Configuring MPLS Traffic Engineering over GRE Tunnel Support

The MPLS Traffic Engineering (TE) over Generic Routing Encapsulation (GRE) Tunnel Support feature enables applications to establish TE tunnels over virtual interfaces.

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Finding Feature Information

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

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

Prerequisites for Configuring MPLS TE over GRE Tunnel Support

Your network must support the following:

- Cisco Express Forwarding
- External data encryptors
- Intermediate System-to-Intermediate System (IS-IS) or Open Shortest Path First (OSPF)
- IPsec that is enabled on the GRE nodes to implement GRE traffic encryption
- MPLS TE that is configured on the interface and on GRE tunnels
Restrictions for Configuring MPLS TE Over GRE Tunnel Support

The following TE features are not supported over GRE tunnels, so they should not be configured for TE tunnels that may traverse GRE tunnels:

- The following TE features are not supported over GRE tunnels. They should not be configured for TE tunnels that may traverse GRE tunnels:
  - Autoroute destinations
  - Automatic bandwidth adjustment
  - Autotunnel primary one-hop tunnels
  - Diff-Serve Aware TE (DS-TE)
  - Explicit path options that identify excluded nodes
  - Interarea/autonomous systems MPLS TE
  - Point-to-multipoint TE
  - Shared Risk Link Groups (SRLGs)
  - Tunnel-Based Admission Control (TBAC)

- GRE tunnels do not support Cisco nonstop forwarding with stateful switchover (NSF with SSO). If a switchover occurs, traffic loss occurs for TE over GRE, and the TE tunnels are resignalized.
- Fast Reroute (FRR) is not supported.

Information About Configuring MPLS TE over GRE Tunnel Support

MPLS TE over GRE Tunnel Support Overview

MPLS TE tunnels provide transport for label switching data through an MPLS network using a path, which is constraint-based, and is not restricted to the IGP shortest cost path. The TE tunnels are usually established over physical links between adjacent routers. However, some applications require establishing TE tunnels over virtual interfaces such as GRE tunnels. Federal Information Processing Standard (FIPS) 140-2 compliance mandates that federal customers require traffic encryption throughout their network infrastructure, which is referred to as Type-I encryption level of security. Type-I encryption environments differentiate between encrypted and unencrypted networks. The encrypted network is the secure part of the network that is in a
secure facility, where encryption is not required. The unencrypted network is the unsecured part of the network where traffic encryption is required.

Two common methods of traffic encryption are as follows:

- External crypto devices
- Cisco IOS IPsec, which is the encryption embedded into Cisco IOS software

External crypto devices operate in Layer 2 (L2), providing link layer encryption of ATM and SONET traffic. Due to the migration of L2 networks to IP network, there is an increasing adoption of IP crypto devices and IPsec. This transition requires that the traffic encryption happens at the IP layer. The IP-based forwarding of service traffic, such as IP or Layer 3 (L3)/L2 VPN MPLS traffic, is implemented only through GRE tunnels.

The following MPLS TE features are supported when enabled over GRE tunnel:

- MPLS TE over GRE (Tunnel establishment and data traffic)
- Metrics (admin weight)
- Attribute flag and affinities
- Explicit path
- BFD
- ECMP without Class Based Tunnel Selection (CBTS)

**Benefits of MPLS TE over GRE Tunnel Support**

The MPLS TE Over GRE Tunnel Support feature enables you to leverage MPLS segmentation capabilities, such as Layer 2 and Layer 3 VPN, on GRE tunnel transport. This feature enables you to deploy MPLS TE to implement explicit path forwarding, FRR, and bandwidth management of traffic over GRE tunnels. Also, this feature helps maintain the TE capabilities currently supported by ATM legacy networks.

**How to Configure MPLS TE over GRE Tunnel Support**

**Configuring Resource Reservation Protocol Bandwidth**

**SUMMARY STEPS**

1. enable
2. configure terminal
3. interface type number
4. bandwidth kbps
5. ip address ip-address mask
6. mpls traffic-eng tunnels
7. tunnel source type number
8. tunnel destination {host-name | ip-address | ipv6-address}
9. ip rsvp bandwidth
### 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> interface type number</td>
<td>Configures a tunnel interface and enters interface configuration mode for the specified tunnel interface.</td>
</tr>
<tr>
<td>Example: Router(config)# interface tunnel 0</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> bandwidth kbps</td>
<td>Sets the total bandwidth for a bandwidth pool.</td>
</tr>
<tr>
<td>Example: Router(config-if)# bandwidth 100000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> ip address ip-address mask</td>
<td>Configures a primary IP address for an interface.</td>
</tr>
<tr>
<td>Example: Router(config-if)# ip address 172.16.0.0 255.255.255.254</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> mpls traffic-eng tunnels</td>
<td>Enables traffic engineering tunnel signaling on the interface.</td>
</tr>
<tr>
<td>Example: Router(config-if)# mpls traffic-eng tunnels</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong> tunnel source type number</td>
<td>Configures the source address for the tunnel interface.</td>
</tr>
<tr>
<td>Example: Router(config-if)# tunnel source loopback 1</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong> tunnel destination {host-name</td>
<td>ip-address</td>
</tr>
<tr>
<td>Example: Router(config-if)# tunnel destination 192.168.1.1</td>
<td>• ip-address—IP address of the host destination expressed in dotted decimal notation.</td>
</tr>
<tr>
<td><strong>Step 9</strong> ip rsvp bandwidth</td>
<td>Enables Resource Reservation Protocol (RSVP) for IP on an interface.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
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</tbody>
</table>
### Configuring an MPLS TE Tunnel

#### SUMMARY STEPS

1. enable
2. configure terminal
3. interface tunnel number
4. ip unnumbered type number
5. tunnel destination {host-name | ip-address | ipv6-address}
6. mpls traffic-eng tunnels
7. tunnel mpls traffic-eng priority setup-priority [hold-priority]
8. tunnel mpls traffic-eng bandwidth kbps
9. tunnel mpls traffic-eng path-option number dynamic
10. tunnel mpls traffic-eng fast-reroute
11. end

#### DETAILED STEPS

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<td>enable</td>
<td>• Enter your password if prompted.</td>
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<td>Example:</td>
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<td>Router&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Enters global configuration mode.</td>
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<tr>
<td>configure terminal</td>
<td></td>
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<tr>
<td>Example:</td>
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<tr>
<td>Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Configures a tunnel interface and enters interface configuration mode for the specified tunnel interface.</td>
</tr>
<tr>
<td>interface tunnel number</td>
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<tr>
<td>Example:</td>
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<tr>
<td>Router(config)# interface tunnel 10</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>Assigns an IP address to the tunnel interface.</td>
</tr>
<tr>
<td>ip unnumbered type number</td>
<td>• An MPLS TE tunnel interface should be unnumbered because it represents a unidirectional link.</td>
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<td>Example:</td>
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<td>Step</td>
<td>Command or Action</td>
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<tr>
<td>5</td>
<td>`tunnel destination host-name</td>
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<td>Example:</td>
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<td></td>
<td><code>Router(config-if)# tunnel destination 192.168.2.2</code></td>
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<tr>
<td>6</td>
<td><code>mpls traffic-eng tunnels</code></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td><code>Router(config-if)# mpls traffic-eng tunnels</code></td>
</tr>
<tr>
<td>7</td>
<td><code>tunnel mpls traffic-eng priority setup-priority [hold-priority]</code></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td><code>Router(config-if)# tunnel mpls traffic-eng priority 7 7</code></td>
</tr>
<tr>
<td>8</td>
<td><code>tunnel mpls traffic-eng bandwidth kbps</code></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
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<tr>
<td></td>
<td><code>Router(config-if)# tunnel mpls traffic-eng bandwidth 10</code></td>
</tr>
<tr>
<td>9</td>
<td><code>tunnel mpls traffic-eng path-option number dynamic</code></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
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<tr>
<td></td>
<td><code>Router(config-if)# tunnel mpls traffic-eng path-option 10 dynamic</code></td>
</tr>
<tr>
<td>10</td>
<td><code>tunnel mpls traffic-eng fast-reroute</code></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td><code>Router(config-if)# tunnel mpls traffic-eng fast-reroute</code></td>
</tr>
<tr>
<td>11</td>
<td><code>end</code></td>
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<tr>
<td></td>
<td>Example:</td>
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<td></td>
<td><code>Router(config-if)# end</code></td>
</tr>
</tbody>
</table>
# Configuring an MPLS TE Tunnel over GRE

## SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `interface tunnel number`
4. `ip unnumbered loopback number`
5. `tunnel destination ip-address`
6. `tunnel mpls traffic-eng autoroute announce`
7. `tunnel mpls traffic-eng`
8. `tunnel mpls traffic-eng path-option number dynamic`
9. `end`

## DETAILED STEPS

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<td><code>Router&gt; enable</code></td>
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<td>Step 2</td>
<td><code>configure terminal</code></td>
<td>Enters global configuration mode.</td>
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<td></td>
<td>Example:</td>
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</tr>
<tr>
<td></td>
<td><code>Router# configure terminal</code></td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td><code>interface tunnel number</code></td>
<td>Configures an interface type and enters interface configuration mode</td>
</tr>
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<td>Example:</td>
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<td></td>
<td><code>Router(config)# interface tunnel 100</code></td>
<td></td>
</tr>
<tr>
<td>Step 4</td>
<td><code>ip unnumbered loopback number</code></td>
<td>Assigns an IP address to the tunnel interface.</td>
</tr>
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<td></td>
<td>Example:</td>
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<tr>
<td></td>
<td><code>Router(config-if)# ip unnumbered loopback 0</code></td>
<td></td>
</tr>
<tr>
<td>Step 5</td>
<td><code>tunnel destination ip-address</code></td>
<td>Specifies the destination for a tunnel.</td>
</tr>
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<td>Example:</td>
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<tr>
<td></td>
<td><code>Router(config-if)# tunnel destination 10.255.1.2</code></td>
<td></td>
</tr>
<tr>
<td>Step 6</td>
<td><code>tunnel mpls traffic-eng autoroute announce</code></td>
<td>Specifies that the IGP should use the tunnel in its enhanced shortest path first (SPF) calculation.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
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<tr>
<td></td>
<td><code>Router(config-if)# tunnel mpls traffic-eng autoroute announce</code></td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
<td></td>
</tr>
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</tr>
</tbody>
</table>
| **Step 7** | **tunnel mpls traffic-eng**  
Example:  
Router(config-if)# tunnel mpls traffic-eng |
| Sets the encapsulation mode of the tunnel to MPLS TE. |
| **Step 8** | **tunnel mpls traffic-eng path-option** *number*  
**dynamic**  
Example:  
Router(config-if)# tunnel mpls traffic-eng  
path-option 10 dynamic |
| Configures a path option for the MPLS TE tunnel.  
- If you specify the `dynamic` keyword, the Cisco IOS software checks both the physical bandwidth of the interface and the available TE bandwidth to make sure that the requested amount of bandwidth does not exceed the physical bandwidth of any link. |
| **Step 9** | **end**  
Example:  
Router(config-if)# end |
| (Optional) Exits interface configuration mode and returns to privileged EXEC mode. |

### Configuration Examples for MPLS TE Over GRE Tunnel Support

#### Example Configuring MPLS TE Over GRE Tunnel Support

The following example shows how to configure MPLS TE over a GRE tunnel between two routers: Router 1 and Router 2. The first loopback interface is used for router identification, and the other for reachability. One OSPF is used for TE and the other for reachability.

**Router 1**

```
configure terminal
no logging console
mpls traffic-eng tunnels
interface Loopback 0
  ip address 172.16.1.1 255.255.255.255
  no shutdown
interface Loopback 1
  ip address 10.255.1.1 255.255.255.0
  no shutdown
interface gigabitethernet 1/1
  ip address 172.16.1.1 255.255.255.255
  ip rsvp bandwidth 100000
  no shutdown
router ospf 172
  router-id 172.16.1.1
  network 172.16.0.0 0.0.255.255 area 0
  mpls traffic-eng router-id Loopback 0
  mpls traffic-eng area 0
  no shutdown
```
! router ospf 10
  router-id 10.255.1.1
  network 10.255.0.0 0.0.255.255 area 0
  no shutdown
!
interface Tunnel 10
bandwidth 20000
  ip address 172.16.0.1 255.255.255.252
  mpls traffic-eng tunnels
  keepalive 10 3
  tunnel source Loopback 1
  tunnel destination 10.255.1.2
  ip rsvp bandwidth 15000 sub-pool 5000
!
!
interface tunnel 100
ip unnumbered loopback 0
  tunnel mode mpls traffic-eng
tunnel destination 192.168.10.10
tunnel mpls traffic-eng autoroute announce
tunnel mpls traffic-eng path-option 10 dynamic
!
end
Router 2
configure terminal
no logging console
mpls traffic-eng tunnels
interface Loopback 0
  ip address 172.16.1.2 255.255.255.255
  no shutdown
!
interface Loopback 1
  ip address 10.255.1.2 255.255.255.255
  no shutdown
!
interface gigabitethernet 1/1
  ip address 10.255.0.2 255.255.255.252
  ip rsvp bandwidth 100000
  no shutdown
!
router ospf 172
  router-id 172.16.1.2
  network 172.16.0.0 0.0.255.255 area 0
  mpls traffic-eng router-id Loopback 0
  mpls traffic-eng area 0
  no shutdown
!
router ospf 10
  router-id 10.255.1.2
  network 10.255.0.0 0.0.255.255 area 0
  no shutdown
!
!
interface Tunnel0
bandwidth 20000
  ip address 172.16.0.2 255.255.255.252
  mpls traffic-eng tunnels
  keepalive 10 3
  tunnel source Loopback 1
  tunnel destination 10.255.1.1
  ip rsvp bandwidth 15000 sub-pool 5000
!
interface tunnel 100
ip unnumbered loopback 0
tunnel mode mpls traffic-eng
tunnel destination 172.16.1.1
tunnel mpls traffic-eng autoroute announce
tunnel mpls traffic-eng path-option 10 dynamic

Example Configuring CBTS with MPLS over GRE

The following example shows how to configure Class-Based Tunnel Selection (CBTS) with MPLS Traffic Engineering (TE) over GRE.

Figure 1: The Network Structure of CBTS with MPLS over GRE

Example Configuring CBTS with MPLS over GRE

Figure 1: The Network Structure of CBTS with MPLS over GRE

Configuration of the Midpoint Router (R1)

mpls traffic-eng tunnels
!
interface Tunnel 102
ip address 203.20.0.1 255.255.255.0
mpls ip
mpls traffic-eng tunnels
tunnel source GigabitEthernet 0/0/0
tunnel destination 192.168.0.1
tunnel key 22
tunnel checksum
ip rsvp bandwidth 500000
!
interface Tunnel 103
ip address 203.10.0.1 255.255.255.0
mpls ip
mpls traffic-eng tunnels
tunnel source GigabitEthernet 0/0/0
tunnel destination 192.168.10.1
tunnel key 33
tunnel checksum
ip rsvp bandwidth 500000
mpls traffic-eng tunnels
!
router ospf 1
router-id 10.1.1.1
Network 10.1.1.1 0.0.0.0 area 1
Network 203.20.0.1 0.0.0.0 area 1
Network 203.10.0.1 0.0.0.0 area 1
MPLS traffic-eng router-id Loopback 0
MPLS traffic-eng area 1

Configuration of the Head Router (R2)

MPLS traffic-eng tunnels
!
interface Tunnel 203
  ip address 203.0.0.1 255.255.255.0
  mpls ip
  mpls traffic-eng tunnels
  tunnel source GigabitEthernet 0/0/0
  tunnel destination 192.168.10.1
  tunnel key 6
  tunnel checksum
  ip rsvp bandwidth 500000
!
interface Tunnel 211
  ip address 172.16.0.2 255.255.255.0
  mpls ip
  mpls traffic-eng tunnels
  tunnel source GigabitEthernet 0/0/0
  tunnel destination 192.168.20.1
  tunnel key 22
  tunnel checksum
  ip rsvp bandwidth 500000
!
interface Tunnel 2300
  ip unnumbered Loopback 0
  tunnel mode mpls traffic-eng
  tunnel destination 10.3.3.3
  tunnel mpls traffic-eng autoroute announce
  tunnel mpls traffic-eng autoroute metric relative -5
  tunnel mpls traffic-eng bandwidth 1000
  tunnel mpls traffic-eng path-option 10 dynamic
  tunnel mpls traffic-eng exp-bundle master
  tunnel mpls traffic-eng exp-bundle member Tunnel 2301
  tunnel mpls traffic-eng exp-bundle member Tunnel 2302
!
interface Tunnel 2301
  ip unnumbered Loopback 0
  tunnel mode mpls traffic-eng
  tunnel destination 10.3.3.3
  tunnel mpls traffic-eng autoroute announce
  tunnel mpls traffic-eng autoroute metric relative -5
  tunnel mpls traffic-eng priority 7 7
  tunnel mpls traffic-eng bandwidth 1000
  tunnel mpls traffic-eng path-option 10 explicit name TE2301
  tunnel mpls traffic-eng exp 6 7
!
interface Tunnel 2302
  ip unnumbered Loopback 0
  tunnel mode mpls traffic-eng
  tunnel destination 10.3.3.3
  tunnel mpls traffic-eng autoroute announce
  tunnel mpls traffic-eng autoroute metric relative -5
  tunnel mpls traffic-eng priority 7 7
  tunnel mpls traffic-eng bandwidth 1000
  tunnel mpls traffic-eng path-option 10 explicit name TE2302
tunnel mpls traffic-eng exp default
!
router ospf 1
   router-id 10.2.2.2
   network 10.2.2.2 0.0.0.0 area 1
   network 203.20.0.2 0.0.0.0 area 1
   network 172.16.0.2 0.0.0.0 area 1
   network 203.0.0.1 0.0.0.0 area 1
mpls traffic-eng router-id Loopback0
mpls traffic-eng area 1
!
ip explicit-path name TE2301 enable
   next-address 203.0.0.2
ip explicit-path name TE2302 enable
   next-address 172.16.0.1
   next-address 172.26.0.2

Configuration of the Tail Router (R3)

mpls traffic-eng tunnels
!
interface Tunnel 302
   ip address 203.0.0.2 255.255.255.0
   mpls ip
   mpls traffic-eng tunnels
   tunnel source GigabitEthernet 0/0/0
   tunnel destination 192.168.0.1
   tunnel key 6
   tunnel checksum
   ip rsvp bandwidth 500000
!
interface Tunnel 311
   ip address 172.26.0.2 255.255.255.0
   mpls ip
   mpls traffic-eng tunnels
   tunnel source GigabitEthernet 0/0/0
   tunnel destination 192.168.20.1
   tunnel key 33
   tunnel checksum
   ip rsvp bandwidth 500000
!
router ospf 1
   router-id 10.3.3.3
   network 10.3.3.3 0.0.0.0 area 1
   network 203.10.0.2 0.0.0.0 area 1
   network 172.26.0.2 0.0.0.0 area 1
   network 203.0.0.2 0.0.0.0 area 1
mpls traffic-eng router-id Loopback0
mpls traffic-eng area 1
!
## Additional References for MPLS TE Over GRE Tunnel Support

### Related Documents

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<td>Cisco IOS commands</td>
<td>Cisco IOS Master Commands List, All Releases</td>
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<tr>
<td>MPLS commands</td>
<td>Cisco IOS Multiprotocol Label Switching Command Reference</td>
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### Standards

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<tr>
<td>FIPS 140-2</td>
<td>Security Requirements for Cryptographic Modules.</td>
</tr>
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### MIBs

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<th>MIB</th>
<th>MIBs Link</th>
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<tbody>
<tr>
<td>MPLS-TE-STD-MIB</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>
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### RFCs

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<tr>
<td>RFC 3812</td>
<td>MPLS TE Management Information Base (MIB)</td>
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### Technical Assistance

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<tbody>
<tr>
<td>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.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
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Feature Information for MPLS TE Over GRE Tunnel Support

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

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

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
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<tbody>
<tr>
<td>MPLS TE over GRE Tunnel Support</td>
<td>Cisco IOS XE Release 3.3S 15.2(1)T Cisco IOS XE Release 3.12S Cisco IOS XE Release 3.16S</td>
<td>The MPLS TE over GRE Tunnel Support feature enables applications to establish traffic engineering tunnels over virtual interfaces. The following commands were introduced or modified: <code>mpls traffic-eng tunnels</code>, <code>tunnel mpls traffic-eng autoroute announce</code>, <code>tunnel mpls traffic-eng bandwidth</code>, <code>tunnel mpls traffic-eng fast-reroute</code>, <code>tunnel mpls traffic-eng path-option</code>, <code>tunnel mpls traffic-eng priority</code>. In Cisco IOS XE 3.12S release, CBTS support was added for GRE interface type on the Cisco ASR 1000 Series Aggregation Services Routers. In Cisco IOS XE 3.16S release, CBTS support was added for GRE interface type on Cisco ISR4451/4431/4351 series Integrated Services Routers.</td>
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