Configuring MPLS Traffic Engineering—Configurable Path Calculation Metric for Tunnels

- Prerequisites for MPLS Traffic Engineering—Configurable Path Calculation Metric for Tunnels, on page 1
- Restrictions for MPLS Traffic Engineering—Configurable Path Calculation Metric for Tunnels, on page 2
- Information About MPLS Traffic Engineering—Configurable Path Calculation Metric for Tunnels, on page 2
- How to Configure MPLS Traffic Engineering—Configurable Path Calculation Metric for Tunnels, on page 3
- Configuration Examples for MPLS Traffic Engineering—Configurable Path Calculation Metric for Tunnels, on page 10
- Additional References, on page 14
- Feature History for MPLS Traffic Engineering—Configurable Path Calculation Metric for Tunnels, on page 15

Prerequisites for MPLS Traffic Engineering—Configurable Path Calculation Metric for Tunnels

Before you configure tunnel path calculation metrics, your network must support the following Cisco IOS XE features:

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

Restrictions for MPLS Traffic Engineering—Configurable Path Calculation Metric for Tunnels

- Unless explicitly configured, the TE link metric for a given link is the IGP link metric. When the TE link metric is used to represent a link property that is different from cost/distance, you must configure every network link that can be used for TE tunnels with a TE link metric that represents that property. You can do this by using the **mpls traffic-eng administrative-weight** command. Failure to do so might cause tunnels to use unexpected paths.
- MPLS traffic engineering supports only a single IGP process/instance. Multiple IGP processes/instances are not supported. MPLS traffic engineering should not be configured in more than one IGP process/instance.

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

The following section provides information about Configurable Path Calculation Metric for MPLS Traffic Engineering tunnels.

Overview

The MPLS Traffic Engineering—Configurable Path Calculation Metric for Tunnels feature enables you to control the metric used in path calculation for traffic engineering (TE) tunnels on a per-tunnel basis.

When MPLS TE is configured in a network, the Interior Gateway Protocol (IGP) floods two metrics for every link. The metrics are the normal IGP (OSPF or IS-IS) link metric and a TE link metric. The IGP uses the IGP link metric in the normal way to compute routes for destination networks.

You can specify that the path calculation for a given tunnel is based on either of the following:

- IGP link metrics
- TE link metrics, which you can configure so that they represent the needs of a particular application. For example, the TE link metrics can be configured to represent link transmission delay.

Benefits

When Traffic Engineering (TE) tunnels carry two types of traffic, the Configurable Path Calculation Metric for Tunnels feature allows you to tailor tunnel path selection to the requirements of each type of traffic.

For example, suppose that certain tunnels are to carry voice traffic (which requires low delay) and other tunnels are to carry data. In this situation, you can use the TE link metric to represent link delay and do the following:

- Configure tunnels that carry voice to use the TE link metric set to represent link delay for path calculation.
- Configure tunnels that carry data to use the IGP metric for path calculation.

How to Configure MPLS Traffic Engineering—Configurable Path Calculation Metric for Tunnels

The following section provides information about the configuration steps for Configurable Path Calculation Metric for Tunnels for MPLS Traffic Engineering.

Configuring a Platform to Support Traffic Engineering Tunnels

To configure a platform to support Traffic Engineering tunnels, perform this procedure.

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. Enter your password, if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip cef distributed** **Example:** `Device(config)# ip cef distributed`	Enables distributed Cisco Express Forwarding operation.
Step 4	**mpls traffic-eng tunnels** **Example:** `Device(config)# mpls traffic-eng tunnels`	Enables the MPLS traffic engineering tunnel feature on a device.
Step 5	**exit** **Example:** `Device(config)# exit`	Exits global configuration mode and returns to privileged EXEC mode.

Configuring IS-IS for MPLS Traffic Engineering

Note MPLS traffic engineering supports only a single IGP process or instance. Multiple IGP processes or instances are not supported. MPLS traffic engineering should not be configured in more than one IGP process or instance.

To configure IS-IS for MPLS traffic engineering, perform the following steps.

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. Enter your password, if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**router isis** **Example:** `Device(config)# router isis`	Enables IS-IS routing and specifies an IS-IS process. The device enters configuration mode.
Step 4	**mpls traffic-eng level** **Example:** `Device(config-router)# mpls traffic-eng level-1`	Turns on MPLS traffic engineering for IS-IS level 1.
Step 5	**mpls traffic-eng level** **Example:** `Device(config-router)# mpls traffic-eng level-2`	Turns on MPLS traffic engineering for IS-IS level 2.
Step 6	**mpls traffic-eng router-id** *type number* **Example:** `Device(config-router)# mpls traffic-eng router-id loopback 0`	Specifies that the traffic engineering router identifier for the node is the IP address associated with interface loopback0.
Step 7	**metric-style wide** **Example:** `Device(config-router)# metric-style wide`	Configures a router to generate and accept only new-style type, length, value objects (TLVs).

Configuring Traffic Engineering Link Metrics

Unless explicitly configured, the TE link metric is the IGP link metric.

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. Enter your password, if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type slot* / *subslot* / *port* [**.** *subinterface-number*] **Example:** `Device(config)# interface port channel 20`	Configures an interface type and enters interface configuration mode. • The *type* argument is the type of interface to be configured. • The *slot* argument is the chassis slot number. • The / *subslot* keyword and argument pair is the secondary slot number. The slash (/) is required. • The / *port* keyword and argument pair is the port or interface number. The slash (/) is required. • The **.** *subinterface-number*keyword and argument pair is the subinterface number in the range 1–4294967293. The number that precedes the period (.) must match the number to which this subinterface belongs.
Step 4	**mpls traffic-eng administrative-weight** *weight* **Example:** `Device(config-if)# mpls traffic-eng administrative-weight 20`	Overrides the IGP administrative weight (cost) of the link. • The *weight* argument is the cost of the link.
Step 5	**exit** **Example:** `Device(config-if)# exit`	Exits interface configuration mode and returns to global configuration mode.

	Command or Action	Purpose
Step 6	**exit** **Example:** `Device(config)# exit`	Exits global configuration mode and returns to privileged EXEC mode.

Configuring an MPLS Traffic Engineering Tunnel

To configure a preferred explicit path for an MPLS TE tunnel, perform this procedure.

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. Enter your password, if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface tunnel** *number* **Example:** `Device(config)# interface Tunnel0`	Configures an interface type and enters interface configuration mode. • The *number* argument is the number of the tunnel.
Step 4	**ip unnumbered** *type number* **Example:** `Device(config-if)# ip unnumbered loopback0`	Enables IP processing on an interface without assigning an explicit IP address to the interface. • The *type* and *number* arguments name the type and number of another interface on which the router has an assigned IP address. It cannot be another unnumbered interface. • An MPLS traffic engineering tunnel interface should be unnumbered because it represents a unidirectional link.
Step 5	**tunnel destination** *ip-address* **Example:** `Device(config-if)# tunnel destination 192.168.4.4`	Specifies the destination for a tunnel interface. • The *ip-address* argument must be the MPLS traffic engineering router ID of the destination device.

	Command or Action	Purpose
Step 6	**tunnel mode mpls traffic-eng** **Example:** `Device(config-if)# tunnel mode mpls traffic-eng`	Sets the tunnel encapsulation mode to MPLS traffic engineering.
Step 7	**tunnel mpls traffic-eng bandwidth** *bandwidth* **Example:** `Device(config-if)# tunnel mpls traffic-eng bandwidth 250`	Configures the bandwidth for the MPLS traffic engineering tunnel. • The *bandwidth* argument is a number in kilobits per second that is set aside for the MPLS traffic engineering tunnel. Range is from 1 through 4294967295. **Note** If automatic bandwidth is configured for the tunnel, use the **tunnel mpls traffic-eng bandwidth** command to configure the initial tunnel bandwidth.
Step 8	**tunnel mpls traffic-eng path-option** *number* {**dynamic** | **explicit** {**name** *path-name* | **identifier** *path-number*}} [**lockdown**] **Example:** `Device(config-if)# tunnel mpls traffic-eng path-option 10 explicit identifier 321`	Configures the tunnel to use a named IP explicit path or a path dynamically calculated from the traffic engineering topology database. • The *number* argument is the preference for this path option. When you configure multiple path options, lower numbered options are preferred. Valid values are from 1 through 1000. • The **dynamic** keyword indicates that the path of the LSP is dynamically calculated. • The **explicit** keyword indicates that the path of the LSP is an IP explicit path. • The **name** *path-name* keyword and argument are the path name of the IP explicit path that the tunnel uses with this option. • The **identifier** *path-number* keyword and argument pair names the path number of the IP explicit path that the tunnel uses with this option. The range is from 1 through 65535. • The **lockdown** keyword specifies that the LSP cannot be reoptimized. **Note**

	Command or Action	Purpose
		A dynamic path is used if an explicit path is currently unavailable.
Step 9	**exit** **Example:** `Device(config-if)# exit`	Exits interface configuration mode and returns to global configuration mode.

Configuring the Metric Type for Tunnel Path Calculation

Unless explicitly configured, the traffic engineering link metric type is used for tunnel path calculation. You can use two commands to control the metric type to use: an interface configuration command that specifies the metric type to be used for a particular TE tunnel. And a global configuration command that specifies the metric type to use for TE tunnels for which a metric type is unspecified by the interface configuration command.

Note If you do not enter either of the path selection metrics commands, the traffic engineering (TE) metric is used.

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. Enter your password, if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface tunnel** *number* **Example:** `Device(config)# interface Tunnel0`	Configures an interface type and enters interface configuration mode. • The *number* argument is the number of the tunnel.
Step 4	**tunnel mpls traffic-eng path-selection metric** {**igp** | **te**} **Example:** `Device(config-if)# tunnel mpls traffic-eng path-selection metric igp`	Specifies the metric type to use for path calculation for a tunnel. • The **igp** keyword specifies the use of the Interior Gateway Protocol (IGP) metric. • The **te** keyword specifies the use of the traffic engineering (TE) metric. The traffic engineering metric is the default.

	Command or Action	Purpose
Step 5	**exit** **Example:** `Device(config-if)# exit`	Exits interface configuration mode and returns to global configuration mode.
Step 6	**mpls traffic-eng path-selection metric** {**igp** | **te**} **Example:** `Device(config)# mpls traffic-eng path-selection metric igp`	Specifies the metric type to use when a metric type was not explicitly configured for a given tunnel. • The **igp** keyword specifies the use of the Interior Gateway Protocol (IGP) metric. • The **te** keyword specifies the use of the traffic engineering (TE) metric. This is the default.
Step 7	**exit** **Example:** `Device(config)# exit`	Exits global configuration mode and returns to privileged EXEC mode.

Verifying the Tunnel Path Metric Configuration

To verify the tunnel path metric configuration, perform the following procedure.

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. Enter your password, if prompted.
Step 2	**show mpls traffic-eng topolog** y **Example:** `Device# show mpls traffic-eng topology`	Displays TE and IGP metrics for each link. You can verify that link metrics are correctly configured for a network.
Step 3	**show mpls traffic-eng tunnels** **Example:** `Device# show mpls traffic-eng tunnels`	Displays the link metric used for tunnel path calculation. You can verify that the desired link metrics are used for each tunnel.
Step 4	**exit** **Example:**	Returns to user EXEC mode.

	Command or Action	Purpose
	`Device# exit`	

Configuration Examples for MPLS Traffic Engineering—Configurable Path Calculation Metric for Tunnels

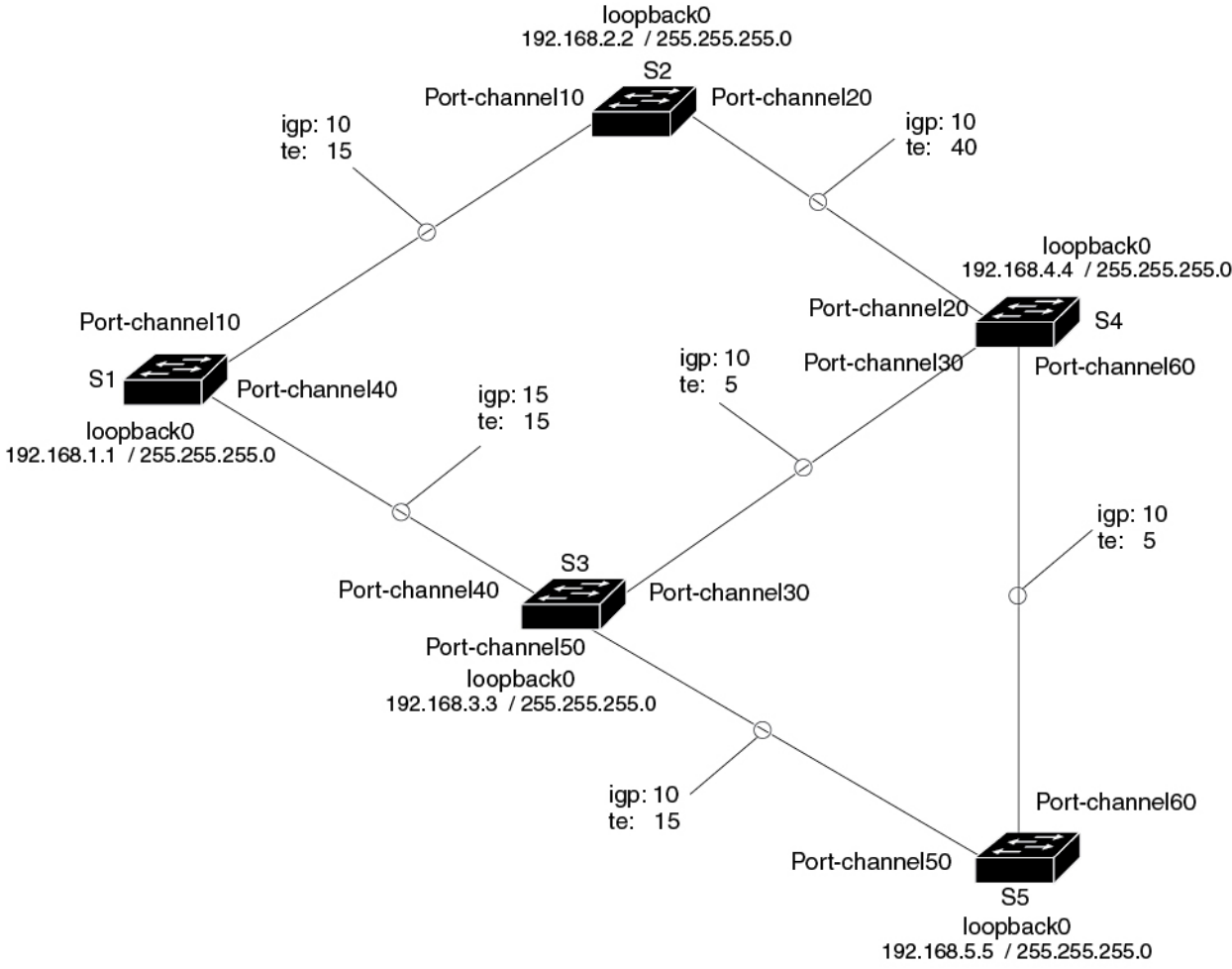
The following section provides configuration examples for configuring a path calculation metric for tunnels.

Example: Configuring Link Type and Metrics for Tunnel Path Selection

The section illustrates how to configure the link metric type to use for tunnel path selection. And how to configure the link metrics themselves. The configuration commands included focus on specifying the metric type for path calculation and assigning metrics to links. You will need additional commands are required to fully configure the example scenario. For example, the IGP commands for traffic engineering and the link interface commands for enabling traffic engineering and specifying available bandwidth.

The examples in this section support the simple network technology shown in the following figure.

Figure 1: Network topology



In the figure above:

- Tunnel1 and Tunnel2 run from S1 (headend) to S4 (tailend).
- Tunnel3 runs from S1 to S5.
- Path calculation for Tunnel1 and Tunnel3 should use a metric that represents link delay because these tunnels carry voice traffic.
- Path calculation for Tunnel2 should use IGP metrics because MPLS TE carries data traffic with no delay requirement.

Configuration fragments follow for each of the devices that illustrate the configuration relating to link metrics and their use in tunnel path calculation. TE metrics that represent link delay must be configured for the network links on each of the devices. And the three tunnels must be configured on S1.

This configuration fragments force Tunnel1 to take path S1-S3-S4, Tunnel2 to take path S1-S2-S4, and Tunnel3 to take path S1-S3-S4-S5 (assuming the links have sufficient bandwidth to accommodate the tunnels).

S1 Configuration

The following example shows how to configure the tunnel headend S1 for Tunnel1, Tunnel2, and Tunnel3 in the preceding figure:

```
interface port channel 40
mpls traffic-eng administrative-weight 15       !TE metric different from IGP metric
interface port channel 10
mpls traffic-eng administrative-weight 15       !TE metric different from IGP metric
interface Tunnel1                               !Tunnel1 uses TE metric (default)
                                                !for path selection
ip unnumbered loopback0
tunnel destination 192.168.4.4 255.255.255.0
tunnel mode mpls traffic-eng
tunnel mpls traffic-eng bandwidth 1000
tunnel mpls traffic-eng path-option 1 dynamic
interface Tunnel2                                !Tunnel2 uses IGP metric
                                                 !for path selection
ip unnumbered loopback0
tunnel destination 192.168.4.4 255.255.255.0
tunnel mode mpls traffic-eng
tunnel mpls traffic-eng bandwidth 1000
tunnel mpls traffic-eng path-option 1 dynamic
tunnel mpls traffic-eng path-selection-metric igp !Use IGP cost for path selection.
interface Tunnel3                                  !Tunnel3 uses TE metric (default)
                                                   !for path selection
ip unnumbered loopback0
tunnel destination 192.168.5.5 255.255.255.0
tunnel mode mpls traffic-eng
tunnel mpls traffic-eng bandwidth 1000
tunnel mpls traffic-eng path-option 1 dynamic
```

S2 Configuration

The following example shows how to configure S2 in the preceding figure:

```
interface port channel 10
mpls traffic-eng administrative-weight 15       !TE metric different from IGP metric
interface port channle 20
mpls traffic-eng administrative-weight 40       !TE metric different from IGP metric
```

S3 Configuration

The following example shows how to configure S3 in the preceding figure:

```
interface port channel 40
mpls traffic-eng administrative-weight 15       !TE metric different from IGP metric
interface port channel 50
mpls traffic-eng administrative-weight 15       !TE metric different from IGP metric
interface port channel 30
mpls traffic-eng administrative-weight 5        !TE metric different from IGP metric
```

S4 Configuration

The following example shows how to configure R4 in the preceding figure:

```
interface port channel 20
mpls traffic-eng administrative-weight 15       !TE metric different from IGP metric
interface port channel 30
```

```
mpls traffic-eng administrative-weight 15       !TE metric different from IGP metric
interface port channel 60
mpls traffic-eng administrative-weight 5        !TE metric different from IGP metric
```

S5 Configuration

The following example shows how to configure S5 in the preceding figure:

```
interface port channel 50
mpls traffic-eng administrative-weight 15       !TE metric different from IGP metric
interface port channel 60
mpls traffic-eng administrative-weight 5        !TE metric different from IGP metric
```

Example: Verifying the Tunnel Path Metric Configuration

The following examples show how to verify the Tunnel Path Metric configuration.

The following example is a sample output of the **show mpls traffic-eng topology** command. This command displays the TE and IGP metrics for each link.

```
Device# show mpls traffic-eng topology
My_System_id: 1440.0000.0044.00 (isis  level-1)
IGP Id: 0090.0000.0009.00, MPLS TE Id:192.168.9.9 Router Node  (isis  level-1)
      link[0 ]:Nbr IGP Id: 0090.0000.0009.03, gen:7
          frag_id 0, Intf Address:10.0.0.99
          TE metric:100, IGP metric:48, attribute_flags:0x0     !!Note TE and IGP metrics
          physical_bw: 10000 (kbps), max_reservable_bw_global: 0 (kbps)
          max_reservable_bw_sub: 0 (kbps)
.
.
.
      link[1 ]:Nbr IGP Id: 0055.0000.0055.00, gen:7
          frag_id 0, Intf Address:10.205.0.9, Nbr Intf Address:10.205.0.55
          TE metric:120, IGP metric:10, attribute_flags:0x0     !!Note TE and IGP metrics
          physical_bw: 155000 (kbps), max_reservable_bw_global: 500000 (kbps)
          max_reservable_bw_sub: 0 (kbps)
```

The following example is a sample output of the **show mpls traffic-eng tunnels** command. This command displays the link metric used for tunnel path calculation.

```
Device# show mpls traffic-eng tunnels
Name: te3640-17-c_t221              (Tunnel22) Destination: 192.168.100.22
  Status:
    Admin: up         Oper: up     Path: valid       Signalling: connected
    path option 1, type dynamic (Basis for Setup, path weight 10)
  Config Parameters:
    Bandwidth: 400 kps (Global)    Priority: 1  1   Affinity: 0x0/0xFFFF
    Metric Type: IGP                                      !!Note metric type
    AutoRoute:  enabled   LockDown: disabled  Loadshare: 0   bw-based
    auto-bw: disabled(0/115) 0  Bandwidth Requested: 0
.
.
.
Name: te3640-17-c_t222              (Tunnel33) Destination: 192.168.100.22
  Status:
    Admin: up         Oper: up     Path: valid       Signalling: connected
    path option 1, type dynamic (Basis for Setup, path weight 10)
  Config Parameters:
    Bandwidth: 200 kbps (Global)   Priority: 1  1   Affinity: 0x0/0xFFFF
    Metric Type: TE                                       !!Note metric type
```

```
    AutoRoute:  enabled   LockDown: disabled  Loadshare: 0   bw-based
    auto-bw: disabled(0/115) 0  Bandwidth Requested: 0
.
.
.
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Configuration tasks for IS-IS and OSPF	*Cisco IOS XE IP Routing Protocols Configuration Guide*
IS-IS and OSPF commands	*Cisco IOS IP Routing Protocols Command Reference*
Configuration tasks for MPLS and MPLS TE	*Cisco IOS XE Multiprotocol Label Switching Configuration Guide*
MPLS TE commands	*Cisco IOS Multiprotocol Label Switching Command Reference*
Configuration tasks for tunnels	• *Cisco IOS XE Interface and Hardware Component Configuration Guide* • *Cisco IOS XE Multiprotocol Label Switching Configuration Guide*
Tunnel configuration commands	• *Cisco IOS Interface and Hardware Component Command Reference* • *Cisco IOS XE Multiprotocol Label Switching Command Reference*

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 History for MPLS Traffic Engineering—Configurable Path Calculation Metric for Tunnels

This table provides release and related information for the features explained in this module.

These features are available in all the releases subsequent to the one they were introduced in, unless noted otherwise.

Release	Feature	Feature Information
Cisco IOS XE Bengaluru 17.6.1	MPLS Traffic Engineering—Configurable Path Calculation Metric for Tunnels	The MPLS Traffic Engineering—Configurable Path Calculation Metric for Tunnels feature enables you to control the metric used in path calculation for traffic engineering (TE) tunnels on a per-tunnel basis.

Use the Cisco Feature Navigator to find information about platform and software image support. To access Cisco Feature Navigator, go to https://cfnng.cisco.com/