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.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see 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 for MPLS Traffic Engineering—LSP Attributes” section on page 41.

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

Contents

- Prerequisites for MPLS Traffic Engineering—LSP Attributes, page 2
- Restrictions for MPLS Traffic Engineering—LSP Attributes, page 2
- Information About MPLS Traffic Engineering—LSP Attributes, page 2
- How to Configure MPLS Traffic Engineering—LSP Attributes, page 6
- Configuration Examples for MPLS Traffic Engineering—LSP Attributes, page 34
- Additional References, page 39
Prerequisites for MPLS Traffic Engineering—LSP Attributes

The MPLS 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—LSP Attributes

To configure the MPLS Traffic Engineering—LSP Attributes feature, you need the following information:

- MPLS Traffic Engineering—LSP Attributes Benefits, page 2
- Traffic Engineering Bandwidth and Bandwidth Pools, page 3
- LSP Attribute Lists Usage and Management, page 3
- Autobandwidth and Path Option for Bandwidth Override, page 4
- Path Option Selection for MPLS TE Tunnel LSPs, page 5

MPLS Traffic Engineering—LSP Attributes Benefits

The MPLS Traffic Engineering—LSP Attributes 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 Attributes 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 Path Option for Bandwidth Override 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.

**LSP Attribute Lists Usage and Management**

This section contains the following topics about LSP attribute lists usage and management:

- Tunnel Attributes and LSP Attributes, page 3
- LSP Attributes and the LSP Attribute List, page 4
- LSP Attribute Lists Management, page 4

**Tunnel Attributes and LSP Attributes**

Cisco IOS 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.

Autobandwidth and Path Option for Bandwidth Override

If Traffic Engineering automatic bandwidth (autobandwidth) adjustment is configured for a tunnel, traffic engineering automatically adjusts the bandwidth allocation for the traffic engineering tunnel based on its measured usage of the bandwidth of the tunnel.

Traffic engineering autobandwidth samples the average output rate for each tunnel marked for automatic bandwidth adjustment. For each marked tunnel, it periodically adjusts the allocated bandwidth for the tunnel to be the largest sample for the tunnel since the last adjustment. The default reoptimization setting in the MPLS AutoBandwidth feature is every 24 hours.

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.

For more information on automatic bandwidth adjustment for TE tunnels, see the *MPLS Traffic Engineering (TE)—Automatic Bandwidth Adjustment for TE Tunnels* feature documentation.

The Path Option for Bandwidth Override feature allows you to override the bandwidth configured on a TE tunnel. This feature also overrides bandwidth configured or recalculated by automatic bandwidth adjustment if the path option in effect has bandwidth override enabled.
Path Option Selection for MPLS TE Tunnel LSPs

This section contains the following topics about path option selection for MPLS TE Tunnel LSPs:

- Constraint-Based Routing and Path Option Selection, page 5
- Tunnel Reoptimization and Path Option Selection, page 5
- Path Option Selection with Bandwidth Override, page 6

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 on page 25).

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 with the `bandwidth` keyword on the `tunnel mpls traffic-eng path-option` command. 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 bandwidth configured directly on the tunnel.

This feature provides you with 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 shows three `tunnel mpls traffic-eng path-option` commands:

```
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.

How to Configure MPLS Traffic Engineering—LSP Attributes

This section contains the following processes for configuring the MPLS Traffic Engineering—LSP Attributes feature:

- Configuring MPLS Traffic Engineering LSP Attribute Lists, page 6
- Configuring a Path Option for Bandwidth Override, page 25

Configuring MPLS Traffic Engineering LSP Attribute Lists

Perform the following tasks to configure and verify MPLS traffic engineering LSP attributes lists:

- Configuring an LSP Attribute List, page 7 (required)
- Adding Attributes to an LSP Attribute List, page 9 (optional)
- Removing an Attribute from an LSP Attribute List, page 11 (optional)
- Modifying an Attribute in an LSP Attribute List, page 12 (optional)
- Deleting an LSP Attribute List, page 14 (optional)
- Verifying Attributes Within an LSP Attribute List, page 15 (optional)
- Verifying All LSP Attribute Lists, page 16 (optional)
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**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
</tr>
<tr>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Router&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td></td>
</tr>
<tr>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router# configure terminal</td>
<td></td>
</tr>
</tbody>
</table>
### Command or Action

<table>
<thead>
<tr>
<th>Step 3</th>
<th>mpls traffic-eng lsp attributes string</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Router(config)# mpls traffic-eng lsp attributes 1</td>
</tr>
</tbody>
</table>

**Purpose:** Configures an LSP attribute list and enters LSP Attributes configuration mode.
- The *string* argument identifies a specific LSP attribute list.

<table>
<thead>
<tr>
<th>Step 4</th>
<th>affinity value [mask value]</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Router(config-lsp-attr)# affinity 0 mask 0</td>
</tr>
</tbody>
</table>

**Purpose:** (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 for 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.

<table>
<thead>
<tr>
<th>Step 5</th>
<th>auto-bw [frequency secs] [max-bw kbps] [min-bw kbps] [collect-bw]</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Router(config-lsp-attr)# auto-bw</td>
</tr>
</tbody>
</table>

**Purpose:** (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 kbps* 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.

| Step 6 | bandwidth [sub-pool | global] kbps |
|--------|---------------------|
| **Example:** | Router(config-lsp-attr)# bandwidth 5000 |

**Purpose:** (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.

<table>
<thead>
<tr>
<th>Step 7</th>
<th>list</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Router(config-lsp-attr)# list</td>
</tr>
</tbody>
</table>

**Purpose:** (Optional) Displays the contents of the LSP attribute list.
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.

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>lockdown</td>
<td>(Optional) Disables reoptimization of the LSP.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config-lsp-attr)# lockdown</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>priority setup-priority [hold-priority]</td>
<td>(Optional) Specifies the LSP priority.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config-lsp-attr)# priority 1 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 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.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 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.</td>
</tr>
<tr>
<td>10</td>
<td>protection fast-reroute</td>
<td>(Optional) Enables failure protection on the LSP.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config-lsp-attr)# protection fast-reroute</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>record-route</td>
<td>(Optional) Records the route used by the LSP.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config-lsp-attr)# record-route</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>no sub-command</td>
<td>(Optional) Removes a specific attribute from the LSP attributes list.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config-lsp-attr)# no record-route</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The sub-command argument names the LSP attribute to remove from the attributes list.</td>
</tr>
<tr>
<td>13</td>
<td>exit</td>
<td>(Optional) Exits from LSP Attributes configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config-lsp-attr)# exit</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>end</td>
<td>(Optional) Exits to privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config)# end</td>
<td></td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** enable | Enables privileged EXEC mode.  
• Enter your password if prompted. |
| Example:          |         |
| Router> enable    |         |
| **Step 2** configure terminal | Enters global configuration mode. |
| Example:          |         |
| Router# configure terminal |         |
| **Step 3** mpls traffic-eng lsp attributes string | Configures an LSP attribute list and enters LSP Attributes configuration mode.  
• The string argument identifies a specific LSP attribute list. |
| Example:          |         |
| Router(config)# mpls traffic-eng lsp attributes |         |
| **Step 4** affinity value [mask value] | (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. |
| Example:          |         |
| Router(config-lsp-atr)# affinity 0 mask 0 |         |
### 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

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 5 bandwidth [sub-pool</td>
<td>global] kbps</td>
</tr>
<tr>
<td>Example: Router(config-lsp-attr)# bandwidth 1000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• The sub-pool keyword indicates a subpool path option.</td>
</tr>
<tr>
<td></td>
<td>• 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.</td>
</tr>
<tr>
<td></td>
<td>• The kbps argument is the number of kilobits per second set aside for the path option. The range is from 1 to 4294967295.</td>
</tr>
<tr>
<td>Step 6 priority setup-priority [hold-priority]</td>
<td>Specifies the LSP priority.</td>
</tr>
<tr>
<td>Example: Router(config-lsp-attr)# priority 2 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• 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.</td>
</tr>
<tr>
<td></td>
<td>• 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.</td>
</tr>
<tr>
<td>Step 7 list</td>
<td>(Optional) Displays the contents of the LSP attribute list.</td>
</tr>
<tr>
<td>Example: Router(config-lsp-attr)# list</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Use the list command to display the path option attributes added to the attribute list.</td>
</tr>
<tr>
<td>Step 8 exit</td>
<td>(Optional) Exits LSP Attributes configuration mode.</td>
</tr>
<tr>
<td>Example: Router(config-lsp-attr)# exit</td>
<td></td>
</tr>
<tr>
<td>Step 9 end</td>
<td>(Optional) Exits to privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Router(config)# end</td>
<td></td>
</tr>
</tbody>
</table>
How to Configure MPLS Traffic Engineering—LSP Attributes

3. `mpls traffic-eng lsp attributes string`
4. `no sub-command`
5. `list`
6. `exit`
7. `end`

**DETAILED STEPS**

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

**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 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

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Router&gt; enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example: Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> mpls traffic-eng lsp attributes string</td>
<td>Configures an LSP attribute list and enters LSP Attributes configuration mode.</td>
</tr>
<tr>
<td>Example: Router(config)# mpls traffic-eng lsp attributes 1</td>
<td>• The string argument identifies a specific LSP attribute list.</td>
</tr>
<tr>
<td><strong>Step 4</strong> affinity value [mask value]</td>
<td>Specifies attribute flags for links comprising an LSP.</td>
</tr>
<tr>
<td>Example: Router(config-lsp-attr)# affinity 1 mask 1</td>
<td>• The value argument is a value required for links comprising an LSP. Values of bits are either 0 or 1.</td>
</tr>
<tr>
<td></td>
<td>• The mask value keyword argument combination indicates which attribute values should be checked.</td>
</tr>
<tr>
<td></td>
<td>– If a bit in the mask is 0, an attribute value of the link or that bit is irrelevant.</td>
</tr>
<tr>
<td></td>
<td>– 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.</td>
</tr>
<tr>
<td><strong>Step 5</strong> list</td>
<td>(Optional) Displays the contents of the LSP attribute list.</td>
</tr>
<tr>
<td>Example: Router(config-lsp-attr)# list</td>
<td>• Use the list command to display the path option attributes configured in the attribute list.</td>
</tr>
</tbody>
</table>
**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

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

## 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:  
|               | Router> enable  
|               | Router# |
Step 2  configure terminal
Use this command to enter global configuration mode. For 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:
  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
  Router(config)#

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

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:

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.

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
.
.
.
}  

**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] kbps
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**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router&gt; enable</td>
<td>- Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td><strong>interface type number</strong></td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Router(config)# interface tunnel 1</td>
</tr>
<tr>
<td><strong>Purpose:</strong></td>
<td>Configures an interface type and enters interface configuration mode.</td>
</tr>
<tr>
<td></td>
<td>- The <em>type</em> argument is the type of interface that you want to configure.</td>
</tr>
<tr>
<td></td>
<td>- The <em>number</em> argument is the number of the tunnel interface that you want to create or configure.</td>
</tr>
</tbody>
</table>

| Step 4 | **tunnel destination {hostname | ip-address}** |
|--------|-----------------------------------------------|
| **Example:** | Router(config-if)# tunnel destination 10.10.10.12 |
| **Purpose:** | 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. |

<table>
<thead>
<tr>
<th>Step 5</th>
<th><strong>tunnel mode mpls traffic-eng</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Router(config-if)# tunnel mode mpls traffic-eng</td>
</tr>
<tr>
<td><strong>Purpose:</strong></td>
<td>Sets the encapsulation mode for the tunnel for MPLS TE.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 6</th>
<th><strong>tunnel mpls traffic-eng autoroute announce</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Router(config-if)# tunnel mpls traffic-eng autoroute announce</td>
</tr>
<tr>
<td><strong>Purpose:</strong></td>
<td>Specifies that the IGP should use the tunnel (if the tunnel is up) in its enhanced shortest path first (SPF) calculation.</td>
</tr>
</tbody>
</table>

| Step 7 | **tunnel mpls traffic-eng bandwidth [sub-pool | global] bandwidth** |
|--------|-----------------------|
| **Example:** | Router(config-if)# tunnel mpls traffic-eng bandwidth 1000 |
| **Purpose:** | 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. |

<table>
<thead>
<tr>
<th>Step 8</th>
<th><strong>tunnel mpls traffic-eng priority setup-priority [hold-priority]</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Router(config-if)# tunnel mpls traffic-eng priority 1 1</td>
</tr>
<tr>
<td><strong>Purpose:</strong></td>
<td>Sets the priority to be used when the system determines which existing tunnels are eligible to be preempted.</td>
</tr>
<tr>
<td></td>
<td>- The <em>setup-priority</em> argument is the priority used when signaling an LSP for this tunnel to determine which existing tunnels can be preempted.</td>
</tr>
<tr>
<td></td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>- The <em>hold-priority</em> 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.</td>
</tr>
<tr>
<td></td>
<td>Valid values are from 0 to 7, where a lower number indicates a higher priority.</td>
</tr>
</tbody>
</table>
How to Configure MPLS Traffic Engineering—LSP Attributes

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
```

Purpose:

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 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.
- 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. You use the `tunnel mpls traffic-eng path-option number dynamic attributes string` command in interface configuration mode to modify the path option to use a different LSP attribute list. The `attributes 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**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Enter your password if prompted.</td>
</tr>
<tr>
<td>Router# enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> interface type number</td>
<td>Configures the interface type and enters interface configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>The <code>type</code> argument is the type of interface that you want to configure.</td>
</tr>
<tr>
<td>Router(config)# interface tunnel 1</td>
<td>The <code>number</code> argument is the number of the tunnel interface that you want to create or configure.</td>
</tr>
<tr>
<td><strong>Step 4</strong> tunnel destination {hostname</td>
<td>ip-address}</td>
</tr>
<tr>
<td>Example:</td>
<td>The <code>hostname</code> argument is the name of the host destination.</td>
</tr>
<tr>
<td>Router(config-if)# tunnel destination 10.10.10.12</td>
<td>The <code>ip-address</code> argument is the IP address of the host destination expressed in decimal in four-part, dotted notation.</td>
</tr>
</tbody>
</table>
### How to Configure MPLS Traffic Engineering—LSP Attributes

#### Step 5

**Command or Action**

```
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

**Purpose**

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 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.
- 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

**Command or Action**

```
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**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Router&gt; enable</td>
<td>- Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> interface type number</td>
<td>Configures the interface type and enters interface configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Router(config)# interface tunnel 1</td>
<td>- The <em>type</em> argument is the type of interface that you want to configure.</td>
</tr>
<tr>
<td></td>
<td>- The <em>number</em> argument is the number of the tunnel interface that you want to create or configure.</td>
</tr>
<tr>
<td><strong>Step 4</strong> tunnel destination {hostname | ip-address}</td>
<td>Specifies the destination of the tunnel for this path option.</td>
</tr>
<tr>
<td><strong>Example:</strong> Router(config-if)# tunnel destination 10.10.10.12</td>
<td>- The <em>hostname</em> argument is the name of the host destination.</td>
</tr>
<tr>
<td></td>
<td>- The <em>ip-address</em> argument is the IP address of the host destination expressed in decimal in four-part, dotted notation.</td>
</tr>
</tbody>
</table>
### Command or Action

**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
```

**Purpose**

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.
- 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.

### Command or Action

**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:

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:

Router# show mpls traffic-eng tunnels tunnel1

Name: Router-10-c_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:

Router# exit
Router>

Configuring a Path Option for Bandwidth Override

This section contains the following tasks for configuring a path option for bandwidth override:
• Configuring Fallback Bandwidth Path Options for TE Tunnels, page 26 (required)
• Modifying the Bandwidth on a Path Option for Bandwidth Override, page 29 (optional)
• Removing a Path Option for Bandwidth Override, page 31 (optional)
• Verifying that LSP Is Signaled Using the Correct Bandwidth, page 33 (optional)

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 `mpls traffic-eng reoptimize` 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

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> configure terminal</td>
<td></td>
</tr>
</tbody>
</table>

| Step 1 enable | Enables privileged EXEC mode. |
| Example: enable | • Enter your password if prompted. |
| Step 2 configure terminal | Enters global configuration mode. |
| Example: configure terminal | |
### 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.
### How to Configure MPLS Traffic Engineering—LSP Attributes

#### Step 5

**Command or Action**

```
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
```

**Purpose**

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* keyword 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* 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 6

**Command or Action**

```
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 `mpls traffic-eng reoptimize` 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**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** enable | Enables privileged EXEC mode.  
- Enter your password if prompted. |
| **Example:**  
Router> enable | |
| **Step 2** configure terminal | Enters global configuration mode. |
| **Example:**  
Router# configure terminal | |
| **Step 3** interface type number | 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. |
| **Example:**  
Router(config)# interface tunnel 1 | |
| **Step 4** tunnel destination {hostname | ip-address} | 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. |
| **Example:**  
Router(config-if)# tunnel destination 10.10.10.12 | |
How to Configure MPLS Traffic Engineering—LSP Attributes

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
```

**Purpose**

- 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.
  - 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.

**Note**

- You can use the `verbatim` keyword only with the explicit path option.

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.
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 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  
7. show mpls traffic-eng tunnels tunnel-interface \{brief\}

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** enable | Enables privileged EXEC mode.  
| **Example:** Router> enable | • Enter your password if prompted. |
| **Step 2** configure terminal | Enters global configuration mode. |
| **Example:** Router# configure terminal | |
| **Step 3** interface type number | Configures an interface type and enters interface configuration mode.  
| **Example:** Router(config)# interface tunnel 1 | • 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\} | Specifies the destination of the tunnel for this path option.  
| **Example:** Router(config-if)# tunnel destination 10.10.10.12 | • 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

**Command or Action**

```
no tunnel mpls traffic-eng path-option number
  (dynamic | explicit (name path-name | path-number) [verbatim])
  [attributes string]
  [bandwidth |sub-pool | global] kbps] [lockdown]
```

**Purpose**

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.

**Example:**

```
Router(config-if)# no tunnel mpls traffic-eng path-option 2 dynamic bandwidth 500
```

**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 6

**Command or Action**

```
end
```

(Optional) Exits to privileged EXEC mode.

**Example:**

```
Router(config-if)# end
```

### Step 7

**Command or Action**

```
show mpls traffic-eng tunnels tunnel-interface
  [brief]
```

(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.

**Example:**

```
Router# show mpls traffic-eng tunnels tunnel1
```
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:

```
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:

```
Router# show mpls traffic-eng tunnels tunnel21
```

```
Name: Router-15-c_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:

```
Router# exit
Router>
```
Troubleshooting Tips

If the tunnel state is down and you configured a path-option with bandwidth override enabled, the `show mpls traffic-eng tunnels` 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—LSP Attributes

This section contains the following configuration examples for the MPLS Traffic Engineering—LSP Attributes features:

- Configuring LSP Attribute List: Examples, page 34
- Configuring a Path Option for Bandwidth Override: Examples, page 37

Configuring LSP Attribute List: Examples

This section contains the following examples for configuring LSP attribute lists:

- Configuring an LSP Attribute List: Example, page 34
- Adding Attributes to an LSP Attribute List: Example, page 35
- Removing an Attribute from an LSP Attribute List: Example, page 35
- Modifying an Attribute in an LSP Attribute List: Example, page 35
- Deleting an LSP Attribute List: Example, page 35
- Associating an LSP Attribute List with a Path Option for a TE Tunnel: Example, page 36
- Modifying a Path Option to Use a Different LSP Attribute List: Example, page 36
- Removing a Path Option for Bandwidth Override: Example, page 39

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:

```plaintext
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:

```plaintext
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:

```plaintext
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:

```plaintext
Router(config)# mpls traffic-eng lsp attributes 1
Router(config-lsp-attr)# affinity 7 7
```
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 Ethernet4/0/1
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 Ethernet4/0/1
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 will have 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 Ethernet4/0/1
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

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

- Path Option for Bandwidth Override and LSP Attribute List Configuration Command Examples, page 37
- Configuring Fallback Bandwidth Path Options for TE Tunnels: Example, page 38
- Modifying the Bandwidth on a Path Option for Bandwidth Override: Example, page 38
- Removing a Path Option for Bandwidth Override: Example, page 39

Path Option for Bandwidth Override and LSP Attribute List Configuration Command Examples

The following are examples of the Cisco IOS command-line interface (CLI) to use when you 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:

```plaintext
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.

```plaintext
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
```

```
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 a Path Option for Bandwidth Override: Example

The following example shows removing a path option for bandwidth override:

```plaintext
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

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPLS TE automatic bandwidth adjustment for TE tunnels configuration tasks</td>
<td><em>MPLS Traffic Engineering (TE)—Automatic Bandwidth Adjustment for TE Tunnels</em></td>
</tr>
<tr>
<td>MPLS TE command descriptions</td>
<td><em>Cisco IOS Multiprotocol Label Switching Command Reference</em></td>
</tr>
</tbody>
</table>

### Standards

<table>
<thead>
<tr>
<th>Standards</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.</td>
<td>—</td>
</tr>
</tbody>
</table>

### MIBs

<table>
<thead>
<tr>
<th>MIBs</th>
<th>MIBs Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>No new or modified MIBs are supported by this feature, and support for existing MIBs has not been modified by this feature.</td>
<td>To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
</tr>
</tbody>
</table>
RFCs

<table>
<thead>
<tr>
<th>RFCs</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>No new or modified RFCs are supported by this feature, and support</td>
<td>—</td>
</tr>
<tr>
<td>for existing RFCs has not been modified by this feature.</td>
<td></td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support website provides extensive online resources, including</td>
<td><a href="http://www.cisco.com/techsupport">http://www.cisco.com/techsupport</a></td>
</tr>
<tr>
<td>documentation and tools for troubleshooting and resolving technical issues</td>
<td></td>
</tr>
<tr>
<td>with Cisco products and technologies.</td>
<td></td>
</tr>
<tr>
<td>To receive security and technical information about your products, you</td>
<td></td>
</tr>
<tr>
<td>can subscribe to various services, such as the Product Alert Tool (accessed</td>
<td></td>
</tr>
<tr>
<td>from Field Notices), the Cisco Technical Services Newsletter, and Really</td>
<td></td>
</tr>
<tr>
<td>Simple Syndication (RSS) Feeds.</td>
<td></td>
</tr>
<tr>
<td>Access to most tools on the Cisco Support website requires a Cisco.com</td>
<td></td>
</tr>
<tr>
<td>user ID and password.</td>
<td></td>
</tr>
</tbody>
</table>

Command Reference


- affinity (LSP Attributes)
- auto-bw (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
- show mpls traffic-eng tunnels
Feature Information for MPLS Traffic Engineering—LSP Attributes

Table 1 lists the release history for this feature.

Not all commands may be available in your Cisco IOS software release. For release information about a specific command, see the command reference documentation.

Use Cisco Feature Navigator to find information about platform support and software image support. Cisco Feature Navigator enables you to determine which Cisco IOS and Catalyst OS software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Note

Table 1 lists only the Cisco IOS software release that introduced support for a given feature in a given Cisco IOS software release train. Unless noted otherwise, subsequent releases of that Cisco IOS software release train also support that feature.

Table 1

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPLS Traffic Engineering—LSP Attributes</td>
<td>12.0(26)S</td>
<td>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. In 12.0(26)S, this feature was introduced.</td>
</tr>
<tr>
<td></td>
<td>12.2(33)SRA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12.2(33)SXH</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12.4(20)T</td>
<td></td>
</tr>
</tbody>
</table>
The following commands were introduced or modified: `affinity` (LSP Attributes), `auto-bw` (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`.

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>• LSP Attribute Lists Usage and Management, page 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Autobandwidth and Path Option for Bandwidth Override, page 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Path Option Selection for MPLS TE Tunnel LSPs, page 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Configuring MPLS Traffic Engineering LSP Attribute Lists, page 6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Configuring a Path Option for Bandwidth Override, page 25</td>
</tr>
</tbody>
</table>

Table 1 Feature Information for MPLS Traffic Engineering—LSP Attributes (continued)
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 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**—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 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.

Cisco and the Cisco Logo are trademarks of Cisco Systems, Inc. and/or its affiliates in the U.S. and other countries. A listing of Cisco's trademarks can be found at www.cisco.com/go/trademarks. Third party trademarks mentioned are the property of their respective owners. The use of the word partner does not imply a partnership relationship between Cisco and any other company. (1005R)

Any Internet Protocol (IP) addresses used in this document are not intended to be actual addresses. Any examples, command display output, and figures included in the document are shown for illustrative purposes only. Any use of actual IP addresses in illustrative content is unintentional and coincidental.

© 2003—2009 Cisco Systems, Inc. All rights reserved.