MPLS Traffic Engineering--LSP Attributes

This document describes how to configure label switched path (LSP) attributes for path options associated with Multiprotocol Label Switching (MPLS) traffic engineering (TE) tunnels.

The MPLS Traffic Engineering--LSP Attributes feature is an extension to MPLS TE that provides an LSP Attribute list feature and a Path Option for Bandwidth Override feature. These features provide flexibility in the configuration of LSP attributes for MPLS TE tunnel path options. Several LSP attributes can be applied to path options for TE tunnels using an LSP attribute list. If bandwidth is the only LSP attribute you require, then you can configure a Path Option for Bandwidth Override.

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Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for MPLS Traffic Engineering--LSP Attributes

TheMPLS Traffic Engineering--LSP Attributes feature requires that you configure an MPLS TE tunnel before you configure either an LSP Attribute List or a Path Option for Bandwidth Override feature.

Restrictions for MPLS Traffic Engineering--LSP Attributes

Reoptimization between path options with different bandwidth pool types (subpool versus global pool) and different priorities is not supported. Specifically,

- With the Path Option for Bandwidth Override feature, you need to configure bandwidth for path options with the same bandwidth pool as configured for the tunnel.
- With the LSP Attribute List feature, you need to configure both a bandwidth pool and priority for path options that are consistent with the bandwidth pool and priority configured on the tunnel or in other path options used by the tunnel.

Information About MPLS Traffic Engineering - Configurable Path Calculation Metric for Tunnels

MPLS Traffic Engineering--LSP Attributes Benefits

The MPLS Traffic Engineering--LSP Attributes feature provides an LSP Attribute List feature and a Path Option for Bandwidth Override feature. These features have the following benefits:

- The LSP Attributes List feature provides the ability to configure values for several LSP-specific path options for TE tunnels.
- One or more TE tunnels can specify specific path options by referencing an LSP Attribute List.
- LSP attribute lists make the MPLS TE user interface more flexible, easier to use, and easier to extend and maintain.
- The Path Option for Bandwidth Override feature provides a single command that allows a TE tunnel to fall back temporarily to path options that can reduce bandwidth constraints.

Traffic Engineering Bandwidth and Bandwidth Pools

MPLS traffic engineering allows constraint-based routing (CBR) of IP traffic. One of the constraints satisfied by CBR is the availability of required bandwidth over a selected path. Regular TE tunnel bandwidth is called the global pool. Subpool bandwidth is a portion of the global pool. Subpool bandwidth is not reserved from the global pool if it is not in use. Therefore, subpool tunnels require a higher priority than nonsubpool tunnels.

You can configure the LSP Attribute bandwidth path option to use either global pool (default) or subpool bandwidth. The bandwidth value for the path option may be any valid value and the pool does not have to be the same as that configured on the tunnel.

Note When you configure bandwidth for path options with the **bandwidth** [**sub-pool** | **global**] *kbps* command, use either all subpool bandwidths or all global-pool bandwidths.

You can configure bandwidth on both dynamic and explicit path options using either the LSP Attribute List feature or the Path Option for Bandwidth Override feature. The commands that enable these features are exclusive of each other. If bandwidth is the only LSP attribute that you need to set on the path option, then use the command to enable the feature. This is the simplest way to configure multiple path options with decreasing bandwidth constraints. Once the **bandwidth** keyword is entered on the **tunnel mpls traffic-eng path-option** command in interface configuration mode, you cannot configure an LSP Attribute List for that path option.

Tunnel Attributes and LSP Attributes

Cisco IOS XE tunneling interfaces have many parameters associated with MPLS TE. Typically, you configure these parameters with **tunnel mpls traffic-eng** commands in interface configuration mode. Many of these commands determine tunnel-specific properties, such as the load-sharing factor for the tunnel. These commands configure parameters that are unrelated to the particular LSP in use by the tunnel. However, some of the tunneling parameters apply to the LSP that the tunnel uses. You can configure the LSP-specific properties using an LSP Attribute list.

LSP Attributes and the LSP Attribute List

An LSP Attribute list can contain values for each LSP-specific parameter that is configurable for a TE tunnel. You configure an LSP attribute list with the **mpls traffic-eng lsp attributes** *string* command, where *string* identifies the attribute list. The LSP attributes that you can specify include the following:

- Attribute flags for links that make up the LSP (**affinity** command)
- Automatic bandwidth configuration (**auto-bw** command)
- LSP bandwidth--global pool or subpool (**bandwidth** command)
- Disable reoptimization of the LSP (**lockdown** command)
- LSP priority (**priority** command)
- Protection failure (**protection** command)
- Record the route used by the LSP (**record-route** command)

LSP Attribute Lists Management

The MPLS Traffic Engineering--LSP Attributes feature also provides commands that help you manage LSP Attribute lists. You can do the following:

- Relist all attribute list entries (**list** command)
- Remove a specific attribute from the list (**no***attribute* command)

The **exit** command exits from the LSP attributes configuration submode and returns you to global configuration mode.

Based on your requirements, you can configure LSP attributes lists with different sets of attributes for different path options. LSP attribute lists also provide an easy way to configure multiple TE tunnels to use the same LSP attributes. That is, you can reference the same LSP attribute list to configure LSP-specific parameters for one or more TE tunnels.

Constraint-Based Routing and Path Option Selection

MPLS traffic engineering automatically establishes and maintains LSPs across the backbone by using the Resource Reservation Protocol (RSVP). The path that an LSP uses is determined by the LSP resource requirements and network resources, such as bandwidth. Traffic engineering tunnels are calculated at the LSP head based on a fit between required and available resources (constraint-based routing).

Without the Path Option for Bandwidth Override feature, a TE tunnel establishes an LSP based on dynamic or explicit path options in order of preference. However, the bandwidth and other attributes configured on the TE tunnel allow the setup of an LSP only if LSP path options satisfy the constraints. If a path cannot be found that satisfies the configured path options, then the tunnel is not set up.

The Path Option for Bandwidth Override feature provides a fallback path option that allows overriding the bandwidth configured on the TE tunnel interface. For example, you can configure a path option that sets the bandwidth to zero (0) effectively removing the bandwidth constraint imposed by the constraint-based routing calculation.

Tunnel Reoptimization and Path Option Selection

Reoptimization occurs when 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 signaling is successful, the device replaces the older LSP with the new, better LSP.

Reoptimization can be triggered by a timer, the issuance of an **mpls traffic-eng reoptimize** command, or a configuration change that requires the resignalling of a tunnel. The MPLS AutoBandwidth feature, for example, uses a timer to set the frequency of reoptimization based on the bandwidth path option attribute. The Path Option for Bandwidth Override feature allows for the switching between bandwidth configured on the TE tunnel interface and bandwidth configured on a specific path option. This increases the success of signaling an LSP for the TE tunnel.

With bandwidth override configured on a path option, the traffic engineering software attempts to reoptimize the bandwidth every 30 seconds to reestablish the bandwidth configured on the tunnel (see the Configuring a Path Option for Bandwidth Override section).

You can disable reoptimization of an LSP with the **lockdown** command in an LSP Attribute list. You can apply the LSP Attribute list containing the **lockdown** command to a path option with the **tunnel mpls traffic-eng path-option** command.

Note When you configure bandwidth for path options with the **bandwidth** [**sub-pool** | **global**] *kpbs* command, use either all subpool bandwidths or all global-pool bandwidths. Do not mix subpool and nonsubpool bandwidths, otherwise the path option does not reoptimize later.

Path Option Selection with Bandwidth Override

The Path Option for Bandwidth Override feature allows you to configure bandwidth parameters on a specific path option. The **tunnel mpls traffic-eng path-option** command's **bandwidth** keyword can be used for this purpose. When an LSP is signaled using a path option with a configured bandwidth, the bandwidth associated with the path option is signaled instead of the tunnel's configured bandwidth.

This feature also provides the ability to configure multiple path options that reduce the bandwidth constraint each time the headend of a tunnel fails to establish an LSP.

The following configuration uses the **tunnel mpls traffic-eng bandwidth** command to configure the bandwidth of the tunnel and three **tunnel mpls traffic-eng path-option** commands that define the signalling path options for the LSP:

```
tunnel mpls traffic-eng bandwidth 1000
tunnel mpls traffic-eng path-option 1 explicit name path1
tunnel mpls traffic-eng path-option 2 explicit name path2 bandwidth 500
tunnel mpls traffic-eng path-option 3 dynamic bandwidth 0
```

The device selects a path option for an LSP in order of preference, as follows:

- The device attempts to signal an LSP using path options starting with path option 1.

The device attempts to signal an LSP with the 1000 kbps bandwidth configured on the tunnel interface because path-option 1 has no bandwidth configured.

- If 1000 kbps bandwidth is not available over the network, the device attempts to establish an LSP using path-option 2.

Path option 2 has a bandwidth of 500 kbps configured. This reduces the bandwidth constraint from the original 1000 kbps configured on the tunnel interface.

- If 500 kbps is not available, the device attempts to establish an LSP using path-option 3.

Path-option 3 is configured as dynamic and has bandwidth 0. The device establishes the LSP if an IP path exists to the destination and all other tunnel constraints are met.

Default Path Option Attributes for TE Tunnels Using LSP Attribute Lists

Values for path option attributes for a TE tunnel are determined in this manner:

- LSP attribute list values referenced by the path option take precedence over the values configured on the tunnel interface.
- If an attribute is not specified in the LSP attribute list, the device uses the attribute in the tunnel configuration. LSP attribute lists do not have defaults.
- If the attribute is not configured on the tunnel, then the device uses the tunnel default value, as follows:

{affinity= affinity 0 mask 0,

auto-bw= no auto-bw,

bandwidth= bandwidth 0,

lockdown= no lockdown,

priority= priority 7 7,

protection fast-reroute= no protection fast-reroute,

record-route= no record-route

.

.

.

}

How to Configure MPLS Traffic Engineering--LSP Attributes

Configuring an LSP Attribute List

Perform this task to configure a label switched path (LSP) attribute list with the desired attributes to be applied on a path option. Based on your requirements, you can configure LSP attributes lists with different sets of attributes for different path options. The LSP attribute list provides a user interface that is flexible, easy to use, and easy to extend and maintain for the configuration of MPLS TE tunnel path options.

LSP attribute lists also provide an easy way to configure multiple TE tunnels to use the same LSP attributes. That is, you can reference the same LSP attribute list to configure LSP-specific parameters for one or more TE tunnels.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **mpls traffic-eng lsp attributes** *string*
4. **affinity** *value* [**mask** *value*]
5. **auto-bw** [**frequency** *secs*] [**max-bw** *kbps*] [**min-bw** *kbps*] [**collect-bw**]
6. **bandwidth** [**sub-pool**| **global**] *kbps*
7. **list**
8. **lockdown**
9. **priority** *setup-priority* [*hold-priority*]
10. **protection fast-reroute**
11. **record-route**
12. **no** *sub-command*
13. **exit**
14. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**mpls traffic-eng lsp attributes** *string* **Example:** `Router(config)# mpls traffic-eng lsp attributes 1`	Configures an LSP attribute list and enters LSP Attributes configuration mode. • The *string* argument identifies a specific LSP attribute list.

Step 4	**affinity** *value* [**mask** *value*]
	
	Example:
	
	`Router(config-lsp-attr)# affinity 0 mask 0`
		(Optional) Specifies attribute flags for links comprising an LSP.
		
		• The *value* argument is a value required for links that make up an LSP. Values of the bits are either 0 or 1.
		• The **mask** *value* keyword argument combination indicates which attribute values should be checked.
		  • If a bit in the mask is 0, an attribute value of the link or that bit is irrelevant.
		  • If a bit in the mask is 1, the attribute value of that link and the required affinity of the LSP for that bit must match.

Step 5	**auto-bw** [**frequency** *secs*] [**max-bw** *kbps*] [**min-bw** *kbps*] [**collect-bw**] **Example:** `Router(config-lsp-attr)# auto-bw`	(Optional) Specifies automatic bandwidth configuration. • The **frequency** *secs* keyword argument combination specifies the interval between bandwidth adjustments. The specified interval can be from 300 to 604800 seconds. • The **max-bw** *kbps* keyword argument combination specifies the maximum automatic bandwidth, in kbps, for this path option. The value can be from 0 to 4294967295. • The **min-bw** *kpbs* keyword argument combination specifies the minimum automatic bandwidth, in kbps, for this path option. The value can be from 0 to 4294967295. • The **collect-bw** keyword collects output rate information for the path option, but does not adjust the bandwidth of the path option.

	Command or Action	Purpose
Step 6	**bandwidth** [**sub-pool**| **global**] *kbps* **Example:** `Router(config-lsp-attr)# bandwidth 5000`	(Optional) Specifies LSP bandwidth. • The **sub-pool** keyword indicates a subpool path option. • The **global** keyword indicates a global pool path option. Entering this keyword is not necessary, for all path options are from the global pool in the absence of the **sub-pool** keyword. • The *kbps* argument is the number of kilobits per second set aside for the path option. The range is from 1 to 4294967295.
Step 7	**list** **Example:** `Router(config-lsp-attr)# list`	(Optional) Displays the contents of the LSP attribute list.
Step 8	**lockdown** **Example:** `Router(config-lsp-attr)# lockdown`	(Optional) Disables reoptimization of the LSP.
Step 9	**priority** *setup-priority* [*hold-priority*] **Example:** `Router(config-lsp-attr)# priority 1 1`	(Optional) Specifies the LSP priority. • The *setup-priority* argument is used when signaling an LSP to determine which existing LSPs 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. • The *hold-priority* argument is associated with an LSP to determine if it should be preempted by other LSPs that are being signaled. Valid values are from 0 to 7, where a lower number indicates a higher priority.
Step 10	**protection fast-reroute** **Example:** `Router(config-lsp-attr)# protection fast-reroute`	(Optional) Enables failure protection on the LSP.
Step 11	**record-route** **Example:** `Router(config-lsp-attr)# record-route`	(Optional) Records the route used by the LSP.
Step 12	**no** *sub-command*	(Optional) Removes a specific attribute from the LSP attributes list.

	Command or Action	Purpose
	Example: `Router(config-lsp-attr)# no record-route`	• The *sub-command*argument names the LSP attribute to remove from the attributes list.
Step 13	**exit** **Example:** `Router(config-lsp-attr)# exit`	(Optional) Exits from LSP Attributes configuration mode.
Step 14	**end** **Example:** `Router(config)# end`	(Optional) Exits to privileged EXEC mode.

Adding Attributes to an LSP Attribute List

Perform this task to add attributes to an LSP attribute list. The LSP attribute list provides a user interface that is flexible, easy to use, and that can be extended or changed at any time to meet the requirements of your MPLS TE tunnel traffic. LSP Attributes configuration mode is used to display the specific LSP attributes list and to add or change the required path option attribute.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **mpls traffic-eng lsp attributes** *string*
4. **affinity** *value* [**mask***value*]
5. **bandwidth** [**sub-pool** | **global**] *kbps*
6. **priority** *setup-priority* [*hold-priority*]
7. **list**
8. **exit**
9. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Router> enable`	• Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**mpls traffic-eng lsp attributes** *string* **Example:** `Router(config)# mpls traffic-eng lsp attributes 1`	Configures an LSP Attribute list and enters LSP Attributes configuration mode. • The *string* argument identifies a specific LSP Attribute list.

Step 4	**affinity** *value* [**mask***value*]
	Example:
	`Router(config-lsp-attr)# affinity 0 mask 0`
		(Optional) Specifies attribute flags for links comprising an LSP.
		• The *value* argument is a value required for links that make up an LSP. Values of the bits are either 0 or 1.
		• The **mask***value* keyword argument combination indicates which attribute values should be checked.
		  • If a bit in the mask is 0, an attribute value of the link or that bit is irrelevant.
		  • If a bit in the mask is 1, the attribute value of that link and the required affinity of the LSP for that bit must match.

Step 5	**bandwidth** [**sub-pool** | **global**] *kbps* **Example:** `Router(config-lsp-attr)# bandwidth 1000`	Specifies an LSP bandwidth. • The **sub-pool** keyword indicates a subpool path option. • The **global** keyword indicates a global pool path option. Entering this keyword is not necessary, for all path options are from the global pool in the absence of the **sub-pool** keyword. • The *kbps* argument is the number of kilobits per second set aside for the path option. The range is from 1 to 4294967295.
Step 6	**priority** *setup-priority* [*hold-priority*] **Example:** `Router(config-lsp-attr)# priority 2 2`	Specifies the LSP priority. • The *setup-priority* argument is used when signaling an LSP to determine which existing LSPs 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. • The *hold-priority* argument is associated with an LSP to determine if it should be preempted by other LSPs that are being signaled. Valid values are from 0 to 7, where a lower number indicates a higher priority.

	Command or Action	Purpose
Step 7	**list** **Example:** `Router(config-lsp-attr)# list`	(Optional) Displays the contents of the LSP attribute list. • Use the **list** command to display the path option attributes added to the attribute list.
Step 8	**exit** **Example:** `Router(config-lsp-attr)# exit`	(Optional) Exits LSP Attributes configuration mode.
Step 9	**end** **Example:** `Router(config)# end`	(Optional) Exits to privileged EXEC mode.

Removing an Attribute from an LSP Attribute List

Perform this task to remove an attribute from an LSP attribute list. The LSP attributes list provides a means to easily remove a path option attribute that is no longer required for your MPLS TE tunnel traffic. LSP Attributes configuration mode is used to display the specific LSP attribute list and for the **no***sub-command*command, which is used to remove the specific attribute from the list. Replace the*sub-command* argument with the command that you want to remove from the list.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **mpls traffic-eng lsp attributes** *string*
4. **no** *sub-command*
5. **list**
6. **exit**
7. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Router> enable`	• Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**mpls traffic-eng lsp attributes** *string* **Example:** `Router(config)# mpls traffic-eng lsp attributes 1`	Configures an LSP Attribute list and enters LSP Attributes configuration mode. • The *string* argument identifies a specific LSP attribute list.
Step 4	**no** *sub-command* **Example:** `Router(config-lsp-attr)# no priority`	Removes a specific attribute from the LSP Attribute list. • The *sub-command*argument names the LSP attribute to remove from the attributes list.
Step 5	**list** **Example:** `Router(config-lsp-attr)# list`	(Optional) Displays the contents of the LSP attribute list. • Use the **list** command to verify that the path option attribute is removed from the attribute list.
Step 6	**exit** **Example:** `Router(config-lsp-attr)# exit`	(Optional) Exits LSP Attributes configuration mode.
Step 7	**end** **Example:** `Router(config)# end`	(Optional) Exits to privileged EXEC mode.

Modifying an Attribute in an LSP Attribute List

Perform this task to modify an attribute in an LSP attribute list. The LSP attribute list provides a flexible user interface that can be extended or modified an any time to meet the requirements of your MPLS TE tunnel traffic. LSP Attributes configuration mode is used to display the specific LSP attributes list and to modify the required path option attribute.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **mpls traffic-eng lsp attributes** *string*
4. **affinity** *value* [**mask***value*]
5. **list**
6. **affinity** *value* [**mask***value*]
7. **list**
8. **exit**
9. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**mpls traffic-eng lsp attributes** *string* **Example:** `Router(config)# mpls traffic-eng lsp attributes 1`	Configures an LSP Attribute list and enters LSP Attributes configuration mode. • The *string* argument identifies a specific LSP attribute list.

Step 4	**affinity** *value* [**mask***value*]
	
	Example:
	
	`Router(config-lsp-attr)# affinity 1 mask 1`
		Specifies attribute flags for links comprising an LSP.
		
		• The *value* argument is a value required for links comprising an LSP. Values of bits are either 0 or 1.
		
		• The **mask***value* keyword argument combination indicates which attribute values should be checked.
		
		  • If a bit in the mask is 0, an attribute value of the link or that bit is irrelevant.
		
		  • If a bit in the mask is 1, the attribute value of that link and the required affinity of the tunnel for that bit must match.

Step 5	**list**	(Optional) Displays the contents of the LSP Attribute list.

	Command or Action	Purpose
	Example: `Router(config-lsp-attr)# list`	• Use the **list** command to display the path option attributes configured in the attribute list.

Step 6	**affinity** *value* [**mask***value*]
	Example:
	`Router(config-lsp-attr)# affinity 0 mask 0`
		Specifies attribute flags for links comprising an LSP.
		• The *value* argument is a value required for links comprising an LSP. Values of bits are either 0 or 1.
		• The **mask***value* keyword argument combination indicates which attribute values should be checked.
		  • If a bit in the mask is 0, an attribute value of the link or that bit is irrelevant.
		  • If a bit in the mask is 1, the attribute value of that link and the required affinity of the tunnel for that bit must match.

Step 7	**list** **Example:** `Router(config-lsp-attr)# list`	(Optional) Displays the contents of the LSP attribute list. • Use the **list** command to verify that the path option attributes is modified in the attribute list.
Step 8	**exit** **Example:** `Router(config-lsp-attr)# exit`	(Optional) Exits LSP Attributes configuration mode.
Step 9	**end** **Example:** `Router(config)# end`	(Optional) Exits to privileged EXEC mode.

Deleting an LSP Attribute List

Perform this task to delete an LSP attribute list. You would perform this task when you no longer require the LSP attribute path options specified in the LSP attribute list for an MPLS TE tunnel.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **no mpls traffic-eng lsp attributes** *string*
4. **end**
5. **show mpls traffic-eng lsp attributes** [*string*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**no mpls traffic-eng lsp attributes** *string* **Example:** `Router(config)# no mpls traffic-eng lsp attributes 1`	Removes a specified LSP Attribute list from the device configuration. • The *string* argument identifies the specific LSP attribute list to remove.
Step 4	**end** **Example:** `Router(config)# end`	(Optional) Exits to privileged EXEC mode.
Step 5	**show mpls traffic-eng lsp attributes** [*string*] **Example:** `Router# show mpls traffic-eng lsp attributes`	(Optional) Displays information about configured LSP attribute lists. • Use the **show mpls traffic-eng lsp attributes** command to verify that the LSP attribute list was deleted from the router.

Verifying Attributes Within an LSP Attribute List

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **mpls traffic-eng lsp attributes** *string* **list**
4. **exit**
5. **end**

DETAILED STEPS

Step 1 **enable**
Use this command to enable privileged EXEC mode. Enter your password if prompted. For example:

Example:

```
Router> enable
Router#
```

Step 2 **configure terminal**
Use this command to enter global configuration mode. For example:

Example:

```
Router# configure terminal
Router(config)#
```

Step 3 **mpls traffic-eng lsp attributes** *string* **list**
Use this command to enter LSP Attributes configuration mode for a specific LSP attribute list and to verify that the contents of the attributes list are as expected. For example:

Example:

```
Router(config)# mpls traffic-eng lsp attributes 1 list
LIST 1
 bandwidth 1000
 priority 1 1
```

Step 4 **exit**
Use this command to exit LSP Attributes configuration mode. For example:

```
Router(config-lsp-attr)# exit
```

Example:

```
Router(config)#
```

Step 5 **end**
Use this command to exit to privileged EXEC mode. For example:

Example:

```
Router(config)# exit
Router#
```

Verifying All LSP Attribute Lists

Perform this task to verify all configured LSP attribute lists. Use this task to display all LSP attribute lists to verify that the attributes lists that you configured are in operation.

SUMMARY STEPS

1. **enable**
2. **show mpls traffic-eng lsp attributes** *string* [**details**]
3. **show running-config** | **begin** *text-string*
4. **exit**

DETAILED STEPS

Step 1 **enable**
Use this command to enable privileged EXEC mode. Enter your password if prompted. For example:

Example:

```
Router> enable
Router#
```

Step 2 **show mpls traffic-eng lsp attributes** *string* [**details**]
Use this command to verify that all configured LSP attribute lists are as expected. For example:

Example:

```
Router# show mpls traffic-eng lsp attributes
LIST 1
  affinity 1 mask 1
  bandwidth 1000
  priority 1 1
LIST 2
  bandwidth 5000
LIST hipriority
  priority 0 0
!
```

Step 3 **show running-config** | **begin** *text-string*
Use this command to verify that all configured LSP attribute lists are as expected. Use the **begin** command modifier with the**mpls traffic-eng lsp** *text-string* to locate the LSP attributes information in the configuration file. For example:

Example:

```
Router# show running-config | begin mpls traffic-eng lsp
mpls traffic-eng lsp attributes 1
  affinity 1 mask 1
  bandwidth 1000
  priority 1 1
!
mpls traffic-eng lsp attributes 2
  bandwidth 5000
!
mpls traffic-eng lsp attributes hipriority
  priority 0 0
.
.
.
Router#
```

Step 4 **exit**

Use this command to exit to user EXEC mode. For example:

Example:

```
Router# exit
Router>
```

Associating an LSP Attribute List with a Path Option for an MPLS TE Tunnel

Perform this task to associate an LSP attribute list with a path option for an MPLS TE tunnel. This task is required if you want to apply the LSP attribute list that you configured to path options for your MPLS TE tunnels.

Based on your requirements, you can configure LSP attributes lists with different sets of attributes for different path options. LSP attribute lists also provide an easy way to configure multiple TE tunnels to use the same LSP attributes. That is, you can reference the same LSP attribute list to configure LSP-specific parameters for one or more TE tunnels.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **tunnel destination** {*hostname* | *ip-address*}
5. **tunnel mode mpls traffic-eng**
6. **tunnel mpls traffic-eng autoroute announce**
7. **tunnel mpls traffic-eng bandwidth** [**sub-pool**| **global**] *bandwidth*
8. **tunnel mpls traffic-eng priority** *setup-priority* [*hold-priority*]
9. **tunnel mpls traffic-eng path-option** *number* {**dynamic** | **explicit** {**name** *path-name* | *path-number*} [**verbatim**]} [**attributes** *string*] [**bandwidth** [**sub-pool** | **global**] *kbps*] [**lockdown**]
10. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Router(config)# interface tunnel 1`	Configures an interface type and enters interface configuration mode. • The *type* argument is the type of interface that you want to configure. • The *number* argument is the number of the tunnel interface that you want to create or configure.
Step 4	**tunnel destination** {*hostname* | *ip-address*} **Example:** `Router(config-if)# tunnel destination 10.10.10.12`	Specifies the destination of the tunnel for this path option. • The *hostname* argument is the name of the host destination. • The *ip-address* argument is the IP address of the host destination expressed in decimal in four-part, dotted notation.
Step 5	**tunnel mode mpls traffic-eng** **Example:** `Router(config-if)# tunnel mode mpls traffic-eng`	Sets the encapsulation mode for the tunnel for MPLS TE.

	Command or Action	Purpose
Step 6	**tunnel mpls traffic-eng autoroute announce** **Example:** `Router(config-if)# tunnel mpls traffic-eng autoroute announce`	Specifies that the IGP should use the tunnel (if the tunnel is up) in its enhanced shortest path first (SPF) calculation.
Step 7	**tunnel mpls traffic-eng bandwidth** [**sub-pool**| **global**] *bandwidth* **Example:** `Router(config-if)# tunnel mpls traffic-eng bandwidth 1000`	Configures the bandwidth required for an MPLS TE tunnel and assigns it either to the subpool or the global pool. • The **sub-pool** keyword indicates a subpool tunnel. • The **global** keyword indicates a global pool tunnel. Entering this keyword is not necessary, for all tunnels are in the global pool in the absence of the **sub-pool** keyword. • The *kbps* argument is the bandwidth, in kilobits per second, set aside for the MPLS TE tunnel. The range is from 1 to 4294967295.
Step 8	**tunnel mpls traffic-eng priority** *setup-priority* [*hold-priority*] **Example:** `Router(config-if)# tunnel mpls traffic-eng priority 1 1`	Sets the priority to be used when the system determines which existing tunnels are eligible to be preempted. • The *setup-priority* argument is the priority used when signaling an LSP for this tunnel to determine which existing tunnels can be preempted. Valid values are from 0 to 7. A lower number indicates a higher priority. An LSP with a setup priority of 0 can preempt any LSP with a non-0 priority. • The *hold-priority* argument is the priority associated with an LSP for this tunnel to determine if it should be preempted by other LSPs that are being signaled. Valid values are from 0 to 7, where a lower number indicates a higher priority.
Step 9	**tunnel mpls traffic-eng path-option** *number* {**dynamic** | **explicit** {**name** *path-name* | *path-number*} [**verbatim**]} [**attributes** *string*] [**bandwidth** [**sub-pool** | **global**] *kbps*] [**lockdown**] **Example:** `Router(config-if)# tunnel mpls traffic-eng path-option 1 dynamic attributes 1` **Example:**	Adds an LSP attribute list to specify LSP-related parameters for a path options for an MPLS TE tunnel. • The *number* argument identifies the path option. • The **dynamic** keyword indicates that the path option is dynamically calculated (the router figures out the best path). • The **explicit** keyword indicates that the path option is specified. You specify the IP addresses of the path. • The **name** *path-name*keyword argument combination identifies the name of the explicit path option. • The *path-number* argument identifies the number of the explicit path option. • The **verbatim** keyword bypasses the topology database verification.

	Command or Action	Purpose
		Note You can use the **verbatim** keyword only with the explicit path option. • The **attributes** *string* keyword argument combination names an attribute list to specify path options for the LSP. • The **bandwidth** keyword specifies LSP bandwidth. • The **sub-pool** keyword indicates a subpool path option. • The **global** keyword indicates a global pool path option. Entering this keyword is not necessary, for all path options are from the global pool in the absence of the **sub-pool** keyword. • The *kbps* argument is the number of kilobits per second set aside for the path option. The range is from 1 to 4294967295. • The **lockdown** keyword disables reoptimization of the LSP.
Step 10	**end** **Example:** `Router(config-if)# end`	(Optional) Exits to privileged EXEC mode.

Modifying a Path Option to Use a Different LSP Attribute List

Perform this task to modify the path option to use a different LSP Attribute list.

Based on your requirements, you can configure LSP attributes lists with different sets of attributes for different path options or change the set of attributes associated with a path option. The **tunnel mpls traffic-eng path-option** *number* **dynamic attributes** *string* command is used in interface configuration mode to modify the path option to use a different LSP attribute list. The **attributes** and *string* keyword and argument names the new LSP attribute list for the path option specified.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **tunnel destination** {*hostname* | *ip-address*}
5. **tunnel mpls traffic-eng path-option** *number* {**dynamic** | **explicit** {**name***path-name* | *path-number*} [**verbatim**]} [**attributes***string*] [**bandwidth** [**sub-pool** | **global**] *kbps*] [**lockdown**]
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Router(config)# interface tunnel 1`	Configures the interface type and enters interface configuration mode. • The *type* argument is the type of interface that you want to configure. • The *number* argument is the number of the tunnel interface that you want to create or configure.
Step 4	**tunnel destination** {*hostname* | *ip-address*} **Example:** `Router(config-if)# tunnel destination 10.10.10.12`	Specifies the destination of the tunnel for this path option. • The *hostname* argument is the name of the host destination. • The *ip-address* argument is the IP address of the host destination expressed in decimal in four-part, dotted notation.
Step 5	**tunnel mpls traffic-eng path-option** *number* {**dynamic** | **explicit** {**name***path-name* | *path-number*} [**verbatim**]} [**attributes***string*] [**bandwidth** [**sub-pool** | **global**] *kbps*] [**lockdown**] **Example:** `Router(config-if)# tunnel mpls traffic-eng path-option 1 dynamic attributes 1`	Adds an LSP Attribute list to specify LSP-related parameters for a path options for an MPLS TE tunnel. • The *number* argument identifies the path option. • The **dynamic** keyword indicates that the path option is dynamically calculated (the router figures out the best path). • The **explicit** keyword indicates that the path option is specified. You specify the IP addresses of the path. • The **name***path-name*keyword argument combination identifies the name of the explicit path option. • The *path-number* argument identifies the number of the explicit path option. • The **verbatim** keyword bypasses the topology database verification. **Note** You can use the **verbatim** keyword only with the explicit path option. • The **attributes***string* keyword argument combination names an attribute list to specify path options for the LSP. • The **bandwidth** keyword specifies LSP bandwidth.

	Command or Action	Purpose
		• The **sub-pool** keyword indicates a subpool path option. • The **global** keyword indicates a global pool path option. Entering this keyword is not necessary, for all path options are from the global pool in the absence of the **sub-pool** keyword. • The *kbps* argument is the number of kilobits per second set aside for the path option. The range is from 1 to 4294967295. • The **lockdown** keyword disables reoptimization of the LSP.
Step 6	**end** **Example:** `Router(config-if)# end`	(Optional) Exits to privileged EXEC mode.

Removing a Path Option for an LSP for an MPLS TE Tunnel

Perform this task to remove a path option for an LSP for an MPLS TE tunnel. Use this task to remove a path option for an LSP when your MPLS TE tunnel traffic requirements change.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **tunnel destination** {*hostname* | *ip-address*}
5. **no tunnel mpls traffic-eng path-option** *number* {**dynamic** | **explicit** {**name***path-name* | *path-number*} [**verbatim**]} [**attributes***string*] [**bandwidth** [**sub-pool** | **global**] *kbps*] [**lockdown**]
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Router(config)# interface tunnel 1`	Configures the interface type and enters interface configuration mode. • The *type* argument is the type of interface that you want to configure. • The *number* argument is the number of the tunnel interface that you want to create or configure.
Step 4	**tunnel destination** {*hostname* | *ip-address*} **Example:** `Router(config-if)# tunnel destination 10.10.10.12`	Specifies the destination of the tunnel for this path option. • The *hostname* argument is the name of the host destination. • The *ip-address* argument is the IP address of the host destination expressed in decimal in four-part, dotted notation.
Step 5	**no tunnel mpls traffic-eng path-option** *number* {**dynamic** | **explicit** {**name***path-name* | *path-number*} [**verbatim**]} [**attributes***string*] [**bandwidth** [**sub-pool** | **global**] *kbps*] [**lockdown**] **Example:** `Router(config-if)# no tunnel mpls traffic-eng path-option 1 dynamic attributes 1`	Removes an LSP Attribute list that specifies LSP-related parameters for a path option for an MPLS TE tunnel. • The *number* argument identifies the path option. • The **dynamic** keyword indicates that the path option is dynamically calculated (the router figures out the best path). • The **explicit** keyword indicates that the path option is specified. You specify the IP addresses of the path. • The **name***path-name*keyword argument combination identifies the name of the explicit path option. • The *path-number* argument identifies the number of the explicit path option. • The **verbatim** keyword bypasses the topology database verification. **Note** You can use the **verbatim** keyword only with the explicit path option. • The **attributes***string* keyword argument combination names an attribute list to specify path options for the LSP. • The **bandwidth** keyword specifies LSP bandwidth. • The **sub-pool** keyword indicates a subpool path option. • The **global** keyword indicates a global pool path option. Entering this keyword is not necessary, for all path options are from the global pool in the absence of the **sub-pool** keyword.

	Command or Action	Purpose
		• The *kbps* argument is the number of kilobits per second set aside for the path option. The range is from 1 to 4294967295. • The **lockdown** keyword disables reoptimization of the LSP.
Step 6	**end** **Example:** `Router(config-if)# end`	(Optional) Exits to privileged EXEC mode.

Verifying that LSP Is Signaled Using the Correct Attributes

SUMMARY STEPS

1. **enable**
2. **show mpls traffic-eng tunnels** *tunnel-interface* [**brief**]
3. **exit**

DETAILED STEPS

Step 1 **enable**

Use this command to enable privileged EXEC mode. Enter your password if prompted. For example:

Example:

```
Router> enable
Router#
```

Step 2 **show mpls traffic-eng tunnels** *tunnel-interface* [**brief**]

Use this command to verify that the LSP is signaled using the correct attributes for the specified tunnel. For example:

Example:

```
Router# show mpls traffic-eng tunnels tunnel1
Name: Router-t1                        (Tunnel1) Destination: 10.10.10.12
  Status:
    Admin: up         Oper: up     Path: valid       Signalling: connected
    path option 2, type explicit path2 (Basis for Setup, path weight 65834)
  Config Parameters:
    Bandwidth: 1000      kbps (Global)  Priority: 1  1   Affinity: 0x0/0xFFFF
    Metric Type: IGP (global)
    AutoRoute:  enabled   LockDown: disabled  Loadshare: 1        bw-based
    auto-bw: disabled
  Active Path Option Parameters:
    State: explicit path option 2 is active
    BandwidthOverride: enabled   LockDown: disabled  Verbatim: disabled
```

```
Bandwidth Override:
  Signalling: 1        kbps (Global)
  Overriding: 1000        kbps (Global) configured on tunnel
```

The output shows that the following attributes are signaled for tunnel tunnel1: affinity 0 mask 0, auto-bw disabled, bandwidth 1000, lockdown disabled, and priority 1 1.

Step 3 **exit**

Use this command to return to user EXEC mode. For example:

Example:

```
Router# exit
Router>
```

Configuring a Path Option for Bandwidth Override

This section contains the following tasks for configuring a path option for bandwidth override:

Note Once you configure bandwidth as a path-option parameter, you can no longer configure an LSP Attribute list as a path-option parameter.

Configuring Fallback Bandwidth Path Options for TE Tunnels

Perform this task to configure fallback bandwidth path options for a TE tunnel. Use this task to configure path options that reduce the bandwidth constraint each time the headend of a tunnel fails to establish an LSP.

Configuration of the Path Option for Bandwidth Override feature can reduce bandwidth constraints on path options temporarily and improve the chances that an LSP is set up for the TE tunnel. When a TE tunnel uses a path option with bandwidth override, the traffic engineering software attempts every 30 seconds to reoptimize the tunnel to use the preferred path option with the original configured bandwidth. The Path Option for Bandwidth Override feature is designed as a temporary reduction in bandwidth constraint. To force immediate reoptimization of all traffic engineering tunnels, you can use the **mplstraffic-engreoptimize** command. You can also configure the **lockdown** command with bandwidth override to prevent automatic reoptimization.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **tunnel destination** {*hostname* | *ip-address*}
5. **tunnel mpls traffic-eng path-option** *number* {**dynamic** | **explicit** {**name***path-name* | *path-number*} [**verbatim**]} [**attributes***string*] [**bandwidth** [**sub-pool** | **global**] *kbps*] [**lockdown**]
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Router(config)# interface tunnel 1`	Configures an interface type and enters interface configuration mode. • The *type* argument is the type of interface that you want to configure. • The *number* argument is the number of the tunnel interface that you want to create or configure.
Step 4	**tunnel destination** {*hostname* | *ip-address*} **Example:** `Router(config-if)# tunnel destination 10.10.10.12`	Specifies the destination of the tunnel for this path option. • The *hostname* argument is the name of the host destination. • The *ip-address* argument is the IP address of the host destination expressed in decimal in four-part, dotted notation.
Step 5	**tunnel mpls traffic-eng path-option** *number* {**dynamic** | **explicit** {**name***path-name* | *path-number*} [**verbatim**]} [**attributes***string*] [**bandwidth** [**sub-pool** | **global**] *kbps*] [**lockdown**] **Example:** `Router(config-if)# tunnel mpls traffic-eng path-option 1 dynamic bandwidth 500`	Adds a Path Option for Bandwidth Override to specify a bandwidth fallback for a path option for an MPLS TE tunnel. • The *number* argument identifies the path option. • The **dynamic** keyword indicates that the path option is dynamically calculated (the router figures out the best path). • The **explicit** keyword indicates that the path option is specified. You specify the IP addresses of the path. • The **name***path-name*keyword argument combination identifies the name of the explicit path option. • The *path-number* argument identifies the number of the explicit path option. • The **verbatim** keyword bypasses the topology database verification. **Note** You can use the **verbatim** keyword only with the explicit path option. • The **attributes***string* keyword argument combination names an attribute list to specify path options for the LSP. • The **bandwidth** keyword specifies LSP bandwidth.

	Command or Action	Purpose
		• The **sub-pool** keyword indicates a subpool path option. • The **global** keyword indicates a global pool path option. Entering this keyword is not necessary, for all path options are from the global pool in the absence of the **sub-pool** keyword. • The *kbps* argument is the number of kilobits per second set aside for the path option. The range is from 1 to 4294967295. • The **lockdown** keyword disables reoptimization of the LSP.
Step 6	**end** **Example:** `Router(config-if)# end`	(Optional) Exits to privileged EXEC mode.

Modifying the Bandwidth on a Path Option for Bandwidth Override

Perform this task to modify the bandwidth on a Path Option for Bandwidth Override. You might need to further reduce or modify the bandwidth constraint for a path option to ensure that the headend of a tunnel establishes an LSP.

The Path Option for Bandwidth Override feature is designed as a temporary reduction in bandwidth constraint. To force immediate reoptimization of all traffic engineering tunnels, you can use the **mplstraffic-engreoptimize** command. You can also configure the **lockdown** command with bandwidth override to prevent automatic reoptimization.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **tunnel destination** {*hostname* | *ip-address*}
5. **tunnel mpls traffic-eng path-option** *number* {**dynamic** | **explicit** {**name***path-name* | *path-number*} [**verbatim**]} [**attributes***string*] [**bandwidth** [**sub-pool** | **global**] *kbps*] [**lockdown**]
6. **end**
7. **show mpls traffic-eng tunnels** *tunnel-interface* [**brief**]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Router> enable`	• Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Router(config)# interface tunnel 1`	Configures the interface type and enters interface configuration mode. • The *type* argument is the type of interface that you want to configure. • The *number* argument is the number of the tunnel interface that you want to create or configure.
Step 4	**tunnel destination** {*hostname* | *ip-address*} **Example:** `Router(config-if)# tunnel destination 10.10.10.12`	Specifies the destination of the tunnel for this path option. • The *hostname* argument is the name of the host destination. • The *ip-address* argument is the IP address of the host destination expressed in decimal in four-part, dotted notation.
Step 5	**tunnel mpls traffic-eng path-option** *number* {**dynamic** | **explicit** {**name***path-name* | *path-number*} [**verbatim**]} [**attributes***string*] [**bandwidth** [**sub-pool** | **global**] *kbps*] [**lockdown**] **Example:** `Router(config-if)# tunnel mpls traffic-eng path-option 2 dynamic bandwidth 500` **Example:**	Adds a Path Option for Bandwidth Override to specify a bandwidth fallback for a path option for an MPLS TE tunnel. • The *number* argument identifies the path option. • The **dynamic** keyword indicates that the path option is dynamically calculated (the router figures out the best path). • The **explicit** keyword indicates that the path option is specified. You specify the IP addresses of the path. • The **name***path-name*keyword argument combination identifies the name of the explicit path option. • The *path-number* argument identifies the number of the explicit path option. • The **verbatim** keyword bypasses the topology database verification. **Note** You can use the **verbatim** keyword only with the explicit path option. • The **attributes***string* keyword argument combination names an attribute list to specify path options for the LSP. • The **bandwidth** keyword specifies LSP bandwidth. • The **sub-pool** keyword indicates a subpool path option.

	Command or Action	Purpose
		• The **global** keyword indicates a global pool path option. Entering this keyword is not necessary, for all path options are from the global pool in the absence of the **sub-pool** keyword. • The *kbps* argument is the number of kilobits per second set aside for the path option. The range is from 1 to 4294967295. • The **lockdown** keyword disables reoptimization of the LSP.
Step 6	**end** **Example:** `Router(config-if)# end`	(Optional) Exits to privileged EXEC mode.
Step 7	**show mpls traffic-eng tunnels** *tunnel-interface* [**brief**] **Example:** `Router# show mpls traffic-eng tunnels tunnel1`	(Optional) Displays information about tunnels. • Use the **showmplstraffic-engtunnels** command to verify which bandwidth path option is in use by the LSP.

Removing a Path Option for Bandwidth Override

Perform this task to remove the bandwidth on the path option for bandwidth override. The Path Option for Bandwidth Override feature is designed as a temporary reduction in bandwidth constraint. Use this task to remove the bandwidth override when it is not required.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface tunnel** *number*
4. **tunnel destination** {*hostname* | *ip-address*}
5. **no tunnel mpls traffic-eng path-option** *number* {**dynamic** | **explicit** {**name** *path-name* | *path-number*} [**verbatim**]} [**attributes** *string*] [**bandwidth** [**sub-pool** | **global**] *kbps*] [**lockdown**]
6. **end**
7. **show mpls traffic-eng tunnels** *tunnel-interface* [**brief**]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Router> enable`	• Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface tunnel** *number* **Example:** `Router(config)# interface tunnel 1`	Configures a tunnel interface type and enters interface configuration mode. • The *number* argument is the number of the tunnel interface that you want to create or configure.
Step 4	**tunnel destination** {*hostname* | *ip-address*} **Example:** `Router(config-if)# tunnel destination 10.10.10.12`	Specifies the destination of the tunnel for this path option. • The *hostname* argument is the name of the host destination. • The *ip-address* argument is the IP address of the host destination expressed in decimal in four-part, dotted notation.
Step 5	**no tunnel mpls traffic-eng path-option** *number* {**dynamic** | **explicit** {**name** *path-name* | *path-number*} [**verbatim**]} [**attributes** *string*] [**bandwidth** [**sub-pool** | **global**] *kbps*] [**lockdown**] **Example:** `Router(config-if)# no tunnel mpls traffic-eng path-option 2 dynamic bandwidth 500`	Removes a path option for bandwidth override that specifies a bandwidth fallback for a path option for an MPLS TE tunnel. • The *number* argument identifies the path option. • The **dynamic** keyword indicates that the path option is dynamically calculated (the router figures out the best path). • The **explicit** keyword indicates that the path option is specified. You specify the IP addresses of the path. • The **name** *path-name*keyword argument combination identifies the name of the explicit path option. • The *path-number* argument identifies the number of the explicit path option. • The **verbatim** keyword bypasses the topology database verification. **Note** You can use the **verbatim** keyword only with the explicit path option. • The **attributes** *string* keyword argument combination names an attribute list to specify path options for the LSP. • The **bandwidth** keyword specifies LSP bandwidth. • The **sub-pool** keyword indicates a subpool path option.

	Command or Action	Purpose
		• The **global** keyword indicates a global pool path option. Entering this keyword is not necessary, for all path options are from the global pool in the absence of the **sub-pool** keyword. • The *kbps* argument is the number of kilobits per second set aside for the path option. The range is from 1 to 4294967295. • The **lockdown** keyword disables reoptimization of the LSP.
Step 6	**end** **Example:** `Router(config-if)# end`	(Optional) Exits to privileged EXEC mode.
Step 7	**show mpls traffic-eng tunnels** *tunnel-interface* [**brief**] **Example:** `Router# show mpls traffic-eng tunnels tunnel1`	(Optional) Displays information about tunnels. • Use the **show mpls traffic-eng tunnels** command to verify which bandwidth path option is in use by the LSP.

Verifying that LSP Is Signaled Using the Correct Bandwidth

SUMMARY STEPS

1. **enable**
2. **show mpls traffic-eng tunnels** *tunnel-interface* [**brief**]
3. **exit**

DETAILED STEPS

Step 1 **enable**
Use this command to enable privileged EXEC mode. Enter your password if prompted. For example:

Example:

```
Router> enable
Router#
```

Step 2 **show mpls traffic-eng tunnels** *tunnel-interface* [**brief**]
Use this command to verify that the LSP is signaled with the correct bandwidth and to verify that the bandwidth configured on the tunnel is overridden. For example:

Example:

```
Router# show mpls traffic-eng tunnels tunnel21
Name: Router-t21                      (Tunnel21) Destination: 10.10.10.12
  Status:
    Admin: up         Oper: up     Path: valid       Signalling: connected
    path option 2, type explicit path2 (Basis for Setup, path weight 65834)
    path option 1, type explicit path1
  Config Parameters:
    Bandwidth: 1000      kbps (Global)  Priority: 1  1   Affinity: 0x0/0xFFFF
    Metric Type: IGP (global)
    AutoRoute:  enabled   LockDown: disabled  Loadshare: 1        bw-based
    auto-bw: disabled
  Active Path Option Parameters:
    State: explicit path option 2 is active
    BandwidthOverride: enabled   LockDown: disabled  Verbatim: disabled
    Bandwidth Override:
      Signalling: 500 kbps (Global)
      Overriding: 1000        kbps (Global) configured on tunnel
```

If bandwidth override is actively being signaled, the **show mpls traffic-eng tunnel** command displays the bandwidth override information under the Active Path Option Parameters heading. The example shows that BandwidthOverride is enabled and that the tunnel is signaled using path-option 2. The bandwidth signaled is 500. This is the value configured on the path option 2 and it overrides the 1000 kbps bandwidth configured on the tunnel interface.

Step 3 **exit**

Use this command to exit to user EXEC mode. For example:

Example:

```
Router# exit
Router>
```

Troubleshooting Tips

If the tunnel state is down and you configured a path-option with bandwidth override enabled, the **showmplstraffic-engtunnels** command indicates other reasons why a tunnel is not established. For example:

- The tunnel destination is not in the routing table.
- If the bandwidth override value is not zero, the bandwidth constraint may still be too large.
- Other attributes configured on the tunnel, such as affinity, might prevent the calculation of a path over the existing topology.
- TE might not be configured on all links necessary to reach tunnel destination.

Configuration Examples for MPLS Traffic Engineering--RSVP Hello State Timer

Configuring LSP Attribute List Examples

Configuring an LSP Attribute List: Example

This example shows the configuration of the affinity, bandwidth, and priority LSP-related attributes in an LSP attribute list identified with the numeral 1:

```
Router(config)# mpls traffic-eng lsp attributes 1
Router(config-lsp-attr)# affinity 7 7
Router(config-lsp-attr)# bandwidth 1000
Router(config-lsp-attr)# priority 1 1
Router(config-lsp-attr)# exit
```

Adding Attributes to an LSP Attribute List: Example

This example shows the addition of protection attributes to the LSP attribute list identified with the numeral 1:

```
Router(config)# mpls traffic-eng lsp attributes 1
Router(config-lsp-attr)# affinity 7 7
Router(config-lsp-attr)# bandwidth 1000
Router(config-lsp-attr)# priority 1 1
Router(config-lsp-attr)# protection fast-reroute
Router(config-lsp-attr)# exit
```

Removing an Attribute from an LSP Attribute List: Example

The following example shows removing the priority attribute from the LSP attribute list identified by the string simple:

```
Router(config)# mpls traffic-eng lsp attributes simple
Router(config-lsp-attr)# priority 1 1
Router(config-lsp-attr)# list
LIST simple
 priority 1 1
!
Router(config-lsp-attr)# no priority
Router(config-lsp-attr)# list
LIST simple
!
Router(config-lsp-attr)# exit
```

Modifying an Attribute in an LSP Attribute List: Example

The following example shows modifying the bandwidth in an LSP attribute list identified by the numeral 5:

```
Router(config)# mpls traffic-eng lsp attributes 5
```

```
Router(config-lsp-attr)# bandwidth 1000
Router(config-lsp-attr)# priority 1 1
Router(config-lsp-attr)# list
LIST 5
 bandwidth 1000
 priority 1 1
Router(config-lsp-attr)# bandwidth 500
Router(config-lsp-attr)# list
LIST 5
 bandwidth 500
 priority 1 1
Router(config-lsp-attr)# exit
```

Deleting an LSP Attribute List: Example

The following example shows the deletion of an LSP attribute list identified by numeral 1:

```
Router(config)# mpls traffic-eng lsp attributes 1
Router(config-lsp-attr)# affinity 7 7
Router(config-lsp-attr)# bandwidth 1000
Router(config-lsp-attr)# priority 1 1

Router(config-lsp-attr)# exit
!
Router(config)# no mpls traffic-eng lsp attributes 1
```

Associating an LSP Attribute List with a Path Option for a TE Tunnel: Example

The following example associates the LSP attribute list identified by the numeral 3 with path option 1:

```
Router(config)# mpls traffic-eng lsp attributes 3
Router(config-lsp-attr)# bandwidth 1000
Router(config-lsp-attr)# priority 2 2
Router(config-lsp-attr)# protection fast-reroute
Router(config-lsp-attr)# exit
!
!
Router(config)# interface Tunnel 1
Router(config-if)# ip unnumbered FastEthernet1/0/1
Router(config-if)# tunnel destination 10.112.0.12
Router(config-if)# tunnel mode mpls traffic-eng
Router(config-if)# tunnel mpls traffic-eng affinity 1
Router(config-if)# tunnel mpls traffic-eng bandwidth 5000
Router(config-if)# tunnel mpls traffic-eng path-option 1 dynamic attributes 3
```

In this configuration, the LSP will have the following attributes:

```
{bandwidth = 1000
 priority = 2 2
 affinity 1
 reroute enabled.
 }
```

The LSP attribute list referenced by the path option will take precedence over the values configured on the tunnel interface.

Modifying a Path Option to Use a Different LSP Attribute List: Example

The following example modifies path option 1 to use an LSP attribute list identified by the numeral 1:

```
Router(config)# mpls traffic-eng lsp attributes 1
Router(config-lsp-attr)# affinity 7 7
Router(config-lsp-attr)# bandwidth 500
```

```
Router(config-lsp-attr)# priority 1 1
Router(config-lsp-attr)# exit
Router(config)# mpls traffic-eng lsp attributes 2
Router(config-lsp-attr)# bandwidth 1000
Router(config-lsp-attr)# priority 1 1
Router(config-lsp-attr)# exit
Router(config)# interface Tunnel 1
Router(config-if)# ip unnumbered FastEthernet1/0/1
Router(config-if)# tunnel destination 10.112.0.12
Router(config-if)# tunnel mode mpls traffic-eng
Router(config-if)# tunnel mpls traffic-eng affinity 1
Router(config-if)# tunnel mpls traffic-eng bandwidth 5000
Router(config-if)# tunnel mpls traffic-eng path-option 1 dynamic attributes 1
```

In this configuration, the LSP has the following attributes:

```
{affinity = 7 7
 bandwidth = 500
 priority = 1 1
 }
```

Removing a Path Option for an LSP for an MPLS TE Tunnel: Example

The following example shows the removal of path option 1 for an LSP for a TE tunnel:

```
Router(config)# interface Tunnel 1
Router(config-if)# ip unnumbered FastEthernet1/0/1
Router(config-if)# tunnel destination 10.112.0.12
Router(config-if)# tunnel mode mpls traffic-eng
Router(config-if)# tunnel mpls traffic-eng affinity 1
Router(config-if)# tunnel mpls traffic-eng bandwidth 5000
Router(config-if)# tunnel mpls traffic-eng path-option 1 explicit path1 attributes 1
Router(config-if)# tunnel mpls traffic-eng path-option 2 explicit path2 attributes 2
!
!
Router(config-if)# no tunnel mpls traffic-eng path-option 1 explicit path1 attributes 1
```

Configuring a Path Option for Bandwidth Override Examples

Configuring a Path Option to Override the Bandwidth: Example

The following examples show how to configure a path option to override the bandwidth:

```
Router(config-if)# tunnel mpls traffic-eng path-option 3 explicit name path1 ?
       attributes Specify an LSP attribute list
       bandwidth  override the bandwidth configured on the tunnel
       lockdown   not a candidate for reoptimization
       <cr>
Router(config-if)# tunnel mpls traffic-eng path-option 3 explicit name path1 bandwidth ?
       <0-4294967295>  bandwidth requirement in kbps
       sub-pool        tunnel uses sub-pool bandwidth
Router(config-if)# tunnel mpls traffic-eng path-option 3 explicit name path1 bandwidth 500
 ?
       lockdown   not a candidate for reoptimization
       <cr>
```

Note Once you configure bandwidth as a path-option parameter, you can no longer configure an LSP attribute list as a path-option parameter.

Configuring Fallback Bandwidth Path Options for TE Tunnels: Example

The following example shows multiple path options configured with the **tunnel mpls traffic-eng path-option** command:

```
interface Tunnel 1
 ip unnumbered Loopback0
 tunnel destination 10.10.10.12
 tunnel mode mpls traffic-eng
 tunnel mpls traffic-eng autoroute announce
 tunnel mpls traffic-eng priority 1 1
 tunnel mpls traffic-eng bandwidth 1000
 tunnel mpls traffic-eng path-option 1 explicit name path1
 tunnel mpls traffic-eng path-option 2 explicit name path2 bandwidth 500
 tunnel mpls traffic-eng path-option 3 dynamic bandwidth 0
end
```

The device selects a path option for an LSP in order of preference, as follows:

- The device attempts to signal an LSP using path options starting with path-option 1.

The device attempts to signal an LSP with the 1000 kbps bandwidth configured on the tunnel interface because path-option 1 has no bandwidth configured.

- If 1000 kbps bandwidth is not available over the network, the device attempts to establish an LSP using path-option 2.

Path-option 2 has a bandwidth of 500 kbps configured. This reduces the bandwidth constraint from the original 1000 kbps configured on the tunnel interface.

- If 500 kbps is not available, the device attempts to establish an LSP using path-option 3.

Path-option 3 is configured as dynamic and has bandwidth 0. The device establishes the LSP if an IP path exists to the destination and all other tunnel constraints are met.

Modifying the Bandwidth on a Path Option for Bandwidth Override: Example

The following example shows modifying the bandwidth on a path option for bandwidth override. Path-option 3 is changed to an explicit path with a bandwidth of 100 kbps. Path-option 4 is configured with bandwidth 0.

```
interface Tunnel 1
 ip unnumbered Loopback0
 tunnel destination 10.10.10.12
 tunnel mode mpls traffic-eng
 tunnel mpls traffic-eng autoroute announce
 tunnel mpls traffic-eng priority 1 1
 tunnel mpls traffic-eng bandwidth 1000
 tunnel mpls traffic-eng path-option 1 explicit name path1
 tunnel mpls traffic-eng path-option 2 explicit name path2 bandwidth 500
 tunnel mpls traffic-eng path-option 3 dynamic bandwidth 0
!
!
Router(config)# tunnel mpls traffic-eng path-option 3 explicit name path3 bandwidth 100
Router(config)# tunnel mpls traffic-eng path-option 4 dynamic bandwidth 0
```

Removing the Path Option Bandwidth Value for an LSP for an MPLS TE Tunnel: Example

The following example shows the removal of the bandwidth for path option 3 for an LSP for an MPLS TE tunnel:

```
interface Tunnel 1
 ip unnumbered Loopback0
 tunnel destination 10.10.10.12
 tunnel mode mpls traffic-eng
 tunnel mpls traffic-eng autoroute announce
 tunnel mpls traffic-eng priority 1 1
 tunnel mpls traffic-eng bandwidth 1000
 tunnel mpls traffic-eng path-option 1 explicit name path1
 tunnel mpls traffic-eng path-option 2 explicit name path2 bandwidth 500
 tunnel mpls traffic-eng path-option 3 explicit name path3 bandwidth 100
 tunnel mpls traffic-eng path-option 4 dynamic bandwidth 0
!
Router(config)# no tunnel mpls traffic-eng path-option 3 explicit name path3 bandwidth 100
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
MPLS TE command descriptions	*Cisco IOS Multiprotocol Label Switching Command Reference*

Standards

Standards	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	--

MIBs

MIBs	MIBs Link
No new or modified MIBs are supported by this feature, and support for existing MIBs has not been modified by this feature.	To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFCs	Title
No new or modified RFCs are supported by this feature, and support for existing RFCs has not been modified by this feature.	--

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for MPLS Traffic Engineering LSP Attributes

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 1: Feature Information for MPLS Traffic Engineering LSP Attributes

Feature Name	Releases	Feature Information
MPLS Traffic Engineering LSP Attributes	Cisco IOS XE Release 2.3	This document describes how to configure label switched path (LSP) attributes for path options associated with Multiprotocol Label Switching (MPLS) traffic engineering (TE) tunnels. The MPLS Traffic Engineering--LSP Attributes feature is an extension to MPLS TE that provides an LSP Attribute List feature and a Path Option for Bandwidth Override feature. These features provide flexibility in the configuration of LSP attributes for MPLS TE tunnel path options. Several LSP attributes can be applied to path options for TE tunnels using an LSP attribute list. If bandwidth is the only LSP attribute you require, then you can configure a Path Option for Bandwidth Override. The following commands were introduced or modified: **affinity** (LSP Attributes), **bandwidth**(LSP Attributes), **exit**(LSP Attributes), **list**(LSP Attributes), **lockdown**(LSP Attributes), **mpls traffic-eng lsp attributes**, **priority**(LSP Attributes), **protection**(LSP Attributes), **record-route**(LSP Attributes), **show mpls traffic-eng lsp attributes**, and **show mpls traffic-eng tunnels**.

Glossary

bandwidth --The difference between the highest and lowest frequencies available for network signals. The term also is used to describe the rated throughput capacity of a given network medium or protocol. The frequency range necessary to convey a signal measured in units of hertz (Hz). For example, voice signals typically require approximately 7 kHz of bandwidth and data traffic typically requires approximately 50 kHz of bandwidth.

bandwidth reservation --The process of assigning bandwidth to users and applications served by a network. This process involves assigning priority to different flows of traffic based on how critical and delay-sensitive they are. This makes the best use of available bandwidth, and if the network becomes congested, lower-priority traffic can be dropped. Sometimes called bandwidth allocation

global pool --The total bandwidth allocated to an Multiprotocol Label Switching (MPLS) traffic engineering link.

label switched path (LSP) tunnel --A configured connection between two routers, using label switching to carry the packets.

LSR --label switch router. A Multiprotocol Label Switching (MPLS) node that can forward native Layer 3 packets. The LSR forwards a packet based on the value of a label attached to the packet.

MPLS TE --Multiprotocol Label Switching (MPLS) traffic engineering (formerly known as “RRR” or Resource Reservation Routing). The use of label switching to improve traffic performance along with an efficient use of network resources.

subpool --The more restrictive bandwidth in an Multiprotocol Label Switching (MPLS) traffic engineering link. The subpool is a portion of the link's overall global pool bandwidth.

TE --traffic engineering. The techniques and processes used to cause routed traffic to travel through the network on a path other than the one that would have been chosen if standard routing methods had been used. The application of scientific principles and technology to measure, model, and control internet traffic in order to simultaneously optimize traffic performance and network resource utilization.

traffic engineering tunnel --A label-switched tunnel used for traffic engineering. Such a tunnel is set up through means other than normal Layer 3 routing; it is used to direct traffic over a path different from the one that Layer 3 routing could cause the tunnel to take.

tunnel --A secure communication path between two peers, such as two routers.