timers</b>	Enables automatic bandwidth adjustment on a platform for tunnels configured for bandwidth adjustment.
	<b>tunnel mpls traffic-eng auto-bw</b>	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** global configuration command. 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

<b>frequency sec</b>	(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.
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### Defaults

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

### Command Modes

Global configuration

### Command History

Release	Modification
Release 12.2(4)T	This command was introduced.

### 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 designates that for each 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
	<b>tunnel mpls traffic-eng auto-bw</b>	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** interface configuration command. To disable automatic bandwidth adjustment for a tunnel, use the **no** version of this command.

```
tunnel mpls traffic-eng auto-bw [collect-bw] [frequency sec] [max-bw n][min-bw n]
```

```
no tunnel mpls traffic-eng auto-bw
```

### Syntax Description

<b>collect-bw</b>	(Optional) Collect output rate information for the tunnel, but do not adjust the tunnel's bandwidth.
<b>frequency sec</b>	(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 <b>mpls traffic-eng auto-bw</b> global configuration command.
<b>max-bw n</b>	(Optional) Maximum automatic bandwidth, in kbps, for this tunnel. The value can be from 0 to 4294967295.
<b>min-bw n</b>	(Optional) Minimum automatic bandwidth, in kbps, for this tunnel. The value can be from 0 to 4294967295.

### Defaults

If the command is entered with no optional parameters, 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** option is entered, the tunnel's bandwidth is sampled but not adjusted, and the other options, if any, are ignored.

If the **collect-bw** option is not entered and some, but not all of the other options 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
Release 12.2(4)T	This command was introduced.

### Usage Guidelines

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

If you enter the **tunnel mpls traffic-eng auto-bw** command without the **collect-bw** option, 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/or **min-bw** arguments and specify the permitted maximum allowable bandwidth and/or 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 commands 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
<b>mpls traffic-eng auto-bw timers</b>	Enables automatic bandwidth adjustment on a platform for tunnels configured for bandwidth adjustment.