



BGP Support for MTR

The BGP Support for MTR feature provides Border Gateway Protocol (BGP) support for multiple logical topologies over a single physical network. This module describes how to configure BGP for Multitopology Routing (MTR).

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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 BGP Support for MTR

- Be familiar with all the concepts in the “Information About BGP Support for MTR” section.
- Configure and activate a global Multitopology Routing (MTR) topology configuration.

Restrictions for BGP Support for MTR

- Redistribution within a topology is permitted. Redistribution from one topology to another is not permitted. This restriction is designed to prevent routing loops. You can use topology translation or topology import functionality to move routes from one topology to another.
- Only a single multicast topology can be configured, and only the base topology can be specified if a multicast topology is created.

Information About BGP Support for MTR

Routing Protocol Support for MTR

You must enable IP routing on the device for Multitopology Routing (MTR) to operate. MTR supports static and dynamic routing in Cisco software. You can enable dynamic routing per topology to support interdomain and intradomain routing. Route calculation and forwarding are independent for each topology. MTR support is integrated into Cisco software for the following protocols:

- Border Gateway Protocol (BGP)
- Enhanced Interior Gateway Routing Protocol (EIGRP)
- Integrated Intermediate System-to-Intermediate System (IS-IS)
- Open Shortest Path First (OSPF)

You apply the per-topology configuration in router address family configuration mode of the global routing process (router configuration mode). The address family and subaddress family are specified when the device enters address family configuration mode. You specify the topology name and topology ID by entering the **topology** command in address family configuration mode.

You configure each topology with a unique topology ID under the routing protocol. The topology ID is used to identify and group Network Layer Reachability Information (NLRI) for each topology in updates for a given protocol. In OSPF, EIGRP, and IS-IS, you enter the topology ID during the first configuration of the **topology** command for a class-specific topology. In BGP, you configure the topology ID by entering the **bgp tid** command under the topology configuration.

You can configure class-specific topologies with different metrics than the base topology. Interface metrics configured on the base topology can be inherited by the class-specific topology. Inheritance occurs if no explicit inheritance metric is configured in the class-specific topology.

You configure BGP support only in router configuration mode. You configure Interior Gateway Protocol (IGP) support in router configuration mode and in interface configuration mode.

By default, interfaces are not included in nonbase topologies. For routing protocol support for EIGRP, IS-IS, and OSPF, you must explicitly configure a nonbase topology on an interface. You can override the default behavior by using the **all-interfaces** command in address family topology configuration mode. The **all-interfaces** command causes the nonbase topology to be configured on all interfaces of the device that are part of the default address space or the virtual routing and forwarding (VRF) instance in which the topology is configured.

BGP Network Scope

To implement Border Gateway Protocol (BGP) support for Multitopology Routing (MTR), the scope hierarchy is required, but the scope hierarchy is not limited to MTR use. The scope hierarchy introduces new configuration modes such as router scope configuration mode. The device enters router scope configuration mode when you configure the **scope** command in router configuration mode. When this command is entered, a collection of routing tables is created.

You configure BGP commands under the scope hierarchy for a single network (globally), or on a per-virtual routing and forwarding (VRF) basis; these configurations are referred to as scoped commands. The scope hierarchy can contain one or more address families.

MTR CLI Hierarchy Under BGP

The Border Gateway Protocol (BGP) CLI provides backward compatibility for pre-Multitopology Routing (MTR) BGP configuration and provides a hierarchical implementation of MTR. Router configuration mode is backward compatible with the pre-address family and pre-MTR configuration CLI. Global commands that affect all networks are configured in this configuration mode. For address family and topology configuration, you configure general session commands and peer templates to be used in address family configuration mode or in topology configuration mode.

After configuring any global commands, you define the scope either globally or for a specific virtual routing and forwarding (VRF) instance. The device enters address family configuration mode when you configure the **address-family** command in router scope configuration mode or in router configuration mode. Unicast is the default address family if no subaddress family identifier (SAFI) is specified. MTR supports only the IPv4 address family with a SAFI of unicast or multicast.

When the device enters address family configuration mode from router configuration mode, the software configures BGP to use pre-MTR-based CLI. This configuration mode is backward compatible with pre-existing address family configurations. Entering address family configuration mode from router scope configuration mode configures the device to use the hierarchical CLI that supports MTR. Address family configuration parameters that are not specific to a topology are entered in this address family configuration mode.

The device enters BGP topology configuration mode when you configure the **topology** command in address family configuration mode. You can configure up to 32 topologies (including the base topology) on a device. You configure the topology ID by entering the **bgp tid** command. All address family and subaddress family configuration parameters for the topology are configured here.



Note

Configuring a scope for a BGP routing process removes CLI support for pre-MTR-based configuration.

The following example shows the hierarchy levels that are used when you configure BGP for MTR implementation:

```
router bgp <autonomous-system-number>
  ! Global commands

  scope {global | vrf <vrf-name>}
  ! Scoped commands

  address-family {<afi>} [<safi>]
  ! Address family specific commands
```

```
topology {<topology-name> | base}
! topology specific commands
```

BGP Sessions for Class-Specific Topologies

Multitopology Routing (MTR) is configured under the Border Gateway Protocol (BGP) on a per-session basis. The base unicast and multicast topologies are carried in the global (default) session. A separate session is created for each class-specific topology that is configured under a BGP routing process. Each session is identified by its topology ID. BGP performs a best-path calculation individually for each class-specific topology. A separate Routing Information Base (RIB) and Forwarding Information Base (FIB) are maintained for each session.

Topology Translation Using BGP

Depending on the design and policy requirements for your network, you might need to install routes from a class-specific topology on one device in a class-specific topology on a neighboring device. Topology translation functionality using the Border Gateway Protocol (BGP) provides support for this operation. Topology translation is BGP neighbor-session based. You configure the **neighbor translate-topology** command by using the IP address and topology ID from the neighbor.

The topology ID identifies the class-specific topology of the neighbor. The routes in the class-specific topology of the neighbor are installed in the local class-specific Routing Information Base (RIB). BGP performs a best-path calculation on all installed routes and installs these routes into the local class-specific RIB. If a duplicate route is translated, BGP selects and installs only one instance of the route per standard BGP best-path calculation behavior.

Topology Import Using BGP

Importing topologies using the Border Gateway Protocol (BGP) is similar to topology translation. The difference is that routes are moved between class-specific topologies on the same device. You configure this function by entering the **import topology** command and specify the name of the class-specific topology or base topology. Best-path calculations are run on the imported routes before they are installed into the topology Routing Information Base (RIB). This **import topology** command also includes a **route-map** keyword to allow you to filter routes that are moved between class-specific topologies.

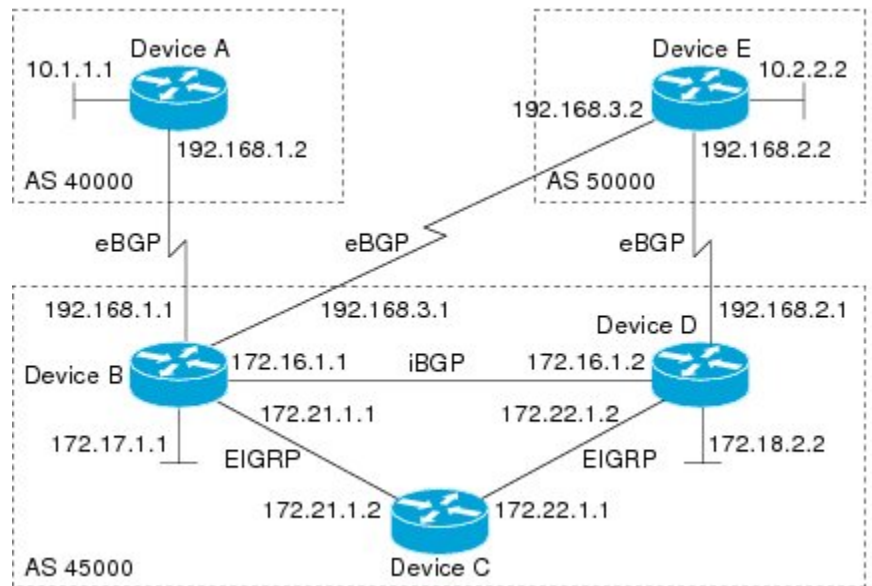
How to Configure BGP Support for MTR

Activating an MTR Topology by Using BGP

Perform this task to activate a Multitopology Routing (MTR) topology inside an address family by using the Border Gateway Protocol (BGP). This task is configured on Device B in the figure below and must also be configured on Device D and Device E. In this task, a scope hierarchy is configured to apply globally, and a neighbor is configured in router scope configuration mode. Under the IPv4 unicast address family, an MTR

topology that applies to video traffic is activated for the specified neighbor. There is no interface configuration mode for BGP topologies.

Figure 1: BGP Network Diagram



SUMMARY STEPS

1. enable
2. configure terminal
3. router bgp *autonomous-system-number*
4. scope {global | vrf *vrf-name*}
5. neighbor {*ip-address* | *peer-group-name*} remote-as *autonomous-system-number*
6. neighbor {*ip-address* | *peer-group-name*} transport {connection-mode {active | passive} | path-mtu-discovery | multi-session | single-session}
7. address-family ipv4 [mdt | multicast | unicast]
8. topology {base | *topology-name*}
9. bgp *tid number*
10. neighbor *ip-address* activate
11. neighbor {*ip-address* | *peer-group-name*} translate-topology *number*
12. end
13. clear ip bgp topology {* | *topology-name*} {*as-number* | dampening [*network-address* [*network-mask*]] | flap-statistics [*network-address* [*network-mask*]] | peer-group *peer-group-name* | table-map | update-group [*number* | *ip-address*]} [in [prefix-filter] | out | soft [in [prefix-filter] | out]]
14. show ip bgp topology {* | *topology*} summary

DETAILED STEPS

	Command or Action	Purpose
Step 1	<p>enable</p> <p>Example:</p> <pre>Device> enable</pre>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	<p>configure terminal</p> <p>Example:</p> <pre>Device# configure terminal</pre>	<p>Enters global configuration mode.</p>
Step 3	<p>router bgp <i>autonomous-system-number</i></p> <p>Example:</p> <pre>Device(config)# router bgp 45000</pre>	<p>Enters router configuration mode to create or configure a BGP routing process.</p>
Step 4	<p>scope {global vrf <i>vrf-name</i>}</p> <p>Example:</p> <pre>Device(config-router)# scope global</pre>	<p>Defines the scope for the BGP routing process and enters router scope configuration mode.</p> <ul style="list-style-type: none"> • BGP general session commands that apply to a single network, or a specified virtual and routing forwarding (VRF) instance, are entered in this configuration mode. • Use the global keyword to specify that BGP uses the global routing table. • Use the vrf <i>vrf-name</i> keyword and argument to specify that BGP uses a specific VRF routing table. The VRF must already exist.
Step 5	<p>neighbor {<i>ip-address</i> <i>peer-group-name</i>}</p> <p>remote-as <i>autonomous-system-number</i></p> <p>Example:</p> <pre>Device(config-router-scope)# neighbor 172.16.1.2 remote-as 45000</pre>	<p>Adds the IP address of the neighbor in the specified autonomous system to the multiprotocol BGP neighbor table of the local device.</p>
Step 6	<p>neighbor {<i>ip-address</i> <i>peer-group-name</i>}</p> <p>transport {connection-mode {active passive} path-mtu-discovery multi-session single-session}</p> <p>Example:</p> <pre>Device(config-router-scope)# neighbor 172.16.1.2 transport multi-session</pre>	<p>Enables a TCP transport session option for a BGP session.</p> <ul style="list-style-type: none"> • Use the connection-mode keyword to specify the type of connection, either active or passive. • Use the path-mtu-discovery keyword to enable the TCP transport path maximum transmission unit (MTU) discovery. • Use the multi-session keyword to specify a separate TCP transport session for each address family.

	Command or Action	Purpose
		<ul style="list-style-type: none"> Use the single-session keyword to specify that all address families use a single TCP transport session.
Step 7	address-family ipv4 [mdt multicast unicast] Example: <pre>Device(config-router-scope)# address-family ipv4</pre>	Specifies the IPv4 address family and enters router scope address family configuration mode. <ul style="list-style-type: none"> Use the mdt keyword to specify IPv4 multicast distribution tree (MDT) address prefixes. Use the multicast keyword to specify IPv4 multicast address prefixes. Use the unicast keyword to specify the IPv4 unicast address family. By default, the device is placed in address family configuration mode for the IPv4 unicast address family if the unicast keyword is not specified with the address-family ipv4 command. Nontopology-specific configuration parameters are configured in this configuration mode.
Step 8	topology {base topology-name} Example: <pre>Device(config-router-scope-af)# topology VIDEO</pre>	Configures the topology instance in which BGP routes class-specific or base topology traffic, and enters router scope address family topology configuration mode.
Step 9	bgp tid number Example: <pre>Device(config-router-scope-af-topo)# bgp tid 100</pre>	Associates a BGP routing process with the specified topology ID. <ul style="list-style-type: none"> Each topology must be configured with a unique topology ID.
Step 10	neighbor ip-address activate Example: <pre>Device(config-router-scope-af-topo)# neighbor 172.16.1.2 activate</pre>	Enables the BGP neighbor to exchange prefixes for the network service access point (NSAP) address family with the local device. <p>Note If you have configured a peer group as a BGP neighbor, do not use this command because peer groups are automatically activated when any peer group parameter is configured.</p>
Step 11	neighbor {ip-address peer-group-name} translate-topology number Example: <pre>Device(config-router-scope-af-topo)# neighbor 172.16.1.2 translate-topology 200</pre>	(Optional) Configures BGP to install routes from a topology on another device to a topology on the local device. <ul style="list-style-type: none"> The topology ID is entered for the <i>number</i> argument to identify the topology on the device.

	Command or Action	Purpose
Step 12	end Example: Device(config-router-scope-af-topo)# end	(Optional) Exits router scope address family topology configuration mode and returns to privileged EXEC mode.
Step 13	clear ip bgp topology <i>{* topology-name}</i> <i>{as-number dampening [network-address [network-mask]] flap-statistics [network-address [network-mask]] peer-group peer-group-name table-map update-group [number ip-address]}</i> <i>[in [prefix-filter] out soft [in [prefix-filter] out]]</i> Example: Device# clear ip bgp topology VIDEO 45000	Resets BGP neighbor sessions under a specified topology or all topologies.
Step 14	show ip bgp topology <i>{* topology}</i> summary Example: Device# show ip bgp topology VIDEO summary	(Optional) Displays BGP information about a topology. <ul style="list-style-type: none"> • Most standard BGP keywords and arguments can be entered following the topology keyword. Note Only the syntax required for this task is shown. For more details, see the <i>Cisco IOS IP Routing: BGP Command Reference</i> .

What to Do Next

Repeat this task for every topology that you want to enable, and repeat this configuration on all neighbor devices that are to use the topologies.

If you want to import routes from one Multitopology Routing (MTR) topology to another on the same device, see the “Importing Routes from an MTR Topology by Using BGP” section.

Importing Routes from an MTR Topology by Using BGP

Perform this task to import routes from one Multitopology Routing (MTR) topology to another on the same device, when multiple topologies are configured on the same device. In this task, a prefix list is defined to permit prefixes from the 10.2.2.0 network, and this prefix list is used with a route map to filter routes moved from the imported topology. A global scope is configured, address family IPv4 is entered, the VIDEO topology is specified, the VOICE topology is imported, and the routes are filtered using the route map named 10NET.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip prefix-list** *list-name* [**seq number**] {**deny** | **permit**} *network/length* [**ge ge-length**] [**le le-length**]
4. **route-map** *map-name* [**permit** | **deny**] [*sequence-number*]
5. **match ip address** {*access-list-number* [*access-list-number ...* | *access-list-name...*] | *access-list-name* [*access-list-number ...* | *access-list-name*] | **prefix-list** *prefix-list-name* [*prefix-list-name...*]}
6. **exit**
7. **router bgp** *autonomous-system-number*
8. **scope** {**global** | **vrf** *vrf-name*}
9. **address-family ipv4** [**mdt** | **multicast** | **unicast**]
10. **topology** {**base** | *topology-name*}
11. **import topology** {**base** | *topology-name*} [**route-map** *map-name*]
12. **end**

DETAILED STEPS

	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 prefix-list <i>list-name</i> [seq number] { deny permit } <i>network/length</i> [ge ge-length] [le le-length] Example: Device(config)# ip prefix-list TEN permit 10.2.2.0/24	Configures an IP prefix list. • In this example, prefix list TEN permits advertising of the 10.2.2.0/24 prefix depending on a match set by the match ip address command.
Step 4	route-map <i>map-name</i> [permit deny] [<i>sequence-number</i>] Example: Device(config)# route-map 10NET	Creates a route map and enters route-map configuration mode. • In this example, the route map named 10NET is created.
Step 5	match ip address { <i>access-list-number</i> [<i>access-list-number ...</i> <i>access-list-name...</i>]	Configures the route map to match a prefix that is permitted by a standard access list, an extended access list, or a prefix list.

	Command or Action	Purpose
	<p><i>access-list-name</i> [<i>access-list-number ... access-list-name</i>] prefix-list <i>prefix-list-name</i> [<i>prefix-list-name...</i>]</p> <p>Example:</p> <pre>Device(config-route-map)# match ip address prefix-list TEN</pre>	<ul style="list-style-type: none"> In this example, the route map is configured to match prefixes permitted by prefix list TEN.
Step 6	<p>exit</p> <p>Example:</p> <pre>Device(config-route-map)# exit</pre>	Exits route-map configuration mode and returns to global configuration mode.
Step 7	<p>router bgp <i>autonomous-system-number</i></p> <p>Example:</p> <pre>Device(config)# router bgp 50000</pre>	Enters router configuration mode to create or configure a Border Gateway Protocol (BGP) routing process.
Step 8	<p>scope {global vrf <i>vrf-name</i>}</p> <p>Example:</p> <pre>Device(config-router)# scope global</pre>	<p>Defines the scope to the BGP routing process and enters router scope configuration mode.</p> <ul style="list-style-type: none"> BGP general session commands that apply to a single network, or a specified virtual routing and forwarding (VRF) instance, are entered in this configuration mode. Use the global keyword to specify that BGP uses the global routing table. Use the vrf <i>vrf-name</i> keyword and argument to specify that BGP uses a specific VRF routing table. The VRF must already exist.
Step 9	<p>address-family ipv4 [mdt multicast unicast]</p> <p>Example:</p> <pre>Device(config-router-scope)# address-family ipv4</pre>	<p>Enters router scope address family configuration mode to configure an address family session under BGP.</p> <ul style="list-style-type: none"> Nontopology-specific configuration parameters are configured in this configuration mode.
Step 10	<p>topology {base <i>topology-name</i>}</p> <p>Example:</p> <pre>Device(config-router-scope-af)# topology VIDEO</pre>	Configures the topology instance in which BGP routes class-specific or base topology traffic, and enters router scope address family topology configuration mode.
Step 11	<p>import topology {base <i>topology-name</i>} [route-map <i>map-name</i>]</p>	(Optional) Configures BGP to move routes from one topology to another on the same device.

	Command or Action	Purpose
	<p>Example:</p> <pre>Device (config-router-scope-af-topo)# import topology VOICE route-map 10NET</pre>	<ul style="list-style-type: none"> The route-map keyword can be used to filter routes that moved between topologies.
Step 12	<p>end</p> <p>Example:</p> <pre>Device (config-router-scope-af-topo)# end</pre>	(Optional) Exits router scope address family topology configuration mode and returns to privileged EXEC mode.

Configuration Examples for BGP Support for MTR

Example: BGP Topology Translation Configuration

The following example shows how to configure the Border Gateway Protocol (BGP) in the VIDEO topology and how to configure topology translation with the 192.168.2.2 neighbor:

```
router bgp 45000
scope global
neighbor 172.16.1.1 remote-as 50000
neighbor 192.168.2.2 remote-as 55000
neighbor 172.16.1.1 transport multi-session
neighbor 192.168.2.2 transport multi-session
address-family ipv4
topology VIDEO
bgp tid 100
neighbor 172.16.1.1 activate
neighbor 192.168.2.2 activate
neighbor 192.168.2.2 translate-topology 200
end
clear ip bgp topology VIDEO 50000
```

Example: BGP Global Scope and VRF Configuration

The following example shows how to configure a global scope for a unicast topology and also for a multicast topology. After the device exits the router scope configuration mode, a scope is configured for the virtual routing and forwarding (VRF) instance named DATA.

```
router bgp 45000
scope global
bgp default ipv4-unicast
neighbor 172.16.1.2 remote-as 45000
neighbor 192.168.3.2 remote-as 50000
address-family ipv4 unicast
topology VOICE
bgp tid 100
neighbor 172.16.1.2 activate
exit
```

```

address-family ipv4 multicast
 topology base
  neighbor 192.168.3.2 activate
 exit
 exit
 exit
scope vrf DATA
 neighbor 192.168.1.2 remote-as 40000
 address-family ipv4
  neighbor 192.168.1.2 activate
 end

```

Examples: BGP Topology Verification

The following example shows summary output for the **show ip bgp topology** command. Information is displayed about Border Gateway Protocol (BGP) neighbors configured to use the Multitopology Routing (MTR) topology named VIDEO.

```
Device# show ip bgp topology VIDEO summary
```

```

BGP router identifier 192.168.3.1, local AS number 45000
BGP table version is 1, main routing table version 1
Neighbor      V   AS MsgRcvd MsgSent  TblVer  InQ OutQ Up/Down State/PfxRcd
172.16.1.2    4 45000   289    289      1    0  0 04:48:44      0
192.168.3.2   4 50000     3     3      1    0  0 00:00:27      0

```

The following partial output displays BGP neighbor information under the VIDEO topology:

```
Device# show ip bgp topology VIDEO neighbors 172.16.1.2
```

```

BGP neighbor is 172.16.1.2, remote AS 45000, internal link
  BGP version 4, remote router ID 192.168.2.1
  BGP state = Established, up for 04:56:30
  Last read 00:00:23, last write 00:00:21, hold time is 180, keepalive interval is 60
seconds
Neighbor sessions:
  1 active, is multisession capable
Neighbor capabilities:
  Route refresh: advertised and received(new)
Message statistics, state Established:
  InQ depth is 0
  OutQ depth is 0

           Sent          Rcvd
Opens:           1           1
Notifications:   0           0
Updates:         0           0
Keepalives:     296         296
Route Refresh:   0           0
Total:          297         297
Default minimum time between advertisement runs is 0 seconds
For address family: IPv4 Unicast topology VIDEO
Session: 172.16.1.2 session 1
BGP table version 1, neighbor version 1/0
Output queue size : 0
Index 1, Offset 0, Mask 0x2
1 update-group member
Topology identifier: 100
.
.
.
Address tracking is enabled, the RIB does have a route to 172.16.1.2
Address tracking requires at least a /24 route to the peer
Connections established 1; dropped 0
Last reset never
Transport(tcp) path-mtu-discovery is enabled
Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Minimum incoming TTL 0, Outgoing TTL 255
Local host: 172.16.1.1, Local port: 11113

```

```
Foreign host: 172.16.1.2, Foreign port: 179
.
.
.
```

Example: Importing Routes from an MTR Topology by Using BGP

The following example shows how to configure an access list to be used by a route map named VOICE to filter routes imported from the Multitopology Routing (MTR) topology named VOICE. Only routes with the prefix 192.168.1.0 are imported.

```
access-list 1 permit 192.168.1.0 0.0.0.255
route-map BLUE
 match ip address 1
 exit
router bgp 50000
 scope global
  neighbor 10.1.1.2 remote-as 50000
  neighbor 172.16.1.1 remote-as 60000
  address-family ipv4
  topology VIDEO
  bgp tid 100
  neighbor 10.1.1.2 activate
  neighbor 172.16.1.1 activate
  import topology VOICE route-map VOICE
 end
clear ip bgp topology VIDEO 50000
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Command List, All Releases
Multitopology Routing (MTR) commands	Cisco IOS Multitopology Routing Command Reference
Border Gateway Protocol (BGP) commands	Cisco IOS IP Routing: BGP Command Reference
BGP concepts and tasks	<i>IP Routing: BGP Configuration Guide</i>

Technical Assistance

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

Feature Information for BGP Support for MTR

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

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

Table 1: Feature Information for BGP Support for MTR

Feature Name	Releases	Feature Information
BGP Support for MTR	12.2(33)SRB 15.0(1)S	<p>This feature provides Border Gateway Protocol (BGP) support for multiple logical topologies over a single physical network.</p> <p>In Cisco IOS XE Release 2.5, support was added for the Cisco ASR 1000 Series Routers.</p> <p>The following commands were introduced or modified: address-family ipv4, bgp tid, clear ip bgp topology, import topology, neighbor translate-topology, neighbor transport, scope, show ip bgp topology, topology.</p>