Cisco IOS Multi-Topology Routing Configuration Guide

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Cisco IOS Multi-Topology Routing Configuration Guide

About Cisco IOS Software Documentation

Last Updated: November 20, 2009

This document describes the objectives, audience, conventions, and organization used in Cisco IOS software documentation. Also included are resources for obtaining technical assistance, additional documentation, and other information from Cisco. This document is organized into the following sections:

Documentation Objectives

Cisco IOS documentation describes the tasks and commands available to configure and maintain Cisco networking devices.

Audience

The Cisco IOS documentation set is intended for users who configure and maintain Cisco networking devices (such as routers and switches) but who may not be familiar with the configuration and maintenance tasks, the relationship among tasks, or the Cisco IOS commands necessary to perform particular tasks. The Cisco IOS documentation set is also intended for those users experienced with Cisco IOS software who need to know about new features, new configuration options, and new software characteristics in the current Cisco IOS release.

Documentation Conventions

In Cisco IOS documentation, the term *router* may be used to refer to various Cisco products; for example, routers, access servers, and switches. These and other networking devices that support Cisco IOS software are shown interchangeably in examples and are used only for illustrative purposes. An example that shows one product does not necessarily mean that other products are not supported.

This section contains the following topics:

- Typographic Conventions, page ii
- Command Syntax Conventions, page ii
- Software Conventions, page iii
- Reader Alert Conventions, page iii

Typographic Conventions

Cisco IOS documentation uses the following typographic conventions:

Convention	Description
^ or Ctrl	Both the ^ symbol and Ctrl represent the Control (Ctrl) key on a keyboard. For example, the key combination **^D** or **Ctrl-D** means that you hold down the Control key while you press the D key. (Keys are indicated in capital letters but are not case sensitive.)
string	A string is a nonquoted set of characters shown in italics. For example, when setting a Simple Network Management Protocol (SNMP) community string to *public*, do not use quotation marks around the string; otherwise, the string will include the quotation marks.

Command Syntax Conventions

Cisco IOS documentation uses the following command syntax conventions:

Convention	Description
bold	Bold text indicates commands and keywords that you enter as shown.
italic	Italic text indicates arguments for which you supply values.
[x]	Square brackets enclose an optional keyword or argument.
...	An ellipsis (three consecutive nonbolded periods without spaces) after a syntax element indicates that the element can be repeated.
|	A vertical line, called a pipe, that is enclosed within braces or square brackets indicates a choice within a set of keywords or arguments.
[x | y]	Square brackets enclosing keywords or arguments separated by a pipe indicate an optional choice.
{x | y}	Braces enclosing keywords or arguments separated by a pipe indicate a required choice.
[x {y | z}]	Braces and a pipe within square brackets indicate a required choice within an optional element.

Software Conventions

Cisco IOS software uses the following program code conventions:

Convention	Description
`Courier font`	Courier font is used for information that is displayed on a PC or terminal screen.
`Bold Courier font`	Bold Courier font indicates text that the user must enter.
< >	Angle brackets enclose text that is not displayed, such as a password. Angle brackets also are used in contexts in which the italic font style is not supported; for example, ASCII text.
!	An exclamation point at the beginning of a line indicates that the text that follows is a comment, not a line of code. An exclamation point is also displayed by Cisco IOS software for certain processes.
[ ]	Square brackets enclose default responses to system prompts.

Reader Alert Conventions

Cisco IOS documentation uses the following conventions for reader alerts:

Caution Means *reader be careful*. In this situation, you might do something that could result in equipment damage or loss of data.

Note Means *reader take note*. Notes contain helpful suggestions or references to material not covered in the manual.

Timesaver Means *the described action saves time*. You can save time by performing the action described in the paragraph.

Documentation Organization

This section describes the Cisco IOS documentation set, how it is organized, and how to access it on Cisco.com. It also lists the configuration guides, command references, and supplementary references and resources that comprise the documentation set. It contains the following topics:

- Cisco IOS Documentation Set, page iv
- Cisco IOS Documentation on Cisco.com, page iv
- Configuration Guides, Command References, and Supplementary Resources, page v

Cisco IOS Documentation Set

The Cisco IOS documentation set consists of the following:

- Release notes and caveats provide information about platform, technology, and feature support for a release and describe severity 1 (catastrophic), severity 2 (severe), and select severity 3 (moderate) defects in released Cisco IOS software. Review release notes before other documents to learn whether updates have been made to a feature.
- Sets of configuration guides and command references organized by technology and published for each standard Cisco IOS release.
  - Configuration guides—Compilations of documents that provide conceptual and task-oriented descriptions of Cisco IOS features.
  - Command references—Compilations of command pages in alphabetical order that provide detailed information about the commands used in the Cisco IOS features and the processes that comprise the related configuration guides. For each technology, there is a single command reference that supports all Cisco IOS releases and that is updated at each standard release.
- Lists of all the commands in a specific release and all commands that are new, modified, removed, or replaced in the release.
- Command reference book for **debug** commands. Command pages are listed in alphabetical order.
- Reference book for system messages for all Cisco IOS releases.

Cisco IOS Documentation on Cisco.com

The following sections describe the organization of the Cisco IOS documentation set and how to access various document types.

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.

New Features List

The New Features List for each release provides a list of all features in the release with hyperlinks to the feature guides in which they are documented.

Feature Guides

Cisco IOS features are documented in feature guides. Feature guides describe one feature or a group of related features that are supported on many different software releases and platforms. Your Cisco IOS software release or platform may not support all the features documented in a feature guide. See the Feature Information table at the end of the feature guide for information about which features in that guide are supported in your software release.

Configuration Guides

Configuration guides are provided by technology and release and comprise a set of individual feature guides relevant to the release and technology.

Command References

Command reference books contain descriptions of Cisco IOS commands that are supported in many different software releases and on many different platforms. The books are organized by technology. For information about all Cisco IOS commands, use the Command Lookup Tool at http://tools.cisco.com/Support/CLILookup or the *Cisco IOS Master Command List, All Releases*, at http://www.cisco.com/en/US/docs/ios/mcl/allreleasemcl/all_book.html.

Cisco IOS Supplementary Documents and Resources

Supplementary documents and resources are listed in Table 2 on page xi.

Configuration Guides, Command References, and Supplementary Resources

Table 1 lists, in alphabetical order, Cisco IOS software configuration guides and command references, including brief descriptions of the contents of the documents. The Cisco IOS command references contain commands for Cisco IOS software for all releases. The configuration guides and command references support many different software releases and platforms. Your Cisco IOS software release or platform may not support all these technologies.

Table 2 lists documents and resources that supplement the Cisco IOS software configuration guides and command references. These supplementary resources include release notes and caveats; master command lists; new, modified, removed, and replaced command lists; system messages; and the debug command reference.

For additional information about configuring and operating specific networking devices, and to access Cisco IOS documentation, go to the Product/Technologies Support area of Cisco.com at the following location:

http://www.cisco.com/go/techdocs

Table 1 Cisco IOS Configuration Guides and Command References

Configuration Guide and Command Reference Titles	Features/Protocols/Technologies
• *Cisco IOS AppleTalk Configuration Guide* • *Cisco IOS AppleTalk Command Reference*	AppleTalk protocol.
• *Cisco IOS Asynchronous Transfer Mode Configuration Guide* • *Cisco IOS Asynchronous Transfer Mode Command Reference*	LAN ATM, multiprotocol over ATM (MPoA), and WAN ATM.

Table 1 Cisco IOS Configuration Guides and Command References (continued)

Configuration Guide and Command Reference Titles	Features/Protocols/Technologies
• *Cisco IOS Bridging and IBM Networking Configuration Guide* • *Cisco IOS Bridging Command Reference* • *Cisco IOS IBM Networking Command Reference*	Transparent and source-route transparent (SRT) bridging, source-route bridging (SRB), Token Ring Inter-Switch Link (TRISL), and token ring route switch module (TRRSM). Data-link switching plus (DLSw+), serial tunnel (STUN), block serial tunnel (BSTUN); logical link control, type 2 (LLC2), synchronous data link control (SDLC); IBM Network Media Translation, including Synchronous Data Logical Link Control (SDLLC) and qualified LLC (QLLC); downstream physical unit (DSPU), Systems Network Architecture (SNA) service point, SNA frame relay access, advanced peer-to-peer networking (APPN), native client interface architecture (NCIA) client/server topologies, and IBM Channel Attach.
• *Cisco IOS Broadband Access Aggregation and DSL Configuration Guide* • *Cisco IOS Broadband Access Aggregation and DSL Command Reference*	PPP over ATM (PPPoA) and PPP over Ethernet (PPPoE).
• *Cisco IOS Carrier Ethernet Configuration Guide* • *Cisco IOS Carrier Ethernet Command Reference*	Connectivity fault management (CFM), Ethernet Local Management Interface (ELMI), IEEE 802.3ad link bundling, Link Layer Discovery Protocol (LLDP), media endpoint discovery (MED), and Operation, Administration, and Maintenance (OAM).
• *Cisco IOS Configuration Fundamentals Configuration Guide* • *Cisco IOS Configuration Fundamentals Command Reference*	Autoinstall, Setup, Cisco IOS command-line interface (CLI), Cisco IOS file system (IFS), Cisco IOS web browser user interface (UI), basic file transfer services, and file management.
• *Cisco IOS DECnet Configuration Guide* • *Cisco IOS DECnet Command Reference*	DECnet protocol.
• *Cisco IOS Dial Technologies Configuration Guide* • *Cisco IOS Dial Technologies Command Reference*	Asynchronous communications, dial backup, dialer technology, dial-in terminal services and AppleTalk remote access (ARA), dial-on-demand routing, dial-out, ISDN, large scale dial-out, modem and resource pooling, Multilink PPP (MLP), PPP, and virtual private dialup network (VPDN).
• *Cisco IOS Flexible NetFlow Configuration Guide* • *Cisco IOS Flexible NetFlow Command Reference*	Flexible NetFlow.
• *Cisco IOS High Availability Configuration Guide* • *Cisco IOS High Availability Command Reference*	A variety of high availability (HA) features and technologies that are available for different network segments (from enterprise access to service provider core) to facilitate creation of end-to-end highly available networks. Cisco IOS HA features and technologies can be categorized in three key areas: system-level resiliency, network-level resiliency, and embedded management for resiliency.
• *Cisco IOS Integrated Session Border Controller Command Reference*	A VoIP-enabled device that is deployed at the edge of networks. An SBC is a toolkit of functions, such as signaling interworking, network hiding, security, and quality of service (QoS).

Table 1 Cisco IOS Configuration Guides and Command References (continued)

Configuration Guide and Command Reference Titles	Features/Protocols/Technologies
• *Cisco IOS Intelligent Services Gateway Configuration Guide* • *Cisco IOS Intelligent Services Gateway Command Reference*	Subscriber identification, service and policy determination, session creation, session policy enforcement, session life-cycle management, accounting for access and service usage, and session state monitoring.
• *Cisco IOS Interface and Hardware Component Configuration Guide* • *Cisco IOS Interface and Hardware Component Command Reference*	LAN interfaces, logical interfaces, serial interfaces, virtual interfaces, and interface configuration.
• *Cisco IOS IP Addressing Services Configuration Guide* • *Cisco IOS IP Addressing Services Command Reference*	Address Resolution Protocol (ARP), Network Address Translation (NAT), Domain Name System (DNS), Dynamic Host Configuration Protocol (DHCP), and Next Hop Address Resolution Protocol (NHRP).
• *Cisco IOS IP Application Services Configuration Guide* • *Cisco IOS IP Application Services Command Reference*	Enhanced Object Tracking (EOT), Gateway Load Balancing Protocol (GLBP), Hot Standby Router Protocol (HSRP), IP Services, Server Load Balancing (SLB), Stream Control Transmission Protocol (SCTP), TCP, Web Cache Communication Protocol (WCCP), User Datagram Protocol (UDP), and Virtual Router Redundancy Protocol (VRRP).
• *Cisco IOS IP Mobility Configuration Guide* • *Cisco IOS IP Mobility Command Reference*	Mobile ad hoc networks (MANet) and Cisco mobile networks.
• *Cisco IOS IP Multicast Configuration Guide* • *Cisco IOS IP Multicast Command Reference*	Protocol Independent Multicast (PIM) sparse mode (PIM-SM), bidirectional PIM (bidir-PIM), Source Specific Multicast (SSM), Multicast Source Discovery Protocol (MSDP), Internet Group Management Protocol (IGMP), and Multicast VPN (MVPN).
• *Cisco IOS IP Routing: BFD Configuration Guide*	Bidirectional forwarding detection (BFD).
• *Cisco IOS IP Routing: BGP Configuration Guide* • *Cisco IOS IP Routing: BGP Command Reference*	Border Gateway Protocol (BGP), multiprotocol BGP, multiprotocol BGP extensions for IP multicast.
• *Cisco IOS IP Routing: EIGRP Configuration Guide* • *Cisco IOS IP Routing: EIGRP Command Reference*	Enhanced Interior Gateway Routing Protocol (EIGRP).
• *Cisco IOS IP Routing: ISIS Configuration Guide* • *Cisco IOS IP Routing: ISIS Command Reference*	Intermediate System-to-Intermediate System (IS-IS).
• *Cisco IOS IP Routing: ODR Configuration Guide* • *Cisco IOS IP Routing: ODR Command Reference*	On-Demand Routing (ODR).
• *Cisco IOS IP Routing: OSPF Configuration Guide* • *Cisco IOS IP Routing: OSPF Command Reference*	Open Shortest Path First (OSPF).
• *Cisco IOS IP Routing: Protocol-Independent Configuration Guide* • *Cisco IOS IP Routing: Protocol-Independent Command Reference*	IP routing protocol-independent features and commands. Generic policy-based routing (PBR) features and commands are included.

Table 1 Cisco IOS Configuration Guides and Command References (continued)

Configuration Guide and Command Reference Titles	Features/Protocols/Technologies
• *Cisco IOS IP Routing: RIP Configuration Guide* • *Cisco IOS IP Routing: RIP Command Reference*	Routing Information Protocol (RIP).
• *Cisco IOS IP SLAs Configuration Guide* • *Cisco IOS IP SLAs Command Reference*	Cisco IOS IP Service Level Agreements (IP SLAs).
• *Cisco IOS IP Switching Configuration Guide* • *Cisco IOS IP Switching Command Reference*	Cisco Express Forwarding, fast switching, and Multicast Distributed Switching (MDS).
• *Cisco IOS IPv6 Configuration Guide* • *Cisco IOS IPv6 Command Reference*	For IPv6 features, protocols, and technologies, go to the IPv6 “Start Here” document.
• *Cisco IOS ISO CLNS Configuration Guide* • *Cisco IOS ISO CLNS Command Reference*	ISO Connectionless Network Service (CLNS).
• *Cisco IOS LAN Switching Configuration Guide* • *Cisco IOS LAN Switching Command Reference*	VLANs, Inter-Switch Link (ISL) encapsulation, IEEE 802.10 encapsulation, IEEE 802.1Q encapsulation, and multilayer switching (MLS).
• *Cisco IOS Mobile Wireless Gateway GPRS Support Node Configuration Guide* • *Cisco IOS Mobile Wireless Gateway GPRS Support Node Command Reference*	Cisco IOS Gateway GPRS Support Node (GGSN) in a 2.5-generation general packet radio service (GPRS) and 3-generation universal mobile telecommunication system (UMTS) network.
• *Cisco IOS Mobile Wireless Home Agent Configuration Guide* • *Cisco IOS Mobile Wireless Home Agent Command Reference*	Cisco Mobile Wireless Home Agent, an anchor point for mobile terminals for which mobile IP or proxy mobile IP services are provided.
• *Cisco IOS Mobile Wireless Packet Data Serving Node Configuration Guide* • *Cisco IOS Mobile Wireless Packet Data Serving Node Command Reference*	Cisco Packet Data Serving Node (PDSN), a wireless gateway that is between the mobile infrastructure and standard IP networks and that enables packet data services in a code division multiple access (CDMA) environment.
• *Cisco IOS Mobile Wireless Radio Access Networking Configuration Guide* • *Cisco IOS Mobile Wireless Radio Access Networking Command Reference*	Cisco IOS radio access network products.
• *Cisco IOS Multiprotocol Label Switching Configuration Guide* • *Cisco IOS Multiprotocol Label Switching Command Reference*	MPLS Label Distribution Protocol (LDP), MPLS Layer 2 VPNs, MPLS Layer 3 VPNs, MPLS traffic engineering (TE), and MPLS Embedded Management (EM) and MIBs.
• *Cisco IOS Multi-Topology Routing Configuration Guide* • *Cisco IOS Multi-Topology Routing Command Reference*	Unicast and multicast topology configurations, traffic classification, routing protocol support, and network management support.
• *Cisco IOS NetFlow Configuration Guide* • *Cisco IOS NetFlow Command Reference*	Network traffic data analysis, aggregation caches, and export features.

Table 1 Cisco IOS Configuration Guides and Command References (continued)

Configuration Guide and Command Reference Titles	Features/Protocols/Technologies
• *Cisco IOS Network Management Configuration Guide* • *Cisco IOS Network Management Command Reference*	Basic system management; system monitoring and logging; troubleshooting, logging, and fault management; Cisco Discovery Protocol; Cisco IOS Scripting with Tool Control Language (Tcl); Cisco networking services (CNS); DistributedDirector; Embedded Event Manager (EEM); Embedded Resource Manager (ERM); Embedded Syslog Manager (ESM); HTTP; Remote Monitoring (RMON); SNMP; and VPN Device Manager Client for Cisco IOS software (XSM Configuration).
• *Cisco IOS Novell IPX Configuration Guide* • *Cisco IOS Novell IPX Command Reference*	Novell Internetwork Packet Exchange (IPX) protocol.
• *Cisco IOS Optimized Edge Routing Configuration Guide* • *Cisco IOS Optimized Edge Routing Command Reference*	Optimized edge routing (OER) monitoring; Performance Routing (PfR); and automatic route optimization and load distribution for multiple connections between networks.
• *Cisco IOS Quality of Service Solutions Configuration Guide* • *Cisco IOS Quality of Service Solutions Command Reference*	Traffic queueing, traffic policing, traffic shaping, Modular QoS CLI (MQC), Network-Based Application Recognition (NBAR), Multilink PPP (MLP) for QoS, header compression, AutoQoS, Resource Reservation Protocol (RSVP), and weighted random early detection (WRED).
• *Cisco IOS Security Command Reference*	Access control lists (ACLs); authentication, authorization, and accounting (AAA); firewalls; IP security and encryption; neighbor router authentication; network access security; network data encryption with router authentication; public key infrastructure (PKI); RADIUS; TACACS+; terminal access security; and traffic filters.
• *Cisco IOS Security Configuration Guide: Securing the Data Plane*	Access Control Lists (ACLs); Firewalls: Context-Based Access Control (CBAC) and Zone-Based Firewall; Cisco IOS Intrusion Prevention System (IPS); Flexible Packet Matching; Unicast Reverse Path Forwarding (uRPF); Threat Information Distribution Protocol (TIDP) and TMS.
• *Cisco IOS Security Configuration Guide: Securing the Control Plane*	Control Plane Policing, Neighborhood Router Authentication.
• *Cisco IOS Security Configuration Guide: Securing User Services*	AAA (includes 802.1x authentication and Network Admission Control [NAC]); Security Server Protocols (RADIUS and TACACS+); Secure Shell (SSH); Secure Access for Networking Devices (includes Autosecure and Role-Based CLI access); Lawful Intercept.
• *Cisco IOS Security Configuration Guide: Secure Connectivity*	Internet Key Exchange (IKE) for IPsec VPNs; IPsec Data Plane features; IPsec Management features; Public Key Infrastructure (PKI); Dynamic Multipoint VPN (DMVPN); Easy VPN; Cisco Group Encrypted Transport VPN (GETVPN); SSL VPN.

Table 1 Cisco IOS Configuration Guides and Command References (continued)

Configuration Guide and Command Reference Titles	Features/Protocols/Technologies
• *Cisco IOS Service Advertisement Framework Configuration Guide* • *Cisco IOS Service Advertisement Framework Command Reference*	Cisco Service Advertisement Framework.
• *Cisco IOS Service Selection Gateway Configuration Guide* • *Cisco IOS Service Selection Gateway Command Reference*	Subscriber authentication, service access, and accounting.
• *Cisco IOS Software Activation Configuration Guide* • *Cisco IOS Software Activation Command Reference*	An orchestrated collection of processes and components to activate Cisco IOS software feature sets by obtaining and validating Cisco software licenses.
• *Cisco IOS Software Modularity Installation and Configuration Guide* • *Cisco IOS Software Modularity Command Reference*	Installation and basic configuration of software modularity images, including installations on single and dual route processors, installation rollbacks, software modularity binding, software modularity processes, and patches.
• *Cisco IOS Terminal Services Configuration Guide* • *Cisco IOS Terminal Services Command Reference*	DEC, local-area transport (LAT), and X.25 packet assembler/disassembler (PAD).
• *Cisco IOS Virtual Switch Command Reference*	Virtual switch redundancy, high availability, and packet handling; converting between standalone and virtual switch modes; virtual switch link (VSL); Virtual Switch Link Protocol (VSLP). **Note** For information about virtual switch configuration, see the product-specific software configuration information for the Cisco Catalyst 6500 series switch or for the Metro Ethernet 6500 series switch.
• *Cisco IOS Voice Configuration Library* • *Cisco IOS Voice Command Reference*	Cisco IOS support for voice call control protocols, interoperability, physical and virtual interface management, and troubleshooting. The library includes documentation for IP telephony applications.
• *Cisco IOS VPDN Configuration Guide* • *Cisco IOS VPDN Command Reference*	Layer 2 Tunneling Protocol (L2TP) dial-out load balancing and redundancy; L2TP extended failover; L2TP security VPDN; multihop by Dialed Number Identification Service (DNIS); timer and retry enhancements for L2TP and Layer 2 Forwarding (L2F); RADIUS Attribute 82 (tunnel assignment ID); shell-based authentication of VPDN users; tunnel authentication via RADIUS on tunnel terminator.
• *Cisco IOS Wide-Area Networking Configuration Guide* • *Cisco IOS Wide-Area Networking Command Reference*	Frame Relay; Layer 2 Tunnel Protocol Version 3 (L2TPv3); L2VPN Pseudowire Redundancy; L2VPN Interworking; Layer 2 Local Switching; Link Access Procedure, Balanced (LAPB); and X.25.
• *Cisco IOS Wireless LAN Configuration Guide* • *Cisco IOS Wireless LAN Command Reference*	Broadcast key rotation, IEEE 802.11x support, IEEE 802.1x authenticator, IEEE 802.1x local authentication service for Extensible Authentication Protocol-Flexible Authentication via Secure Tunneling (EAP-FAST), Multiple Basic Service Set ID (BSSID), Wi-Fi Multimedia (WMM) required elements, and Wi-Fi Protected Access (WPA).

Table 2 lists documents and resources that supplement the Cisco IOS software configuration guides and command references.

Table 2 Cisco IOS Supplementary Documents and Resources

Document Title or Resource	Description
Cisco IOS Master Command List, All Releases	Alphabetical list of all the commands documented in all Cisco IOS releases.
Cisco IOS New, Modified, Removed, and Replaced Commands	List of all the new, modified, removed, and replaced commands for a Cisco IOS release.
Cisco IOS System Message Guide	List of Cisco IOS system messages and descriptions. System messages may indicate problems with your system, may be informational only, or may help diagnose problems with communications lines, internal hardware, or system software.
Cisco IOS Debug Command Reference	Alphabetical list of **debug** commands including brief descriptions of use, command syntax, and usage guidelines.
Release Notes and Caveats	Information about new and changed features, system requirements, and other useful information about specific software releases; information about defects in specific Cisco IOS software releases.
MIBs	Files used for network monitoring. To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator.
RFCs	Standards documents maintained by the Internet Engineering Task Force (IETF) that Cisco IOS documentation references where applicable. The full text of referenced RFCs may be obtained at the following URL: http://www.rfc-editor.org/

Additional Resources and Documentation Feedback

What's New in Cisco Product Documentation is released monthly and describes all new and revised Cisco technical documentation. The *What's New in Cisco Product Documentation* publication also provides information about obtaining the following resources:

- Technical documentation
- Cisco product security overview
- Product alerts and field notices
- Technical assistance

Cisco IOS technical documentation includes embedded feedback forms where you can rate documents and provide suggestions for improvement. Your feedback helps us improve our documentation.

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

Using the Command-Line Interface in Cisco IOS Software

Last Updated: October 14, 2009

This document provides basic information about the command-line interface (CLI) in Cisco IOS software and how you can use some of the CLI features. This document contains the following sections:

For more information about using the CLI, see the "Using the Cisco IOS Command-Line Interface" section of the *Cisco IOS Configuration Fundamentals Configuration Guide*.

For information about the software documentation set, see the "About Cisco IOS Software Documentation" document.

Initially Configuring a Device

Initially configuring a device varies by platform. For information about performing an initial configuration, see the hardware installation documentation that is provided with the original packaging of the product or go to the Product/Technologies Support area of Cisco.com at http://www.cisco.com/go/techdocs.

After you have performed the initial configuration and connected the device to your network, you can configure the device by using the console port or a remote access method, such as Telnet or Secure Shell (SSH), to access the CLI or by using the configuration method provided on the device, such as Security Device Manager.

Changing the Default Settings for a Console or AUX Port

There are only two changes that you can make to a console port and an AUX port:

- Change the port speed with the **config-register 0x** command. Changing the port speed is not recommended. The well-known default speed is 9600.
- Change the behavior of the port; for example, by adding a password or changing the timeout value.

Note The AUX port on the Route Processor (RP) installed in a Cisco ASR 1000 series router does not serve any useful customer purpose and should be accessed only under the advisement of a customer support representative.

Using the CLI

This section describes the following topics:

- Understanding Command Modes, page ii
- Using the Interactive Help Feature, page v
- Understanding Command Syntax, page vi
- Understanding Enable and Enable Secret Passwords, page vii
- Using the Command History Feature, page viii
- Abbreviating Commands, page ix
- Using Aliases for CLI Commands, page ix
- Using the no and default Forms of Commands, page x
- Using the debug Command, page x
- Filtering Output Using Output Modifiers, page x
- Understanding CLI Error Messages, page xi

Understanding Command Modes

The CLI command mode structure is hierarchical, and each mode supports a set of specific commands. This section describes the most common of the many modes that exist.

Table 1 lists common command modes with associated CLI prompts, access and exit methods, and a brief description of how each mode is used.

Table 1 CLI Command Modes

Command Mode	Access Method	Prompt	Exit Method	Mode Usage
User EXEC	Log in.	`Router>`	Issue the **logout** or **exit** command.	• Change terminal settings. • Perform basic tests. • Display device status.
Privileged EXEC	From user EXEC mode, issue the **enable** command.	`Router#`	Issue the **disable** command or the **exit** command to return to user EXEC mode.	• Issue **show** and **debug** commands. • Copy images to the device. • Reload the device. • Manage device configuration files. • Manage device file systems.
Global configuration	From privileged EXEC mode, issue the **configure terminal** command.	`Router(config)#`	Issue the **exit** command or the **end** command to return to privileged EXEC mode.	Configure the device.
Interface configuration	From global configuration mode, issue the **interface** command.	`Router(config-if)#`	Issue the **exit** command to return to global configuration mode or the **end** command to return to privileged EXEC mode.	Configure individual interfaces.
Line configuration	From global configuration mode, issue the **line vty** or **line console** command.	`Router(config-line)#`	Issue the **exit** command to return to global configuration mode or the **end** command to return to privileged EXEC mode.	Configure individual terminal lines.

Table 1 CLI Command Modes (continued)

Command Mode	Access Method	Prompt	Exit Method	Mode Usage
ROM monitor	From privileged EXEC mode, issue the **reload** command. Press the **Break** key during the first 60 seconds while the system is booting.	`rommon # >` The # symbol represents the line number and increments at each prompt.	Issue the **continue** command.	• Run as the default operating mode when a valid image cannot be loaded. • Access the fall-back procedure for loading an image when the device lacks a valid image and cannot be booted. • Perform password recovery when a Ctrl-Break sequence is issued within 60 seconds of a power-on or reload event.
Diagnostic (available only on Cisco ASR 1000 series routers)	The router boots or enters diagnostic mode in the following scenarios. When a Cisco IOS process or processes fail, in most scenarios the router will reload. • A user-configured access policy was configured using the **transport-map** command, which directed the user into diagnostic mode. • The router was accessed using an RP auxiliary port. • A break signal (**Ctrl-C**, **Ctrl-Shift-6**, or the **send break** command) was entered, and the router was configured to enter diagnostic mode when the break signal was received.	`Router(diag)#`	If a Cisco IOS process failure is the reason for entering diagnostic mode, the failure must be resolved and the router must be rebooted to exit diagnostic mode. If the router is in diagnostic mode because of a transport-map configuration, access the router through another port or use a method that is configured to connect to the Cisco IOS CLI. If the RP auxiliary port was used to access the router, use another port for access. Accessing the router through the auxiliary port is not useful for customer purposes.	• Inspect various states on the router, including the Cisco IOS state. • Replace or roll back the configuration. • Provide methods of restarting the Cisco IOS software or other processes. • Reboot hardware (such as the entire router, an RP, an ESP, a SIP, a SPA) or other hardware components. • Transfer files into or off of the router using remote access methods such as FTP, TFTP, and SCP.

EXEC commands are not saved when the software reboots. Commands that you issue in a configuration mode can be saved to the startup configuration. If you save the running configuration to the startup configuration, these commands will execute when the software is rebooted. Global configuration mode is the highest level of configuration mode. From global configuration mode, you can enter a variety of other configuration modes, including protocol-specific modes.

ROM monitor mode is a separate mode that is used when the software cannot load properly. If a valid software image is not found when the software boots or if the configuration file is corrupted at startup, the software might enter ROM monitor mode. Use the question symbol (?) to view the commands that you can use while the device is in ROM monitor mode.

```
rommon 1 > ?
alias               set and display aliases command
boot                boot up an external process
confreg             configuration register utility
cont                continue executing a downloaded image
context             display the context of a loaded image
cookie              display contents of cookie PROM in hex
.
.
.
rommon 2 >
```

The following example shows how the command prompt changes to indicate a different command mode:

```
Router> enable
Router# configure terminal
Router(config)# interface ethernet 1/1
Router(config-if)# ethernet
Router(config-line)# exit
Router(config)# end
Router#
```

Note A keyboard alternative to the **end** command is Ctrl-Z.

Using the Interactive Help Feature

The CLI includes an interactive Help feature. Table 2 describes the purpose of the CLI interactive Help commands.

Table 2 CLI Interactive Help Commands

Command	Purpose
help	Provides a brief description of the Help feature in any command mode.
?	Lists all commands available for a particular command mode.
*partial command***?**	Provides a list of commands that begin with the character string (no space between the command and the question mark).
partial command<**Tab**>	Completes a partial command name (no space between the command and <Tab>).
command **?**	Lists the keywords, arguments, or both associated with the command (space between the command and the question mark).
command keyword **?**	Lists the arguments that are associated with the keyword (space between the keyword and the question mark).

The following examples show how to use the help commands:

help

```
Router> help
Help may be requested at any point in a command by entering a question mark '?'. If nothing
matches, the help list will be empty and you must backup until entering a '?' shows the
available options.
Two styles of help are provided:
1. Full help is available when you are ready to enter a command argument (e.g. 'show ?')
and describes each possible argument.
2. Partial help is provided when an abbreviated argument is entered and you want to know
what arguments match the input (e.g. 'show pr?'.)
```

?

```
Router# ?
Exec commands:
  access-enable        Create a temporary access-List entry
  access-profile       Apply user-profile to interface
  access-template      Create a temporary access-List entry
  alps                 ALPS exec commands
  archive              manage archive files
<snip>
```

partial command?

```
Router(config)# zo?
zone  zone-pair
```

partial command<Tab>

```
Router(config)# we<Tab> webvpn
```

command ?

```
Router(config-if)# pppoe ?
  enable        Enable pppoe
  max-sessions  Maximum PPPOE sessions
```

command keyword ?

```
Router(config-if)# pppoe enable ?
  group  attach a BBA group
  <cr>
```

Understanding Command Syntax

Command syntax is the format in which a command should be entered in the CLI. Commands include the name of the command, keywords, and arguments. Keywords are alphanumeric strings that are used literally. Arguments are placeholders for values that a user must supply. Keywords and arguments may be required or optional.

Specific conventions convey information about syntax and command elements. Table 3 describes these conventions.

Table 3 CLI Syntax Conventions

Symbol/Text	Function	Notes
< > (angle brackets)	Indicate that the option is an argument.	Sometimes arguments are displayed without angle brackets.
A.B.C.D.	Indicates that you must enter a dotted decimal IP address.	Angle brackets (< >) are not always used to indicate that an IP address is an argument.
WORD (all capital letters)	Indicates that you must enter one word.	Angle brackets (< >) are not always used to indicate that a WORD is an argument.
LINE (all capital letters)	Indicates that you must enter more than one word.	Angle brackets (< >) are not always used to indicate that a LINE is an argument.
<cr> (carriage return)	Indicates the end of the list of available keywords and arguments, and also indicates when keywords and arguments are optional. When <cr> is the only option, you have reached the end of the branch or the end of the command if the command has only one branch.	—

The following examples show syntax conventions:

```
Router(config)# ethernet cfm domain ?
  WORD  domain name
Router(config)# ethernet cfm domain dname ?
  level
Router(config)# ethernet cfm domain dname level ?
  <0-7>  maintenance level number
Router(config)# ethernet cfm domain dname level 7 ?
  <cr>

Router(config)# snmp-server file-transfer access-group 10 ?
  protocol  protocol options
  <cr>

Router(config)# logging host ?
  Hostname or A.B.C.D  IP address of the syslog server
  ipv6                 Configure IPv6 syslog server
```

Understanding Enable and Enable Secret Passwords

Some privileged EXEC commands are used for actions that impact the system, and it is recommended that you set a password for these commands to prevent unauthorized use. Two types of passwords, enable (not encrypted) and enable secret (encrypted), can be set. The following commands set these passwords and are issued in global configuration mode:

- **enable** *password*
- **enable secret** *password*

Using an enable secret password is recommended because it is encrypted and more secure than the enable password. When you use an enable secret password, text is encrypted (unreadable) before it is written to the config.text file. When you use an enable password, the text is written as entered (readable) to the config.text file.

Each type of password is case sensitive, can contain from 1 to 25 uppercase and lowercase alphanumeric characters, and can start with a numeral. Spaces are also valid password characters; for example, “two words” is a valid password. Leading spaces are ignored, but trailing spaces are recognized.

Note Both password commands have numeric keywords that are single integer values. If you choose a numeral for the first character of your password followed by a space, the system will read the number as if it were the numeric keyword and not as part of your password.

When both passwords are set, the enable secret password takes precedence over the enable password.

To remove a password, use the **no** form of the commands: **no enable** *password* or **no enable secret** *password*.

For more information about password recovery procedures for Cisco products, see http://www.cisco.com/en/US/products/sw/iosswrel/ps1831/products_tech_note09186a00801746e6.shtml.

Using the Command History Feature

The command history feature saves, in a command history buffer, the commands that you enter during a session. The default number of saved commands is 10, but the number is configurable within the range of 0 to 256. This command history feature is particularly useful for recalling long or complex commands.

To change the number of commands saved in the history buffer for a terminal session, issue the **terminal history size** command:

```
Router# terminal history size num
```

A command history buffer is also available in line configuration mode with the same default and configuration options. To set the command history buffer size for a terminal session in line configuration mode, issue the **history** command:

```
Router(config-line)# history [size num]
```

To recall commands from the history buffer, use the following methods:

- Press Ctrl-P or the Up Arrow key—Recalls commands beginning with the most recent command. Repeat the key sequence to recall successively older commands.
- Press Ctrl-N or the Down Arrow key—Recalls the most recent commands in the history buffer after they have been recalled using Ctrl-P or the Up Arrow key. Repeat the key sequence to recall successively more recent commands.

  Note The arrow keys function only on ANSI-compatible terminals such as the VT100.

- Issue the **show history** command in user EXEC or privileged EXEC mode—Lists the most recent commands that you entered. The number of commands that are displayed is determined by the setting of the **terminal history size** and **history** commands.

The command history feature is enabled by default. To disable this feature for a terminal session, issue the **terminal no history** command in user EXEC or privileged EXEC mode or the **no history** command in line configuration mode.

Abbreviating Commands

Typing a complete command name is not always required for the command to execute. The CLI recognizes an abbreviated command when the abbreviation contains enough characters to uniquely identify the command. For example, the **show version** command can be abbreviated as **sh ver**. It cannot be abbreviated as **s ver** because **s** could mean **show**, **set**, or **systat**. The **sh v** abbreviation also is not valid because the **show** command has **vrrp** as a keyword in addition to **version**. (Command and keyword examples are from Cisco IOS Release 12.4(13)T.)

Using Aliases for CLI Commands

To save time and the repetition of entering the same command multiple times, you can use a command alias. An alias can be configured to do anything that can be done at the command line, but an alias cannot move between modes, type in passwords, or perform any interactive functions.

Table 4 shows the default command aliases.

Table 4 Default Command Aliases

Command Alias	Original Command
h	help
lo	logout
p	ping
s	show
u or **un**	undebug
w	where

To create a command alias, issue the **alias** command in global configuration mode. The syntax of the command is **alias** *mode command-alias original-command*. Following are some examples:

- Router(config)# **alias exec prt partition**—privileged EXEC mode
- Router(config)# **alias configure sb source-bridge**—global configuration mode
- Router(config)# **alias interface rl rate-limit**—interface configuration mode

To view both default and user-created aliases, issue the **show alias** command.

For more information about the **alias** command, see http://www.cisco.com/en/US/docs/ios/fundamentals/command/reference/cf_a1.html.

Using the no and default Forms of Commands

Most configuration commands have a **no** form that is used to reset a command to its default value or disable a feature or function. For example, the **ip routing** command is enabled by default. To disable this command, you would issue the **no ip routing** command. To re-enable IP routing, you would issue the **ip routing** command.

Configuration commands may also have a **default** form, which returns the command settings to their default values. For commands that are disabled by default, using the **default** form has the same effect as using the **no** form of the command. For commands that are enabled by default and have default settings, the **default** form enables the command and returns the settings to their default values.

The **no** form is documented in the command pages of command references. The **default** form is generally documented in the command pages only when the **default** form performs a different function than the plain and **no** forms of the command. To see what **default** commands are available on your system, enter **default ?** in the appropriate command mode.

Using the debug Command

A **debug** command produces extensive output that helps you troubleshoot problems in your network. These commands are available for many features and functions within Cisco IOS software. Some **debug** commands are **debug all**, **debug aaa accounting**, and **debug mpls packets**. To use **debug** commands during a Telnet session with a device, you must first enter the **terminal monitor** command. To turn off debugging completely, you must enter the **undebug all** command.

For more information about **debug** commands, see the *Cisco IOS Debug Command Reference* at http://www.cisco.com/en/US/docs/ios/debug/command/reference/db_book.html.

Caution Debugging is a high priority and high CPU utilization process that can render your device unusable. Use **debug** commands only to troubleshoot specific problems. The best times to run debugging are during periods of low network traffic and when few users are interacting with the network. Debugging during these periods decreases the likelihood that the **debug** command processing overhead will affect network performance or user access or response times.

Filtering Output Using Output Modifiers

Many commands produce lengthy output that may use several screens to display. Using output modifiers, you can filter this output to show only the information that you want to see.

The following three output modifiers are available:

- **begin** *regular-expression*—Displays the first line in which a match of the regular expression is found and all lines that follow.
- **include** *regular-expression*—Displays all lines in which a match of the regular expression is found.
- **exclude** *regular-expression*—Displays all lines except those in which a match of the regular expression is found.

To use one of these output modifiers, type the command followed by the pipe symbol (|), the modifier, and the regular expression that you want to search for or filter. A regular expression is a case-sensitive alphanumeric pattern. It can be a single character or number, a phrase, or a more complex string.

The following example illustrates how to filter output of the **show interface** command to display only lines that include the expression “protocol.”

```
Router# show interface | include protocol

FastEthernet0/0 is up, line protocol is up
Serial4/0 is up, line protocol is up
Serial4/1 is up, line protocol is up
Serial4/2 is administratively down, line protocol is down
Serial4/3 is administratively down, line protocol is down
```

Understanding CLI Error Messages

You may encounter some error messages while using the CLI. Table 5 shows the common CLI error messages.

Table 5 Common CLI Error Messages

Error Message	Meaning	How to Get Help
% Ambiguous command: “show con”	You did not enter enough characters for the command to be recognized.	Reenter the command followed by a space and a question mark (?). The keywords that you are allowed to enter for the command appear.
% Incomplete command.	You did not enter all the keywords or values required by the command.	Reenter the command followed by a space and a question mark (?). The keywords that you are allowed to enter for the command appear.
% Invalid input detected at “^” marker.	You entered the command incorrectly. The caret (^) marks the point of the error.	Enter a question mark (?) to display all the commands that are available in this command mode. The keywords that you are allowed to enter for the command appear.

For more system error messages, see the following document:

- *Cisco IOS Release 12.4T System Message Guide*

Saving Changes to a Configuration

To save changes that you made to the configuration of a device, you must issue the **copy running-config startup-config** command or the **copy system:running-config nvram:startup-config** command. When you issue these commands, the configuration changes that you made are saved to the startup configuration and saved when the software reloads or power to the device is turned off or interrupted. The following example shows the syntax of the **copy running-config startup-config** command:

```
Router# copy running-config startup-config
Destination filename [startup-config]?
```

You press Enter to accept the startup-config filename (the default), or type a new filename and then press Enter to accept that name. The following output is displayed indicating that the configuration was saved.

```
Building configuration...
[OK]
Router#
```

On most platforms, the configuration is saved to NVRAM. On platforms with a Class A flash file system, the configuration is saved to the location specified by the CONFIG_FILE environment variable. The CONFIG_FILE variable defaults to NVRAM.

Additional Information

- "Using the Cisco IOS Command-Line Interface" section of the *Cisco IOS Configuration Fundamentals Configuration Guide*

  http://www.cisco.com/en/US/docs/ios/fundamentals/configuration/guide/cf_cli-basics.html
- Cisco Product/Technology Support

  http://www.cisco.com/go/techdocs
- Support area on Cisco.com (also search for documentation by task or product)

  http://www.cisco.com/en/US/support/index.html
- Software Download Center (downloads; tools; licensing, registration, advisory, and general information) (requires Cisco.com user ID and password)

  http://www.cisco.com/kobayashi/sw-center/
- Error Message Decoder, a tool to help you research and resolve error messages for Cisco IOS software

  http://www.cisco.com/pcgi-bin/Support/Errordecoder/index.cgi
- Command Lookup Tool, a tool to help you find detailed descriptions of Cisco IOS commands (requires Cisco.com user ID and password)

  http://tools.cisco.com/Support/CLILookup
- Output Interpreter, a troubleshooting tool that analyzes command output of supported **show** commands

  https://www.cisco.com/pcgi-bin/Support/OutputInterpreter/home.pl

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Multi-Topology Routing

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Multi-Topology Routing (MTR) allows the configuration of service differentiation through class-based forwarding. MTR supports multiple unicast topologies and a separate multicast topology. A topology is a subset of the underlying network (or base topology) characterized by an independent set of Network Layer Reachability Information (NLRI). A topology can overlap with another or share any subset of the underlying network. MTR provides separate forwarding capabilities on a per topology basis. A separate forwarding table is maintained for each topology, allowing you to broadly apply independent forwarding configurations or add a level of granularity to independent forwarding configurations. MTR can be used, for example, to define separate topologies for voice, video, and data traffic classes.

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 Multi-Topology Routing" section on page 67.

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

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Prerequisites for Multi-Topology Routing

- You should have a clear understanding of the physical topology and traffic classification in your network before deploying MTR.
- MTR should be deployed consistently throughout the network. Cisco Express Forwarding (CEF) or distributed CEF (dCEF) and IP routing must be enabled on all networking devices.
- We recommend that you deconfigure custom route configurations, such as route summarization and default routes before enabling a topology and that you reapply custom route configuration only after the topology is fully enabled. This recommendation is designed to prevent traffic interruption, as some destinations may be obscured during the transition. It is also a best practice when disabling an existing topology. Custom route configuration is most useful when all of the more specific routes are available in the routing table of the topology.

Restrictions for Multi-Topology Routing

- Only the IPv4 address family is supported.
- Multiple unicast topologies cannot be configured within a Virtual Routing and Forwarding (VRF) instance. However, multiple unicast topologies and a separate multicast topology can be configured under the global address space, and a separate multicast topology can be configured within a VRF.
- All topologies share a common address space. MTR is not intended to enable address reuse. Configuring address reuse in separate topologies is not supported.
- IP Differentiated Services or IP Precedence can be independently configured in a network where MTR is also deployed. However, MTR requires exclusive use of some subset of the DiffServ Code Point (DSCP) bits in the IP packet header for specific topology traffic. For this reason, simultaneous configuration must be carefully coordinated. Remarking DSCP bits in the IP packet header is not recommended or supported on routers that contain class-specific topologies.
- Distance Vector Multicast Routing Protocol (DVMRP) CLI and functionality are not provided in Cisco IOS software images that provide MTR support.

Information About Multi-Topology Routing

You should understand the following concepts before configuring MTR in a production network:

MTR Overview

MTR introduces the capability to configure service differentiation through class-based forwarding. There are two primary components to configuring MTR: independent topology configuration and traffic classification configuration.

A topology is defined as a subset of routers and links in a network for which a separate set of routes is calculated. The entire network itself, for which the usual set of routes is calculated, is known as the base topology. The base topology (or underlying network) is characterized by the NLRI that a router uses to calculate the global routing table to make routing and forwarding decisions. In other words, the base topology is the default routing environment that exists prior to enabling MTR.

Any additional topologies are known as class-specific topologies and are a subset of the base topology. Each class-specific topology carries a class of traffic and is characterized by an independent set of NLRI that is used to maintain a separate Routing Information Base (RIB) and Forwarding Information Base (FIB). This design allows the router to perform independent route calculation and forwarding for each topology.

Within a given router, MTR creates a selection of routes upon which to forward to a given destination. The specific choice of route is based on the class of the packet being forwarded, a class that is an attribute of the packet itself. This design allows packets of different classes to be routed independently from one another. The path that the packet follows is determined by classifiers configured on the routers and interfaces in the network. Figure 1 shows the base topology, which is a superset of the red, blue, and green topologies.

Figure 1 MTR Base Topology

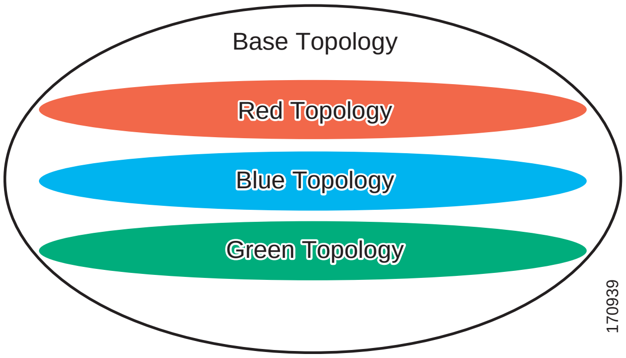


Figure 2 shows an MTR-enabled network that is configured using the service separation model. The base topology (shown in black) uses NLRI from all reachable devices in the network. The blue, red, and purple paths each represent a different class-specific topology. Each class-specific topology calculates a separate set of paths through the network. Routing and forwarding are independently calculated based on individual sets of NLRI that are carried for each topology.

Figure 2 *Defining MTR Topologies*

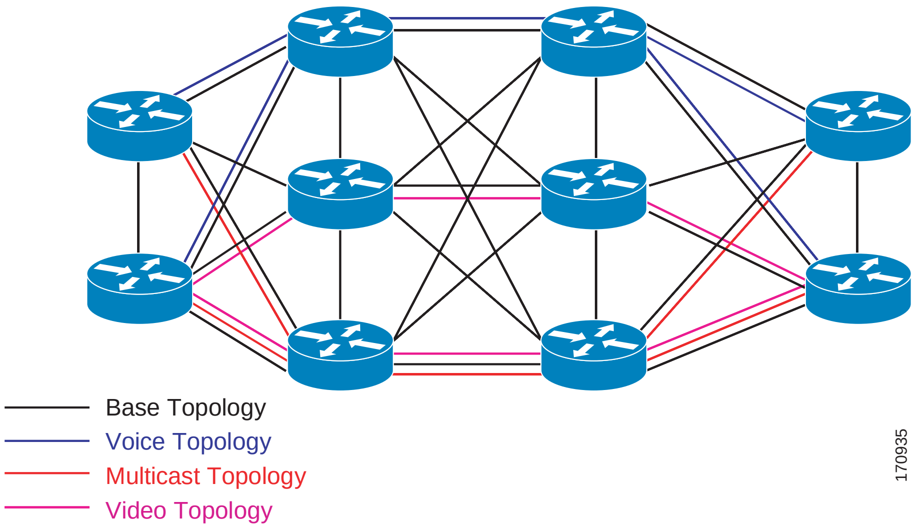
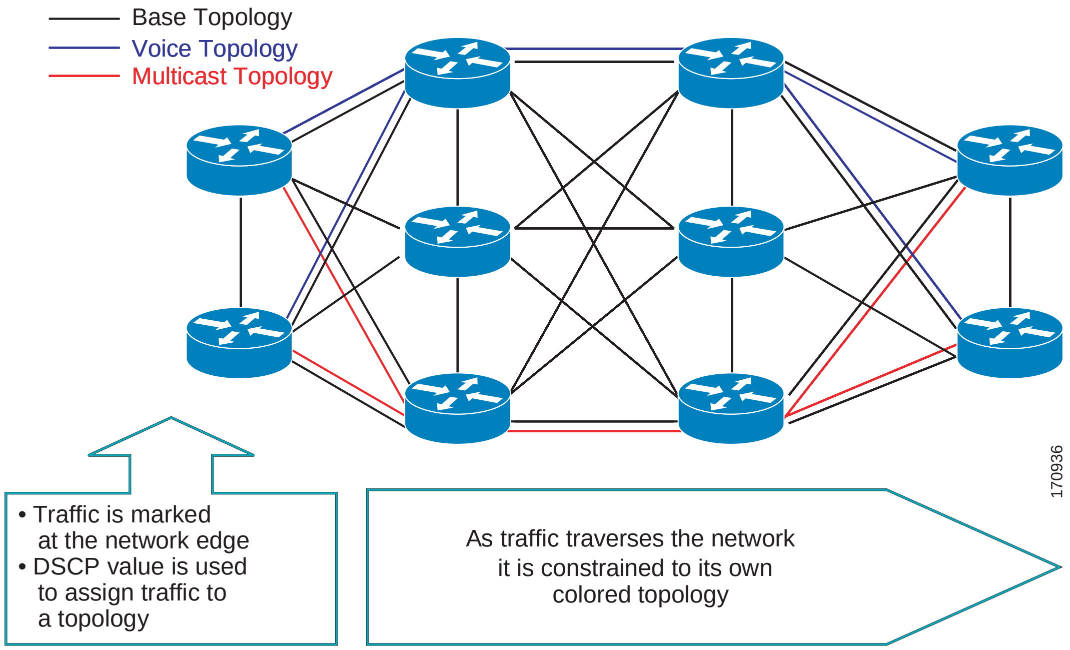


Figure 3 shows that the traffic is marked at the network edge. As the traffic traverses the network, the marking is used during classification and forwarding to constrain the traffic to its own colored topology.

Figure 3 *Traffic Follows Class-Specific Forwarding Paths*



- Traffic is marked at the network edge
- DSCP value is used to assign traffic to a topology

As traffic traverses the network it is constrained to its own colored topology

The same topology can have configured backup paths. In Figure 4, the preferential path for the voice topology is represented by the solid blue line. In case this path becomes unavailable, MTR can be configured to choose the voice backup path represented by the dotted blue line. Both of these paths represent the same topology and none overlap.

Figure 4 MTR Backup Contingencies Within a Topology

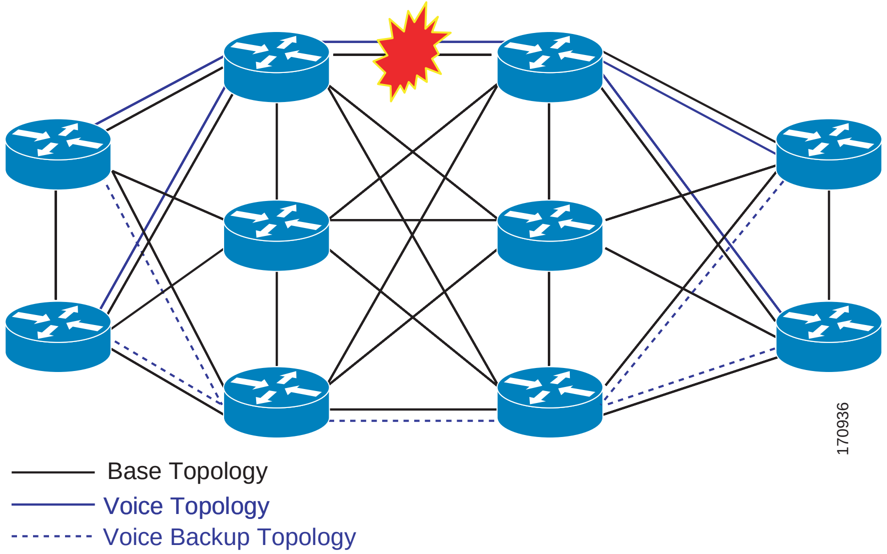
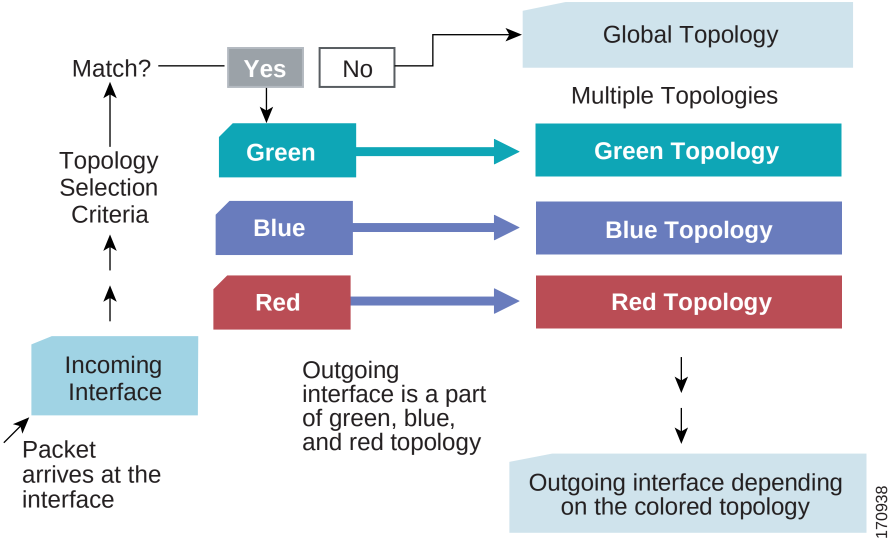


Figure 5 shows the MTR forwarding model at the system level. When a packet arrives at the incoming interface, the marking is examined. If the packet marking matches a topology, the associated topology is consulted, the next hop for that topology is determined, and the packet is forwarded. If there is no forwarding entry within a topology, the packet is dropped. If the packet does not match any classifier, it is forwarded to the base topology. The outgoing interface is a function of the colored route table in which the lookup is done.

Figure 5 MTR Forwarding at the System Level


Match?
Yes
No
Global Topology
Multiple Topologies
Green
Green Topology
Blue
Blue Topology
Red
Red Topology
Topology Selection Criteria
Incoming Interface
Packet arrives at the interface
Outgoing interface is a part of green, blue, and red topology
Outgoing interface depending on the colored topology
170938

MTR is implemented in Cisco IOS software on a per address family and subaddress family basis. Only the IPv4 (unicast and multicast) address family is currently supported. MTR supports up to 32 unicast topologies (including the base topology) and a separate multicast topology. A topology can overlap with another or share any subset of the underlying network. Each topology is configured with a unique topology ID. The topology ID is configured under the routing protocol and is used to identify and group NLRI for each topology in updates for a given protocol.

Unicast Topology Configuration for MTR

Up to 32 unicast topologies can be configured on each router. The topology is first defined by entering the **global-address-family** command in global configuration mode. The address family and optionally the subaddress family are specified in this step. The **topology** subcommand is then entered in global address family configuration mode. This command places the router in address family topology configuration mode. The following global topology configuration parameters are applied in this mode:

- Global interface configuration—The topology can be configured on all interfaces by entering the **all-interfaces** command in address family topology configuration mode. All interfaces are removed from the topology by entering the **no** form of this command, which is the default.
- Forwarding mode—The method that the router uses to look up forwarding entries in the FIB is configured by entering the **forward-base** command. Entering this command enables incremental forwarding mode. Entering the **no** form enables strict forwarding mode, which is the default mode for MTR. In strict forwarding mode, the router will look for a forwarding entry only within the class-specific topology FIB. If an entry is not found, the packet is dropped. In incremental mode, the router will first look in the class-specific topology FIB. If a class-specific forwarding entry is not found, the router will then look in the base topology FIB.
- Maximum route limit—A limit for the number of routes that will be permitted in the topology and installed to the topology RIB is configured by entering the **maximum routes** (MTR) command. This functionality is similar to routing and VPN maximum route features. No limit is the default.

Note Per-interface topology configuration parameters override configurations applied in global address family topology configuration mode and router address family topology configuration mode.

Multicast Topology Configuration for MTR

Cisco IOS software supports legacy (pre-MTR) IP multicast behavior by default. MTR support for IP multicast must be explicitly enabled. Legacy IP multicast uses reverse path forwarding on routes in the unicast RIB (base unicast topology) to build multicast distribution trees (MDTs).

Note Legacy DVMRP support is not provided in Cisco IOS software images that provide support for MTR.

MTR introduces a multicast topology that is completely independent from the unicast topology. MTR integration with multicast will allow the user to control the path of multicast traffic in the network.

The multicast topology maintains separate routing and forwarding tables. The following list summarizes MTR multicast support that is integrated into Cisco IOS software:

- Conventional longest match support for multicast routes.
- RPF support for Protocol Independent Multicast (PIM).
- Border Gateway Protocol (BGP) MDT subaddress family identifier (SAFI) support for Inter-AS Virtual Private Networks (VPNs) (SAFI number 66).

- Support for static multicast routes is integrated into the **ip route topology** command (modifying the **ip mroute** command).

Multicast support is enabled by configuring the **ip multicast-routing** command in global configuration mode, as in pre-MTR software. MTR support for multicast is enabled by configuring the **ip multicast rpf multitopology** command. The **global-address-family** command is entered with the IPv4 address family and multicast subaddress family. The **topology** command is then entered with the **base** keyword. The following global topology configuration parameters are applied in this mode:

- Topology route replication—The **route-replicate** command is used to replicate (copy) routes from another multicast topology RIB. Routes can be replicated from the unicast base topology or a class-specific topology. However, route replication cannot be configured from a class-specific topology that is configured to forward the base topology (incremental forwarding).
- Unicast topology RPF—The **use-topology** command configures the multicast topology to perform RPF checks on routes in a unicast topology RIB. The base unicast or a class-specific topology can be specified. The RIB of the base multicast topology is not used when this command is enabled.

Note Only a single multicast topology is currently supported. Support for multiple multicast topologies will be provided in a future development phase.

Routing Protocol Support for MTR

IP routing must be enabled on the router in order for MTR to operate. MTR supports static and dynamic routing in Cisco IOS software. Dynamic routing can be enabled per-topology to support inter-domain and intra-domain routing. Route calculation and forwarding are independent for each topology. MTR support is integrated into Cisco IOS 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)

Per-topology configuration is applied under the router address family configuration of the global routing process (router configuration mode). The address family and subaddress family are specified when entering address-family configuration mode. The topology name and topology ID are specified under the address-family configuration by entering the **topology** command.

Each topology is configured with a unique topology ID. The topology ID is configured under the routing protocol and is used to identify and group NLRI for each topology in updates for a given protocol. In OSPF, EIGRP, and IS-IS, the topology ID is entered during the first configuration of the **topology** command for a class-specific topology. In BGP, the topology ID is configured by entering the **bgp tid** command under the topology configuration.

Class-specific topologies can be configured 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.

BGP support is configured only in router configuration mode. IGP support is configured in router configuration mode and/or interface configuration mode.

By default, interfaces are not included in non-base topologies. For routing protocol support for EIGRP, IS-IS, and OSPF, explicit configuration of a non-base topology on an interface is required. The default behavior can be overridden by using the **all-interfaces** command in address family topology configuration mode. The **all-interfaces** command causes the non-base topology to be configured on all interfaces of the router that are part of the default address space or the VRF in which the topology is configured.

BGP Routing Protocol Support for MTR

Before using BGP to support MTR, you should be familiar with the following concepts:

- BGP Network Scope, page 8
- MTR CLI Hierarchy Under BGP, page 8
- BGP Sessions for Class-Specific Topologies, page 9
- Topology Translation Using BGP, page 9
- Topology Import Using BGP, page 9

BGP Network Scope

A new configuration hierarchy, named scope, has been introduced into the BGP protocol. To implement MTR for BGP, the scope hierarchy is required, but the scope hierarchy is not limited to MTR use. The scope hierarchy introduces some new configuration modes such as router scope configuration mode. Router scope configuration mode is entered by configuring the **scope** command in router configuration mode, and a collection of routing tables is created when this command is entered. BGP commands configured under the scope hierarchy are configured for a single network (globally), or on a per-VRF basis, and are referred to as scoped commands. The scope hierarchy can contain one or more address families.

MTR CLI Hierarchy Under BGP

The BGP CLI has been modified to provide backwards compatibility for pre-MTR BGP configuration and to provide a hierarchical implementation of MTR. Router configuration mode is backwards 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, general session commands and peer templates can be configured to be used in the address-family or topology configuration modes.

After any global commands are configured, the scope is defined either globally or for a specific VRF. Address family configuration mode is entered by configuring the **address-family** command in router scope configuration mode or router configuration mode. Unicast is the default address family if no subaddress family (SAFI) is specified. MTR supports only the IPv4 address family with a SAFI of unicast or multicast. Entering address family configuration mode from router configuration mode configures BGP to use pre-MTR-based CLI. This configuration mode is backwards compatible with pre-existing address family configurations. Entering address family configuration mode from router scope configuration mode configures the router 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.

BGP topology configuration mode is entered by configuring the **topology** (BGP) command in address family configuration mode. Up to 32 topologies (including the base topology) can be configured on a router. The topology ID is configured 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 shows the hierarchy levels that are used when configuring 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

MTR is configured under 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 RIB and FIB are maintained for each session.

Topology Translation Using BGP

Depending on the design and policy requirements for your network, you may need to install routes from a class-specific topology on one router in a class-specific topology on a neighboring router. Topology translation functionality using BGP provides support for this operation. Topology translation is BGP neighbor-session based. The **neighbor translate-topology** command is configured 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 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 will select and install only one instance of the route per standard BGP best-path calculation behavior.

Topology Import Using BGP

Topology import functionality using BGP is similar to topology translation. The difference is that routes are moved between class-specific topologies on the same router using BGP. This function is configured by entering the **import topology** command. The name of the class-specific topology or base topology is specified when entering this command. Best-path calculations are run on the imported routes before they are installed into the topology RIB. This command also includes a **route-map** keyword to allow you to filter routes that are moved between class-specific topologies.

MTR Traffic Classification

MTR cannot be enabled on a router until traffic classification has been configured, even if only one class-specific topology has been configured. Traffic classification is used to configure topology specific forwarding behaviors when multiple topologies are configured on the same router. Traffic classification must be applied consistently throughout the network. Class-specific packets are associated with the corresponding topology table forwarding entries.

Traffic classification is configured using the Modular QoS CLI (MQC). MTR traffic classification is similar to QoS traffic classification. However, there is an important distinction. MTR traffic classification is defined globally for each topology, rather than at the interface level as in Quality of Service (QoS).

A subset of DSCP bits is used to encode classification values in the IP packet header. A class map is configured to define the traffic class by entering the **class-map** command in global configuration mode. Only the **match-any** keyword is supported for MTR. The traffic class is associated with a policy by configuring the **policy-map type class-routing ipv4 unicast** command in global configuration mode. The policy is activated for the topology by configuring the **service-policy type class-routing** command in global address family configuration mode. When configured, the service policy is associated with all interfaces on the router.

Some of the same goals can be achieved through QoS configuration, to which MTR provides a more powerful and flexible alternative. MTR traffic classification and IP Differentiated Services or IP Precedence-based traffic classification can be configured in the same network. However, MTR requires exclusive use of some subset of the DSCP bits in the IP packet header for specific topology traffic. In a network where MTR and QoS traffic classification are configured, simultaneous configuration must be carefully coordinated.

Network Management Support for MTR

Standard network management utilities, such as ping and traceroute, have been enhanced to support MTR. You can configure a standard or extended ping using the topology name in place of a hostname or IP address. Traceroute has been similarly enhanced. Context-based Simple Network Management Protocol (SNMP) functionality has been integrated into Cisco IOS software and can be used to support MTR.

ISSU—MTR

All protocols and applications that support MTR and that also support In Service Software Upgrade (ISSU) have extended their ISSU support to include the MTR functionality. See the *Cisco IOS In Service Software Upgrade Process* module for information on ISSU-capable protocols and applications.

ISSU allows a high-availability (HA) system to run in Stateful Switchover (SSO) mode even when different versions of Cisco IOS software are running on the active and standby Route Processors (RPs). This feature allows the system to switch over to a secondary RP that is running upgraded (or downgraded) software and to continue forwarding packets without session loss and with minimal or no packet loss.

This feature is enabled by default.

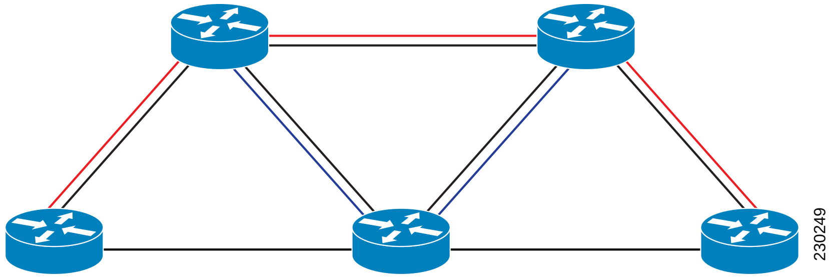
MTR Deployment Models

The base topology is the superset of all topologies in the network. It is defined by NLRI for all reachable routers regardless of the deployment model that is used. MTR can be deployed using the service separation MTR model shown in Figure 6, or it can deployed using the overlapping MTR model shown in Figure 7. Each of these models represent a different approach to deploying MTR. However, these models are not mutually exclusive. Any level of variation of a combined model can be deployed.

Service Separation MTR Model

Figure 6 shows the service separation model where no colored topologies (except for the base) overlap with each other. In the service separation model, each class of traffic is constrained to its own exclusive topology. This model restricts the given class of traffic to a subset of the network. This model is less configuration intensive because no topology-specific metrics need to be configured.

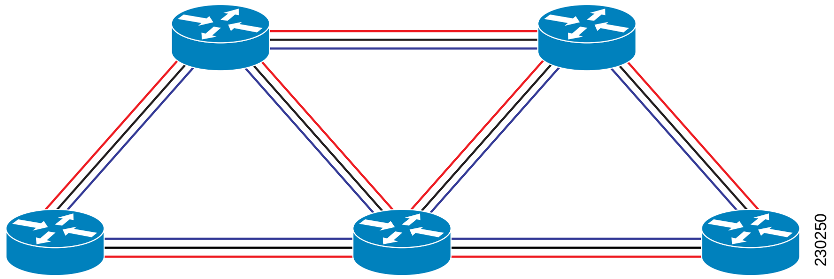
Figure 6 Service-Separation MTR Model



Overlapping MTR Model

In the overlapping MTR model, all topologies are configured to run over all routers in the network. This model provides the highest level of redundancy. All classes of traffic may use all links. Per-topology metrics are then configured to bias different classes of traffic to use different parts of the network. The redundancy that this model provides, however, makes it more configuration intensive. Figure 7 shows the red and gray topologies. All topologies are configured to run over all network routers. In this model, per-topology metrics are configured to bias the preferred routes for each topology.

Figure 7 Overlapping MTR Model



MTR Deployment Configuration

MTR supports both full and incremental deployment configurations. To support these options, MTR provides two different, configurable forwarding rules. For full deployment, MTR supports a (default) longest-match lookup in only the forwarding table of the corresponding class-specific topology. If no route is found, the packet is dropped. For incremental deployment, MTR supports a longest- match lookup first in the forwarding table for the corresponding class-specific topology, and subsequently, in the base topology if no class-specific entry is found. The former forwarding rule is known as “strict mode,” the latter as “incremental mode.”

Full Deployment

Strict forwarding mode is the default forwarding mode in MTR. In this mode, the router will look for a forwarding route only in the class-specific FIB. If no forwarding route is found, the packet is dropped. In this mode, the router performs a longest match look up for the topology FIB entry. This mode is designed for full deployment, where MTR is enabled on every router in the network or every router in the topology. Strict forwarding mode should be enabled after an incremental deployment transition has been completed or when all routers in the network or topology are MTR enabled. Strict forwarding mode can be enabled after incremental forwarding mode by entering the **no** form of the **forward-base** command.

Incremental Deployment

Incremental forwarding mode is designed to support transitional or incremental deployment of MTR, where there are routers in the network that are not MTR enabled. In this mode, the router will look for a forwarding entry first in the class-specific FIB. If an entry is not found, the router will then look for the longest match in the base topology FIB. If an entry is found in the base topology FIB, the packet will be forwarded on the base topology. If a forwarding entry is not found in the base topology FIB, the packet is dropped.

This mode is designed to preserve connectivity during an incremental deployment of MTR and is recommended to be used only during migration (the transition from a non-MTR to MTR enabled network). Class-specific traffic for a given destination is forwarded over contiguous segments of the class-specific topology containing that destination; otherwise it is forwarded over the base topology.

This forwarding mode can also be enabled to support mixed networks where some routers are not configured to run MTR. Incremental forwarding mode is enabled by entering the **forward-base** command in address family topology configuration mode.

Guidelines for Enabling and Disabling MTR

The section provides guidelines and procedures for enabling or disabling MTR in a production network. These guidelines assume that all participating networking devices are running a software image that supports MTR. They are designed to prevent major traffic interruptions due to misconfiguration and to minimize temporary transitional effects that can occur when introducing or removing a topology from a network. The procedures described below must be implemented in the order that they are described.

First, create a class-specific topology on all networking devices and enable incremental forwarding mode by entering the **forward-base** command in the address family topology configuration. Incremental forwarding should be configured whenever a topology is introduced or removed from the network. The topology is defined as a global container at this stage. No routing or forwarding can occur within the topology. Routing protocol support should not be configured.

Second, configure classification rules for the class-specific topology. Classification must be consistently applied on all routers in the topology; each router has identical classifier configuration. The topology is activated when a valid classification configuration is attached to the global topology configuration. Reachability can be verified, for interfaces and networking devices that are in the same topology and configured with identical classification, using ping and trace route.

Third, configure routing protocol support and/or static routing. The routers in the topology should be configured one at a time. This configuration includes interface, router process, and routing protocol-specific metrics and filters.

You should enable routing in the topology using a physical pattern in a contiguous manner relative to a single starting point. For example, you should configure all interfaces on a single router, and then all interfaces on each adjacent router. You should follow this pattern until the task is complete. The starting point can be on the edge or core of the network. This recommendation is designed to increase the likelihood that class-specific traffic is forwarded on the same paths in the incremental topology during as it is on the full topology when MTR is completely deployed.

Incremental forwarding should be disabled (if your network design requires strict forwarding mode) only after routing has been configured on all routers in a given topology. At this stage, MTR is fully operational. Class-specific traffic is forwarded only over devices within the topology. Traffic that is not classified or destined for the topology is dropped.

When disabling a topology, you should reenable incremental forwarding mode. You should remove custom route configuration, such as route summarization and default routes before disabling a topology, and you should reapply custom route configuration only after the topology is reenabled. This recommendation is designed to prevent traffic interruption, as some destinations may be obscured during the transition. Custom route configuration is most useful when all of the more specific routes are available in the routing table of the topology.

Note These recommendations apply only when a given classifier is enabled or disabled for a given topology. All other MTR configuration, including interface and routing protocol specific configuration (other than the topology ID) may be modified dynamically as necessary.

How to Configure Multi-Topology Routing

This section contains the following tasks:

- Configuring a Unicast Topology for MTR, page 14
- Configuring a Multicast Topology for MTR, page 16
- Configuring MTR Traffic Classification, page 19
- Activating an MTR Topology Using OSPF, page 22
- Activating an MTR Topology Using EIGRP, page 24
- Activating an MTR Topology Using IS-IS, page 26
- Activating an MTR Topology Using BGP, page 28
- Importing Routes from an MTR Topology Using BGP, page 32
- Configuring an MTR Topology in Interface Configuration Mode, page 35
- Activating an MTR Topology in Interface Configuration Mode Using OSPF, page 37
- Activating an MTR Topology in Interface Configuration Mode Using EIGRP, page 39
- Activating an MTR Topology in Interface Configuration Mode Using IS-IS, page 41
- Configuring SNMP Support for MTR, page 43
- Enabling and Monitoring MTR Topology Statistics Accounting, page 47
- Testing Network Connectivity for MTR, page 49

Configuring a Unicast Topology for MTR

Perform this task to configure a unicast topology. Only Steps 1 through 4 are required to complete this task. The remaining steps are optional.

MTR Scaling Characteristics

For each new topology that you configure on a router, you increase the total number of routes from the global routing table by the number of routes that are in each new topology [base+topology(*n*)]. If the router carries a large global routing table, and you plan to add a significant number of routes through MTR topology configuration, you can configure the **maximum routes** (MTR) command in address family topology configuration mode to limit the number of routes that the router will accept for a given topology and install into the corresponding RIB.

Prerequisites

- IP routing and CEF must be enabled.

Restrictions

- Only the IPv4 address family (multicast and unicast) is currently supported.

Note Support for other address families will be added in future development phases.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **global-address-family ipv4** [**multicast** | **unicast**]
4. **topology** {**base** | *topology-name*}
5. **all-interfaces**
6. **forward-base**
7. **maximum routes** *number* [*threshold* **[reinstall** *threshold*] | **warning-only**]
8. **shutdown**
9. **end**
10. **show topology** [**cache** [*topology-id]* | **ha** | [[**detail** | **interface** | **lock** | **router**] [**all** | **ipv4** | **ipv6** | **vrf** *vpn-instance*]]]

DETAILED STEPS

	Command or Action	Purpose

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

Step 2	**`configure terminal`**
	Example:
	`Router# configure terminal`
		Enters global configuration mode.

Step 3	**`global-address-family ipv4`** [**`multicast`** | **`unicast`**] **Example:** `Router(config)# global-address-family ipv4`	Enters global address family topology configuration mode to configure the global topology. • The address family for the class-specific topology is specified in this step. The subaddress family can be optionally specified. Unicast is the default if no subaddress family is entered.

Step 4	**`topology`** {**`base`** | *`topology-name`*}
	Example:
	`Router(config-af)# topology VOICE`
		Configures the global topology instance and enters address family topology configuration mode.
		• The **base** keyword is used to configure the base topology or a multicast topology.
		• The *topology-name* argument is entered to label a class-specific topology. Topology names are case-sensitive. For example, VOICE and voice identify two different topologies.
		• MTR supports 32 unicast topologies including the base topology.

Step 5	**`all-interfaces`**
	Example:
	`Router(config-af-topology)# all-interfaces`
		(Optional) Configures the topology instance to use all interfaces on a router.
		• By default, no interfaces are used.
		Note The configuration of this command does not override the topology configuration applied in interface configuration mode.

Step 6	**`forward-base`**
	Example:
	`Router(config-af-topology)# forward-base`
		(Optional) Configures the forwarding mode under a topology instance.
		• Strict mode (default) configures the router to look for forwarding entries only in the topology-specific FIB.
		• The **forward-base** command is used in incremental deployment. Incremental mode (enable form) configures the router to look first in the class-specific topology FIB. If a forwarding route is not found, then the router will look in the base topology FIB.

	Command or Action	Purpose
Step 7	**maximum routes** *number* [*threshold* [**reinstall** *threshold*] | **warning-only**] **Example:** `Router(config-af-topology)# maximum routes 1000 warning-only`	(Optional) Configures the maximum number of routes that a topology instance will accept and install into the RIB. • Use the **warning-only** keyword to generate only a warning, to set an upper limit, and to set a lower limit (low water mark) for reinstalling routes after the maximum limit has been exceeded.
Step 8	**shutdown** **Example:** `Router(config-af-topology)# shutdown`	(Optional) Temporarily disables a topology instance without removing the topology configuration. • This command is used to temporarily disable a topology, while other topology parameters are configured and other routers are configured with MTR.

Step 9	**end**
	Example:
	`Router(config-af-topology)# end`
		(Optional) Exits routing topology configuration mode and enters privileged EXEC mode.

Step 10	**show topology** [**cache** [*topology-id*] | **ha** | [[**detail** | **interface** | **lock** | **router**] [**all** | **ipv4** | **ipv6** | **vrf** *vpn-instance*]]] **Example:** `Router# show topology`	(Optional) Displays information about class-specific and base topologies.

What to Do Next

Repeat this task for each unicast topology instance that you need to create. Proceed to "Configuring a Multicast Topology for MTR" section on page 16 to configure a multicast topology.

Configuring a Multicast Topology for MTR

Cisco IOS software supports legacy (pre-MTR) multicast behavior by default. Perform this task to configure a multicast topology. Only Steps 1 through 6 are required to complete this task. The remaining steps are optional.

Prerequisites

- IP routing and Cisco Express Forwarding (CEF) must be enabled.

Restrictions

- Distance Vector Multicast Routing Protocol (DVMRP) CLI and functionality are not provided in Cisco IOS software images that provide MTR support.
- Only the IPv4 address family (multicast and unicast) is supported.
- Only a single multicast topology can be configured, and only the **base** keyword can be entered when the multicast topology is created in Step 6.

Note Support for multiple multicast topologies will be added in a future development phase.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip multicast-routing** [**vrf** *name*]
4. **ip multicast rpf multitopology**
5. **global-address-family ipv4** [**multicast** | **unicast**]
6. **topology** {**base** | *topology-name*}
7. **route-replicate from** {**multicast** | **unicast**} [**topology** {**base** | *name*}] *protocol* [**route-map** *name* | **vrp** *name*]
8. **use-topology unicast** {**base** | *topology-name*}
9. **shutdown**
10. **end**
11. **show topology** [**cache** [*topology-id]* | **ha** | [[**detail** | **interface** | **lock** | **router**] [**all** | **ipv4** | **ipv6** | **vrf** *vpn-instance*]]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip multicast-routing** [**vrf** *name*] **Example:** `Router(config)# ip multicast-routing`	Enables IP multicast routing.
Step 4	**ip multicast rpf multitopology** **Example:** `Router(config)# ip multicast rpf multitopology`	Enables MTR support for IP multicast routing.
Step 5	**global-address-family ipv4** [**multicast** | **unicast**] **Example:** `Router(config)# global-address-family ipv4 multicast`	Enters global address family configuration mode to configure the global topology. • The address family for the class-specific topology is specified in this step. The subaddress family can be specified. Unicast is the default if no subaddress family is entered.

	Command or Action	Purpose

Step 6	**topology** {**base** | *topology-name*}
	Example:
	`Router(config-af)# topology base`
		Configures the global topology instance and enters address family topology configuration mode.
		• Only the **base** keyword can be accepted for a multicast topology.

Step 7	**route-replicate from** {**multicast** | **unicast**} [**topology** {**base** | *name*}] *protocol* [**route-map** *name* | **vrf** *name*] **Example:** `Router(config-af-topology)# route-replicate from unicast topology VOICE ospf 100 route-map map1`	(Optional) Replicates routes in the multicast topology RIB. • The *protocol* argument is configured to specify the protocol which is the source of the route. • Replicated routes can be filtered through a route map before they are installed into the multicast RIB.

Step 8	**use-topology unicast** {**base** | *topology-name*}
	Example:
	`Router(config-af-topology)# use-topology unicast VIDEO`
		(Optional) Configures a multicast topology to perform RPF computations using a unicast topology RIB.
		• The base or a class-specific unicast topology can be configured. When this command is configured, the multicast topology uses routes in the specified unicast topology table to build multicast distribution trees.
		Note This multicast RIB is not used when this command is enabled, even if the multicast RIB is populated and supported by a routing protocol.

Step 9	**shutdown** **Example:** `Router(config-af-topology)# shutdown`	(Optional) Temporarily disables a topology instance without removing the topology configuration. • This command is used to temporarily disable a topology, while other topology parameters are configured and other routers are configured with MTR.

Step 10	**end**
	Example:
	`Router(config-af-topology)# end`
		(Optional) Exits address family topology configuration mode and enters privileged EXEC mode.

Step 11	**show topology** [**cache** [*topology-ID*] | **ha** | [[**detail** | **interface** | **lock** | **router**] [**all** | **ipv4** | **ipv6** | **vrf** *vpn-instance*]] **Example:** `Router# show topology detail`	(Optional) Displays information about class-specific and base topologies.

What to Do Next

The topology is not activated until classification is configured. Proceed to the "Configuring MTR Traffic Classification" section on page 19 to configure classification for a class-specific topology.

Configuring MTR Traffic Classification

Perform this task to define MTR traffic classification. Traffic classification is used to associate different classes of traffic with different topologies when multiple topologies are configured on the same router. MTR traffic classification is similar to QoS traffic classification and is configured using the MQC.

The **service-policy type class-routing** command is used to attach a service policy to a policy map for topology traffic classification. The service policy is activated for the topology after the **service-policy type class-routing** command is entered, enabling traffic classification. Following the correct order of the commands in this task is very important. Ensure that all configuration that affects traffic classification is complete before entering the **service-policy type class-routing** command.

Note Traffic classification is defined globally for each topology, rather than at the interface level as in QoS.

It is also important that all routers throughout the network have the same definition of classifiers and the same sequencing of classifiers.

MTR and QoS Traffic Classification in the Same Network

MTR traffic classification and IP Differentiated Services or IP Precedence based traffic classification can be configured in the same network. However, MTR requires exclusive use of the DSCP bits in the IP packet header for specific topology traffic. In a network where MTR and QoS traffic classification is configured, simultaneous configuration must be carefully coordinated.

Before configuring MTR traffic classification, you should be familiar with all the concepts documented in the "MTR Traffic Classification" section on page 9.

Prerequisites

- A topology must be defined globally before traffic classification can be configured.

Restrictions

- MTR classification values must be unique for each topology. An error message will be generated if you attempt to configure overlapping values.
- A topology cannot be placed in the shutdown state if it is referenced by any active policy map.
- A subset of DSCP bits is used to encode classification values in the IP packet header. Certain DSCP values are reserved. These DSCP values are commonly used by routing software components for purposes unrelated to MTR (for example, OSPF, BFD, and/or SNMP). Using these values for MTR classification is likely to interfere with correct operation of the router and is strongly discouraged. These values include:
  - DSCP 48 (cs6)
  - DSCP 16 (cs2)

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **class-map match-any** *class-map-name*

4. **match** [**ip**] **dscp** *dscp-value* [*dscp-value dscp-value dscp-value dscp-value dscp-value dscp-value dscp-value*]
5. **exit**
6. **policy-map type class-routing ipv4 unicast** *policy-map-name*
7. **class** {*class-name* | **class-default**}
8. **select-topology** *topology-name*
9. **exit**
10. **global-address-family ipv4** [**multicast** | **unicast**]
11. **service-policy type class-routing** *policy-map-name*
12. **end**
13. **show topology detail**
14. **show policy-map type class-routing ipv4 unicast** [**interface** [*interface-type interface-number*]]
15. **show mtm table**

DETAILED STEPS

	Command or Action	Purpose

Step 1	`enable`
	Example:
	`Router> enable`
		Enables privileged EXEC mode.
		• Enter your password if prompted.

Step 2	`configure terminal`
	Example:
	`Router# configure terminal`
		Enters global configuration mode.

Step 3	**`class-map match-any`** *`class-map-name`*
	Example:
	`Router(config)# class-map match-any VOICE-CLASS`
		Creates a class map to be used for matching packets to a specified class and enters class-map configuration mode.
		• The MTR traffic class is defined using this command.
		Note The **match-any** keyword must be entered when configuring classification for MTR.

Step 4	**`match`** `[`**`ip`**`]` **`dscp`** *`dscp-value`* `[`*`dscp-value dscp-value dscp-value dscp-value dscp-value dscp-value dscp-value`*`]`
	Example:
	`Router(config-cmap)# match ip dscp 9`
		Identifies a DSCP value as a match criteria.
		• Use the *dcsp-value* argument to define a specific metric value.
		• Do not use the DSCP values 48 and 16. See "Restrictions" for more information.

Step 5	`exit`
	Example:
	`Router(config-cmap)# exit`
		Exits class-map configuration mode, and enters global configuration mode.

	Command or Action	Purpose
Step 6	**policy-map type class-routing ipv4 unicast** *policy-map-name* **Example:** `Router(config)# policy-map type class-routing ipv4 unicast VOICE-CLASS-POLICY`	Creates or modifies a policy map that can be attached to one or more interfaces to specify a service policy and enters policy-map configuration mode. • If you do not specify the **type** keyword option, the command defaults to the QoS policy.

Step 7	**class** {*class-name* | **class-default**}
	Example:
	`Router(config-pmap)# class VOICE-CLASS`
		Specifies the name of the class whose policy you want to create or change or specifies the default class and enters policy-map class configuration mode.
		• The class map is referenced.
		• For a class map to be referenced in a class-routing policy map, it must first be defined by the **class-map** command as shown in Step 3.

Step 8	**select-topology** *topology-name* **Example:** `Router(config-pmap-c)# select-topology VOICE`	Attaches the policy map to the topology. • The topology name configured by the **topology** command in global address family configuration mode is referenced. See Step 4 of the "Configuring a Unicast Topology for MTR" section.
Step 9	**exit** **Example:** `Router(config-pmap-c)# exit`	Exits policy-map class configuration mode and enters policy-map configuration mode. • Repeat this step to enter global configuration mode.
Step 10	**global-address-family ipv4** [**multicast** | **unicast**] **Example:** `Router(config)# global-address-family ipv4`	Enters global address family configuration mode to configure MTR.
Step 11	**service-policy type class-routing** *policy-map-name* **Example:** `Router(config-af)# service-policy type class-routing VOICE-CLASS-POLICY`	Attaches the service policy to the policy map for MTR traffic classification and activates MTR. • The *policy-map-name* argument must match that configured in step 6. **Note** After this command is entered, traffic classification is enabled. Ensure that all configuration that affects traffic classification is complete before entering this important command.

Step 12	**end**
	Example:
	`Router(config-af)# end`
		Exits global address family configuration mode and enters privileged EXEC mode.

Step 13	**show topology detail** **Example:** `Router# show topology detail`	(Optional) Displays detailed information about class-specific and base topologies.

	Command or Action	Purpose
Step 14	**show policy-map type class-routing ipv4 unicast** [**interface** [*interface-type interface-number*]] **Example:** `Router# show policy-map type class-routing ipv4 unicast`	(Optional) Displays the class-routing policy map configuration. • If you specify the **interface** keyword without the argument, statistics on all interfaces under the global space will be displayed.
Step 15	**show mtm table** **Example:** `Router# show mtm table`	(Optional) Displays information about the DSCP values assigned to each topology.

What to Do Next

The next four tasks show how to enable MTR support under a routing protocol. Proceed to "Activating an MTR Topology Using OSPF" section on page 22 to enable routing protocol support.

Activating an MTR Topology Using OSPF

Perform this task to configure OSPF for an MTR topology. Only MTR commands are shown in this task.

Before using OSPF to support MTR, you should be familiar with the concepts documented in the "Routing Protocol Support for MTR" section on page 7.

Prerequisites

- A global topology configuration has been configured and activated.
- IP routing and CEF must be enabled.
- Check your OSPF router configuration and enter the topology-aware router configuration commands in router address family configuration mode.

Several OSPF router configuration commands need to be topology-aware. Before you configure OSPF MTR, you need to enter these commands in router address family configuration mode if they are used in your original OSPF router configuration.

- **area** *area-id* **default-cost** *cost*
- **area** *area-id* **filter-list prefix** {*prefix-list-name* **in** | **out**}
- *area area-id* **nssa** [**default-information-originate** [**metric** *metric-number*] [*metric-type*]] | [**no-redistribution**] | [**no-summary**] [**metric**] [*metric-type*]] [**translate type7 suppress-fa**]
- **area** *area-id* **range** *ip-address mask* [**advertise** | **not-advertise**] [**cost** *cost*]
- **area** *area-id* **stub** [**no-summary**]
- **area** *transit-area-id* **virtual-link** *transit-router-id* **topology disable**
- **default-information originate** [**always**] [**metric** *metric-value*] [**metric-type** *type-value*] [**route-map map-name**]
- **default-metric** *metric-value*
- **discard-route** [**external** | **internal**]

- **distance ospf** {**external** *dist1* | **inter-area** *dist2* | **intra-area** *dist3*}
- **distribute-list in (IP)**
- **distribute-list out (IP)**
- **max-metric router-lsa** [**on-startup** {*seconds* | **wait-for-bgp**}]
- **maximum-paths** *maximum maximum-paths* {[*number-of-paths*] [**import** *number-of-paths*] | [**import** *number-of-paths*]}
- **neighbor** *ip-address* [**cost** *number*]
- **redistribute** *protocol* [*process-id*] {**level-1** | **level-1-2** | **level-2**} [*as-number*] [**metric** {*metric-value* | **transparent**}] [*metric-type type-value*] [**match** {**external** | **internal** | **nssa-external**}] [**tag** tag-value] [**route-map** *map-tag*] [**subnets**]
- **summary-address** {**ip-address** *mask* | **prefix** *mask*} [**not-advertise**] [**tag** *tag*]
- **timers throttle spf** *spf-start spf-hold spf-max-wait*
- **traffic-share min across-interfaces**

Restrictions

Only the IPv4 address family (multicast and unicast) is supported.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router ospf** *process-id* [**vrf** *vrf-name*]
4. **address-family ipv4** [**multicast** | **unicast**]
5. **topology** {**base** | *topology-name* **tid** *number*}
6. **end**
7. **show ip ospf** [*process-id*] **topology-info** [**multicast**] [**topology** {*topology-name* | **base**}]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** Router> enable	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** Router# configure terminal	Enters global configuration mode.
Step 3	**router ospf** *process-id* [**vrf** *vrf-name*] **Example:** Router(config)# router ospf 1	Enables an OSPF routing process and enters router configuration mode.

	Command or Action	Purpose
Step 4	**address-family ipv4** [**multicast** | **unicast**] **Example:** Router(config-router)# address-family ipv4	Enter router address family configuration mode to configure an OSPF address family session. • Currently, only the base topology can be configured under the multicast subaddress family.
Step 5	**topology** {**base** | *topology-name* **tid** *number*} **Example:** Router(config-router-af)# topology VOICE tid 10	Configures OSPF support for the topology and assigns a TID number for each topology. Enters router address family topology configuration mode. • Use the **tid** keyword and *number* argument to configure a topology ID. The topology ID must be configured in the first configuration of the specified topology. It is optional for subsequent configuration. **Note** The **base** keyword is accepted only for IPv4 multicast. The **tid** keyword is accepted only for IPv4 or IPv6 unicast.
Step 6	**end** **Example:** Router(config-router-af-topology)# end	Exits router address family topology configuration mode and enters privileged EXEC mode.
Step 7	**show ip ospf** [*process-id*] **topology-info** [**multicast**] [**topology** {*topology-name* | **base**}] **Example:** Router# show ip ospf topology-info topology VOICE	(Optional) Displays OSPF information about the specified topology.

What to Do Next

If an EIGRP topology configuration is required, proceed to the next task. If an IS-IS topology configuration is required proceed to the "Activating an MTR Topology Using IS-IS" section on page 26.

Activating an MTR Topology Using EIGRP

Perform this task to configure EIGRP for an MTR topology. Only MTR commands are shown in this task.

Before using EIGRP to support MTR, you should be familiar with the concepts documented in the "Routing Protocol Support for MTR" section on page 7.

Prerequisites

- A global topology configuration has been configured and activated.
- IP routing and CEF must be enabled.

Restrictions

- Only the IPv4 address family is currently supported.
- Graceful restart in EIGRP will only work for base topologies. All other service topologies will reset with new adjacencies.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router eigrp** *name*
4. **address-family ipv4** [**unicast** | **multicast** | **vrf** *vrf-name*] **autonomous-system** *as-number*
5. **topology** {**base** | *topology-name* **tid** *number*}
6. **end**
7. **show ip protocols topology** *name* [**summary**]
8. **show ip eigrp topology** *name*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**router eigrp** *name* **Example:** `Router(config)# router eigrp MTR`	Configures an EIGRP process for MTR, and enters router configuration mode. • You can use the command without configuring MTR, but it defaults to the base topology.
Step 4	**address-family ipv4** [**unicast** | **multicast** | **vrf** *vrf-name*] **autonomous-system** *as-number* **Example:** `Router(config-router)# address-family ipv4 autonomous-system 1`	Enters router address family configuration mode to configure EIGRP for MTR.

Step 5	**topology** {**base** | *topology-name* **tid** *number*}
	Example:
	`Router(config-router-af)# topology VIDEO tid 100`
		Configures an EIGRP process to route IP traffic under the specified topology instance and enters router address family topology configuration mode.
		• Each topology must be configured with a unique topology ID. The topology ID must be entered each time this command is entered.

	Command or Action	Purpose

Step 6	**end**
	Example:
	`Router(config-router-af-topology)# end`
		Exits router address family topology configuration mode and enters privileged EXEC mode.

Step 7	**show ip protocols topology** *name* [**summary**] **Example:** `Router# show ip protocols topology VIDEO`	Displays the status of routing protocols configured in a topology. **Tip** This command can be entered to display the status, under a topology, of any configured routing protocol.
Step 8	**show ip eigrp topology** *name* **Example:** `Router# show ip eigrp topology VIDEO`	Displays the routing table of an EIGRP process configured under a topology.

What to Do Next

If an IS-IS topology configuration is required, proceed to the next task. If a BGP topology configuration is required, proceed to "Activating an MTR Topology Using BGP" section on page 28.

Activating an MTR Topology Using IS-IS

Once a global MTR topology has been configured and activated, you can configure MTR support for IS-IS. To configure MTR for IS-IS, you must perform two tasks. You must activate an MTR topology on an IS-IS router. You must also configure the MTR topology to globally configure all interfaces using the **all-interfaces** address family topology configuration command, or you must configure the IS-IS topology in interface configuration mode to configure only IS-IS interfaces. The order in which you perform the two tasks does not matter. This section describes the task to enable an MTR topology on an IS-IS router and enable support for IPv4 unicast and multicast address families. Only MTR commands are shown in this task.

Before using IS-IS to support MTR, you should be familiar with the concepts documented in the "Routing Protocol Support for MTR" section on page 7.

Prerequisites

- A global topology configuration has been configured and activated.
- IP routing and CEF must be enabled.

Restrictions

- Only the IPv4 address family (multicast and unicast) and IPv6address family unicast are supported. For information about configuring Multitopology IS-IS for IPV6, see the *Implementing IS-IS for IPv6* section of the Cisco IOS IPv6 Configuration Library.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router isis** [*area-tag*]
4. **net** *network-entity-title*
5. **metric-style wide**
6. **address-family ipv4** [**multicast** | **unicast**]
7. **topology** *topology-name* **tid** *number*
8. **end**
9. **show isis neighbors detail**

DETAILED STEPS

	Command or Action	Purpose

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

Step 2	**`configure terminal`**
	Example:
	`Router# configure terminal`
		Enters global configuration mode.

Step 3	**`router isis`** `[`*`area-tag`*`]`
	Example:
	`Router(config)# router isis`
		Enables the IS-IS routing protocol and optionally specifies an IS-IS process. Enters router configuration mode.

Step 4	**`net`** *`network-entity-title`*
	Example:
	`Router(config-router)# net 31.3131.3131.3131.00`
		Configures an IS-IS network entity title (NET) for a Connectionless Network Service (CLNS) routing process.

Step 5	**`metric-style wide`** `[`**`transition`**`] [`**`level-1`** `|` **`level-2`** `|` **`level-1-2`**`]`
	Example:
	`Router(config-router)# metric-style wide`
		Globally changes the metric value for all IS-IS interfaces.
		Note Wide style metrics are required for prefix tagging.

Step 6	**`address-family ipv4`** `[`**`multicast`** `|` **`unicast`**`]`
	Example:
	`Router(config-router)# address-family ipv4`
		Enters router address family configuration mode under IS-IS router configuration mode.

Step 7	**`topology`** *`topology-name`* **`tid`** *`number`*
	Example:
	`Router(config-router-af)# topology DATA tid 100`
		Configures IS-IS support for the topology and assigns a TID number for each topology.
		• IS-IS support for the DATA topology is configured.

	Command or Action	Purpose

Step 8	`end`
	Example:
	`Router(config-router-topology)# end`
		Exits router address family configuration mode and enters privileged EXEC mode.

Step 9	**`show isis neighbors detail`**
	Example:
	`Router# show isis neighbors detail`
		(Optional) Displays information about IS-IS neighbors.
		Note This command has been modified to display MTR information for the TID values for the router and its IS-IS neighbors.

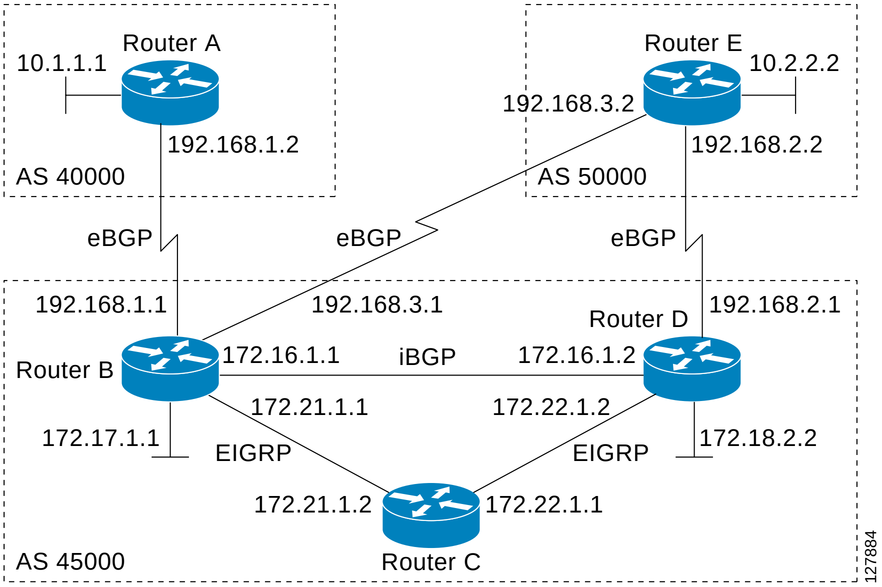
What to Do Next

If a BGP topology configuration is required, proceed to "Activating an MTR Topology Using BGP" section on page 28.

Activating an MTR Topology Using BGP

Perform this task to activate an MTR topology inside an address family using BGP. This task is configured on Router B in Figure 8 and must also be configured on Router D and Router E. In this task, a scope hierarchy is configured to apply globally and a neighbor is configured under 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 8 BGP Network Diagram



The BGP CLI has been modified to provide backwards compatibility for pre-MTR BGP configuration and to provide a hierarchical implementation of MTR. A new configuration hierarchy, named scope, has been introduced into the BGP protocol. To implement MTR for BGP, the scope hierarchy is required, but the scope hierarchy is not limited to MTR use. The scope hierarchy introduces some new configuration modes such as router scope configuration mode. Router scope configuration mode is entered by configuring the **scope** command in router configuration mode, and a collection of routing tables is created when this command is entered. The following shows the hierarchy levels that are used when configuring 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
```

Before using BGP to support MTR, you should be familiar with all the concepts documented in the "Information About BGP Support for MTR" section on page 2.

Prerequisites

- A global MTR topology configuration has been configured and activated.
- IP routing and CEF are enabled.

Restrictions

- 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 the IPv4 address family (multicast and unicast) is supported.
- Only a single multicast topology can be configured, and only the base topology can be specified if a multicast topology is created.

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-name*} **summary**

DETAILED STEPS

	Command or Action	Purpose

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

Step 2	**`configure terminal`**
	Example:
	`Router# configure terminal`
		Enters global configuration mode.

Step 3	**`router bgp`** *`autonomous-system-number`*
	Example:
	`Router(config)# router bgp 45000`
		Enters router configuration mode to create or configure a BGP routing process.

Step 4	**`scope`** `{`**`global`** `|` **`vrf`** *`vrf-name`*`}`
	Example:
	`Router(config-router)# scope global`
		Defines the scope to the BGP routing process and enters router scope configuration mode.
		• BGP general session commands that apply to a single network, or a specified VRF, are entered in this configuration mode.
		• Use the **global** keyword to specify that BGP uses the global routing table.
		• Use the **vrf** keyword and *vrf-name* argument to specify that BGP uses a specific VRF routing table. The VRF must already exist.

Step 5	**`neighbor`** `{`*`ip-address`* `|` *`peer-group-name`*`}` **`remote-as`** *`autonomous-system-number`*
	Example:
	`Router(config-router-scope)# neighbor 172.16.1.2 remote-as 45000`
		Adds the IP address of the neighbor in the specified autonomous system to the multiprotocol BGP neighbor table of the local router.

	Command or Action	Purpose

Step 6	**neighbor** {*ip-address* | *peer-group-name*} **transport** {**connection-mode** {**active** | **passive**} | **path-mtu-discovery** | **multi-session** | **single-session**}
	Example:
	`Router(config-router-scope)# neighbor 172.16.1.2 transport multi-session`
		Enables a TCP transport session option for a BGP session.
		• Use the **connection-mode** keyword to specify the type of connection, either active or passive.
		• Use the **path-mtu-discovery** keyword to enable TCP transport path maximum transmission unit (MTU) discovery.
		• Use the **multi-session** keyword to specify a separate TCP transport session for each address family.
		• 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:** `Router(config-router-scope)# address-family ipv4`	Specifies the IPv4 address family and enters router scope address family configuration mode. • Use the **mdt** keyword to specify IPv4 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 router 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. • Non-topology-specific configuration parameters are configured in this configuration mode.

Step 8	**topology** {**base** | *topology-name*}
	Example:
	`Router(config-router-scope-af)# topology VIDEO`
		Configures the topology instance in which BGP will route class-specific or base topology traffic, and enters router scope address family topology configuration mode.

Step 9	**bgp tid** *number* **Example:** `Router(config-router-scope-af-topo)# bgp tid 100`	Associates a BGP routing process with the specified topology ID. • Each topology must be configured with a unique topology ID.
Step 10	**neighbor** *ip-address* **activate** **Example:** `Router(config-router-scope-af-topo)# neighbor 172.16.1.2 activate`	Enables the BGP neighbor to exchange prefixes for the NSAP address family with the local router. **Note** If you have configured a peer group as a BGP neighbor, you do not use this command because peer groups are automatically activated when any peer group parameter is configured.
Step 11	**neighbor** {*ip-address* | *peer-group-name*} **translate-topology** *number* **Example:** `Router(config-router-scope-af-topo)# neighbor 172.16.1.2 translate-topology 200`	(Optional) Configures BGP to install routes from a topology on another router to a topology on the local router. • The topology ID is entered for the *number* argument to identify the topology on the router.

	Command or Action	Purpose

Step 12	**end**
	Example:
	`Router(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** {* | *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**]] **Example:** `Router# clear ip bgp topology VIDEO 45000`	Resets BGP neighbor sessions under a specified topology or all topologies.
Step 14	**show ip bgp topology** {* | *topology*} **summary** **Example:** `Router# show ip bgp topology VIDEO summary`	(Optional) Displays BGP information about a topology. • 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 *Cisco IOS IP Routing Protocols Command Reference*.

Examples

The following example shows summary output for the **show ip bgp topology** command and the VIDEO topology:

```
Router# 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
```

What to Do Next

Repeat this task for every topology that you want to enable, and repeat this configuration on all neighbor routers that are to use the topologies. If you want to import routes from one MTR topology to another on the same router, proceed to the next task.

Importing Routes from an MTR Topology Using BGP

Perform this task to import routes from one MTR topology to another on the same router, when multiple topologies are configured on the same router. 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.

Prerequisites

- A global topology configuration has been configured and activated.
- IP routing and CEF are enabled.

Restrictions

- Redistribution within a topology is permitted. Redistribution from one topology to another is not permitted. This restriction is designed to prevent routing loops from occurring. You can use topology translation or topology import functionality to move routes from one topology to another.
- Only the IPv4 address family (multicast and unicast) is supported.
- Only a single multicast topology can be configured, and only the base topology can be specified if a multicast topology is created.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip prefix-list** *list-name* [**seq** *seq-value*] {**deny** *network/length* | **permit** *network/length*} [**ge** *ge-value*] [**le** *le-value*]
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:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip prefix-list** *list-name* [**seq** *seq-value*] {**deny** *network/length* | **permit** *network/length*} [**ge** *ge-value*] [**le** *le-value*] **Example:** `Router(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** *map-name* [**permit** | **deny**] [*sequence-number*] **Example:** `Router(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** {*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*...]}
	Example:
	`Router(config-route-map)# match ip address prefix-list TEN`
		Configures the route map to match a prefix that is permitted by a standard access list, an extended access list, or a prefix list.
		• In this example, the route map is configured to match prefixes permitted by prefix list TEN.

Step 6	**exit** **Example:** `Router(config-route-map)# exit`	Exits route map configuration mode and returns to global configuration mode.
Step 7	**router bgp** *autonomous-system-number* **Example:** `Router(config)# router bgp 50000`	Enters router configuration mode to create or configure a BGP routing process.

	Command or Action	Purpose

Step 8	**scope** {**global** | **vrf** *vrf-name*}
	Example:
	`Router(config-router)# scope global`
		Defines the scope to the BGP routing process and enters router scope configuration mode.
		• BGP general session commands that apply to a single network, or a specified VRF, are entered in this configuration mode.
		• Use the **global** keyword to specify that BGP uses the global routing table.
		• Use the **vrf** keyword and *vrf-name* argument to specify that BGP uses a specific VRF routing table. The VRF must already exist.

Step 9	**address-family ipv4** [**mdt** | **multicast** | **unicast**] **Example:** `Router(config-router-scope)# address-family ipv4`	Enters router scope address family configuration mode to configure an address family session under BGP. • Non-topology-specific configuration parameters are configured in this configuration mode.

Step 10	**topology** {**base** | *topology-name*}
	Example:
	`Router(config-router-scope-af)# topology VIDEO`
		Configures the topology instance in which BGP will route class-specific or base topology traffic, and enters router scope address family topology configuration mode.

Step 11	**import topology** {**base** | *topology-name*} [**route-map** *map-name*]
	Example:
	`Router(config-router-scope-af-topo)# import topology VOICE route-map 10NET`
		(Optional) Configures BGP to move routes from one topology to another on the same router.
		• The **route-map** keyword can be used to filter routes that moved between topologies.

Step 12	**end**
	Example:
	`Router(config-router-scope-af-topo)# end`
		(Optional) Exits router scope address family topology configuration mode, and returns to privileged EXEC mode.

Configuring an MTR Topology in Interface Configuration Mode

Perform this task to configure an MTR topology in interface configuration mode. The configuration of an MTR topology in interface configuration mode allows you to enable or disable MTR on a per-interface basis. By default, a class-specific topology does not include any interfaces.

Individual interfaces can be included or excluded by configuring the **topology** (interface) command. The address family and topology (base or class-specific) are specified when entering this command. The subaddress family can be optionally specified. If no subaddress family is specified, the unicast subaddress family is used by default.

Note Interfaces cannot be excluded from the base topology by design. However, an Interior Gateway Protocol (IGP) can be excluded from an interface in a base topology configuration.

All interfaces on a router are included globally in a topology by entering the **all-interfaces** command in routing topology configuration mode. Per-interface topology configuration applied with the **topology** (interface) command overrides global interface configuration.

Per-Interface Routing

IGP routing and metric configurations can be applied in interface topology configuration mode. Per interface metrics and routing behaviors can be configured for each IGP. Interface configuration mode IGP commands are documented in the configuration section for each routing protocol.

Prerequisites

A topology must be defined globally before per-interface topology configuration can be configured.

Restrictions

Only the IPv4 address family is currently supported.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **topology ipv4** [**multicast** | **unicast**] {*topology-name* [**disable**] | **base**}
5. **end**

DETAILED STEPS

	Command or Action	Purpose

Step 1	`enable`
	Example:
	`Router> enable`
		Enables privileged EXEC mode.
		• Enter your password if prompted.

Step 2	`configure terminal`
	Example:
	`Router# configure terminal`
		Enters global configuration mode.

Step 3	`interface` *type number* **Example:** `Router(config)# interface Ethernet 0/0`	Specifies the interface type and number, and enters interface configuration mode.

	Command or Action	Purpose

Step 4	`topology ipv4 [multicast | unicast] {topology-name [disable] | base}`
	Example:
	`Router(config-if)# topology ipv4 VOICE`
		Enters interface topology configuration mode to configure an MTR topology instance on an interface.
		• Use the **disable** keyword to disable the topology instance on the interface. This form is used to exclude a topology configuration from an interface.
		• If the **no** form of this command is used, the topology interface configuration is removed.
		• If the **no** form of this command is used with the **disable** keyword, the topology instance is enabled on the interface.

Step 5	`end`
	Example:
	`Router(config-if-topology)# end`
		Exits interface topology configuration mode, and enters privileged EXEC mode.

What to Do Next

The next three tasks show how to activate an MTR topology and various routing protocol features in interface configuration mode. Proceed to the next task for more information.

Activating an MTR Topology in Interface Configuration Mode Using OSPF

Perform this task to configure OSPF features used in MTR in interface configuration mode. Configuring a topology in interface configuration mode allows you to enable or disable MTR on per-interface basis. By default, a class-specific topology does not include any interfaces.

OSPF Interface Topology Configuration

Interface mode OSPF configurations for a class-specific topology are applied in interface topology configuration mode. In this mode, you can configure an interface cost or disable OSPF routing on the interface without removing the interface from the global topology configuration.

Prerequisites

A topology must be defined globally before per-interface topology configuration can be configured.

Restrictions

Only the IPv4 address family is currently supported.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*

4. **topology ipv4** [**multicast** | **unicast**] {*topology-name* [**disable**] | **base**}
5. **ip ospf cost** *number*
6. **ip ospf topology disable**
7. **end**
8. **show ip ospf** [*process-id*] **interface** [*interface-type interface-number*] [**brief**] [**multicast**] [**topology** {*topology-name* | **base**}]

DETAILED STEPS

	Command or Action	Purpose

Step 1	`enable`
	Example:
	`Router> enable`
		Enables privileged EXEC mode.
		• Enter your password if prompted.

Step 2	`configure terminal`
	Example:
	`Router# configure terminal`
		Enters global configuration mode.

Step 3	**`interface`** *`type number`*
	Example:
	`Router(config)# interface Ethernet 0/0`
		Specifies the interface type and number, and enters interface configuration mode.

Step 4	**`topology ipv4`** `[`**`multicast`** `|` **`unicast`**`]` `{`*`topology-name`* `[`**`disable`**`]` `|` **`base`**`}`
	Example:
	`Router(config-if)# topology ipv4 VOICE`
		Enters interface topology configuration mode to configure MTR.
		Note Entering this command with the **disable** keyword disables the topology instance on the interface. This form is used to exclude a topology configuration from an interface.

Step 5	**`ip ospf cost`** *`number`*
	Example:
	`Router(config-if-topology)# ip ospf cost 100`
		Applies a cost to the interface in a topology instance.
		• The lowest cost number has the highest preference.

Step 6	**`ip ospf topology disable`**
	Example:
	`Router(config-if-topology)# ip ospf topology disable`
		Prevents OSPF from advertising the interface as part of the topology without disabling the OSPF process or the topology on the interface.

	Command or Action	Purpose

Step 7	**end**
	Example:
	`Router(config-if-topology)# end`
		Exits interface topology configuration mode, and enters privileged EXEC mode.

Step 8	**show ip ospf** [*process-id*] **interface** [*interface-type interface-number*] [**brief**] [**multicast**] [**topology** {*topology-name* |**base**}] **Example:** `Router# show ip ospf 1 interface topology VOICE`	(Optional) Displays OSPF-related interface information. • Displays OSPF and interface information about the specified topology when the **topology** keyword is entered.

Activating an MTR Topology in Interface Configuration Mode Using EIGRP

Perform this task to configure EIGRP features used in MTR in interface configuration mode. Configuring a topology in interface configuration mode allows you enable or disable MTR on per-interface basis. By default, a class-specific topology does not include any interfaces.

EIGRP Interface Topology Configuration

Interface mode EIGRP configurations for a class-specific topology are applied in interface topology configuration mode. In this mode, you can configure various EIGRP features.

Prerequisites

IP routing and CEF must be enabled.

Restrictions

Only the IPv4 address family is currently supported.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **topology ipv4** [**multicast** | **unicast**] {*topology-name* [**disable**] | **base**}
5. **eigrp** *as-number* **delay** *value*
6. **eigrp** *as-number* **next-hop-self**
7. **eigrp** *as-number* **shutdown**
8. **eigrp** *as-number* **split-horizon**
9. **eigrp** *as-number* **summary-address** *ip-address wildcard-mask* [**distance**]
10. **end**
11. **show ip eigrp topology** *name* **interfaces**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Router(config)# interface Ethernet 0/0`	Specifies the interface type and number, and enters interface configuration mode.

Step 4	**topology ipv4** [**multicast** | **unicast**] {*topology-name* [**disable**] | **base**}
	Example:
	`Router(config-if)# topology ipv4 VOICE`
		Configures an MTR topology instance on an interface and enters interface topology configuration mode.
		Note Entering this command with the **disable** keyword disables the topology instance on the interface. This form is used to exclude a topology configuration from an interface.

Step 5	**eigrp** *as-number* **delay** *value* **Example:** `Router(config-if-topology)# eigrp 1 delay 100000`	Configures the delay value that EIGRP uses for interface metric calculation. • The *value* argument is entered in microseconds. The example configures an interface delay metric of 100 milliseconds.
Step 6	**eigrp** *as-number* **next-hop-self** **Example:** `Router(config-if-topology)# eigrp 1 next-hop-self`	Configures an EIGRP process to advertise itself as the next hop. • This command is enabled by default.
Step 7	**eigrp** *as-number* **shutdown** **Example:** `Router(config-if-topology)# eigrp 1 shutdown`	Disables an EIGRP process on the interface without disabling the global topology configuration on the interface.
Step 8	**eigrp** *as-number* **split-horizon** **Example:** `Router(config-if-topology)# eigrp 1 split-horizon`	Configures an EIGRP process to use split horizon. • This command is enabled by default.
Step 9	**eigrp** *as-number* **summary-address** *ip-address wildcard-mask* [**distance**] **Example:** `Router(config-if-topology)# eigrp 1 summary-address 10.1.1.0 0.0.0.255`	Configures an EIGRP summary address. • An administrative distance of 5 is applied to EIGRP summary routes if the distance is not specified.

	Command or Action	Purpose

Step 10	`end`
	Example:
	`Router(config-if-topology)# end`
		Exits interface topology configuration mode and enters privileged EXEC mode.

Step 11	**show ip eigrp topology** *name* interfaces **Example:** `Router# show ip eigrp topology VOICE interfaces`	Displays information about interfaces, on which EIGRP is configured, in a topology.

Activating an MTR Topology in Interface Configuration Mode Using IS-IS

Perform this task to configure IS-IS features used in MTR in interface configuration mode. Configuring a topology in interface configuration mode allows you to enable or disable MTR on per-interface basis. By default, a class-specific topology does not include any interfaces.

IS-IS Interface Topology Configuration

Interface mode IS-IS configurations for a class-specific topology are applied in interface topology configuration mode. By using the interface configuration mode, you can configure an interface cost or disable IS-IS routing on the interface without removing the interface from the global topology configuration.

Prerequisites

A topology must be defined globally before per-interface topology configuration can be configured.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ip address** *ip-address mask* [**secondary**]
5. **ip router isis** *area-tag*
6. **topology ipv4** [**multicast** | **unicast**] {*topology-name* [**disable** | **base**]}
7. **isis topology disable**
8. **topology ipv4** [**multicast** | **unicast**] {*topology-name* [**disable** | **base**]}
9. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Router(config)# interface Ethernet 2/0`	Enters interface configuration mode.
Step 4	**ip address** *ip-address mask* [**secondary**] **Example:** `Router(config-if)# ip address 192.168.7.17 255.255.255.0`	Sets a primary or secondary IP address for an interface.
Step 5	**ip router isis** [*area-tag*] **Example:** `Router(config-if)# ip router isis`	Configures an IS-IS routing process for IP on an interface and to attaches an area designator to the routing process. **Note** If a tag is not specified, a null tag is assumed and the process is referenced with a null tag.

Step 6	**topology ipv4** [**multicast** | **unicast**] {*topology-name* [**disable** | **base**]}
	Example:
	`Router(config-if)# topology ipv4 DATA`
		Configures an MTR topology instance on an interface. Enters interface topology configuration mode.
		Note In this example, the topology instance DATA is configured for an MTR network that has a global topology named DATA.

Step 7	**isis topology disable** **Example:** `Router(config-if-topology)# isis topology disable`	(Optional) Prevents an IS-IS process from advertising the interface as part of the topology. **Note** In this example, the topology instance DATA will not advertise the interface as part of the topology.

Step 8	**topology ipv4** [**multicast** | **unicast**] {*topology-name* [**disable** | **base**]}
	Example:
	`Router(config-if-topology)# topology ipv4 VOICE`
		Configures an MTR topology instance on an interface.
		Note In this example, the topology instance VOICE is configured for an MTR network that has a global topology named “VOICE”.

Step 9	**end**
	Example:
	`Router(config-if-topology)# end`
		Exits interface topology configuration mode and enters privileged EXEC mode.

Configuring SNMP Support for MTR

This section contains the following tasks:

- Associating an SNMP Context with a VRF for MTR, page 43
- Associating an SNMP Context with a Data Topology for MTR, page 44
- Associating an SNMP Context with a Routing Protocol for MTR, page 45

SNMP Context Mapping for MTR

Context-based Simple Network Management Protocol (SNMP) support has been integrated into Cisco IOS software. SNMP support for MTR leverages context-based SNMP to extend support for existing MIBs from representing the management information for just the base topology to representing the same information for multiple topologies.

The SNMP agent software component on the router can be configured to pass a context string to existing MIB access functions. Network management applications can provide these context strings in SNMP transactions to direct those transactions to a specific virtual private network (VPN) routing and forwarding (VRF) instance, a specific topology, and/or routing protocol instance. The SNMP infrastructure on the receiving router verifies that a context string is defined for the router, and that the accompanying internal identifier is defined for that context string, before passing on the context string and internal identifier to the MIB access function.

Associating an SNMP Context with a VRF for MTR

In the following task, the context name will be associated with the specified VRF.

Prerequisites

- SNMP must be enabled on the router.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip vrf** *vrf-name*
4. **snmp context** *context-name*
5. **end**
6. **show snmp context mapping**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip vrf** *vrf-name* **Example:** `Router(config)# ip vrf red`	Defines a VRF instance and enters VRF configuration mode.
Step 4	**snmp context** *context-name* **Example:** `Router(config-vrf)# snmp context comp-vrf`	Creates an SNMP context for MTR for a specific VRF.

Step 5	**end**
	Example:
	`Router(config-af-topology)# exit`
		Exits VRF configuration mode and enters privileged EXEC mode.

Step 6	**show snmp context mapping** **Example:** `Router# show snmp context mapping`	(Optional) Displays information about SNMP contexts for MTR.

Associating an SNMP Context with a Data Topology for MTR

In the following task, the context name will be associated with the specified topology.

Prerequisites

- SNMP must be enabled.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **global-address-family ipv4** [**multicast** | **unicast**]
4. **topology** {**base** | *topology-name*}
5. **snmp context** *context-name*
6. **end**
7. **show snmp context mapping**

DETAILED STEPS

	Command or Action	Purpose

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

Step 2	**`configure terminal`**
	Example:
	`Router# configure terminal`
		Enters global configuration mode.

Step 3	**`global-address-family ipv4`** `[`**`multicast`** `|` **`unicast`**`]`
	Example:
	`Router(config)# global-address-family ipv4`
		Enters global address family base topology configuration mode to configure the global topology.
		• The address family for the class-specific topology is specified in this step. The subaddress family can be optionally specified. Unicast is the default if no subaddress family is entered.

Step 4	**`topology`** `{`**`base`** `|` *`topology-name`*`}`
	Example:
	`Router(config-af)# topology VOICE`
		Configures the global topology instance and enters routing topology configuration mode.

Step 5	**`snmp context`** *`context-name`*
	Example:
	`Router(config-af-topology)# snmp context comp-topol`
		Creates an SNMP context for MTR for a specific topology.

Step 6	**`end`**
	Example:
	`Router(config-af-topology)# end`
		Exits routing topology configuration mode and enters privileged EXEC mode.

Step 7	**`show snmp context mapping`**
	Example:
	`Router# show snmp context mapping`
		(Optional) Displays information about SNMP contexts for MTR.

Associating an SNMP Context with a Routing Protocol for MTR

In the following task, the context name will be associated with the specified routing protocol instance.

Prerequisites

- SNMP must be enabled.

SUMMARY STEPS

1. **enable**
2. **configure terminal**

3. **router ospf** *process-id* [**vrf** *vrf-name*]
4. **snmp context** *context-name*
5. **address-family ipv4** [**multicast** | **unicast**]
6. **topology** {**base** | *topology-name* **tid** *number*}
7. **snmp context** *context-name*
8. **end**
9. **show snmp context mapping**

DETAILED STEPS

	Command or Action	Purpose

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

Step 2	**`configure terminal`**
	Example:
	`Router# configure terminal`
		Enters global configuration mode.

Step 3	**`router ospf`** *`process-id`* `[`**`vrf`** *`vrf-name`*`]`
	Example:
	`Router(config)# router ospf 1`
		Enables an OSPF routing process and enters router configuration mode.
		• You can configure support for multiple routing protocols.

Step 4	**`snmp context`** *`context-name`*
	Example:
	`Router(config-router)# snmp context comp-prot`
		Creates an SNMP context for MTR for a specific topology under a routing protocol.

Step 5	**`address-family ipv4`** `[`**`multicast`** `|` **`unicast`**`]`
	Example:
	`Router(config-router)# address-family ipv4`
		Enters global address family configuration mode to configure an OSPF address family session.

Step 6	**`topology`** `{`**`base`** `|` *`topology-name`* **`tid`** *`number`*`}`
	Example:
	`Router(config-router-af)# topology VOICE tid 10`
		Enters router address family topology configuration mode.

Step 7	**`snmp context`** *`context-name`*
	Example:
	`Router(config-router-af-topology)# snmp context comp-protocol`
		Creates an SNMP context for MTR for a specific topology under a routing protocol.

	Command or Action	Purpose

Step 8	**end**
	Example:
	`Router(config-router-af-topology)# end`
		Exits router address family topology configuration mode and enters privileged EXEC mode.

Step 9	**show snmp context mapping** **Example:** `Router# show snmp context mapping`	(Optional) Displays information about SNMP contexts for MTR.

Enabling and Monitoring MTR Topology Statistics Accounting

This section contains the following tasks related to managing MTR statistics:

- Enabling Topology Statistics Accounting for MTR, page 47
- Monitoring Interface and Topology IP Traffic Statistics for MTR, page 48

Enabling Topology Statistics Accounting for MTR

This section describes how to enable topology statistics accounting on all of the interfaces in the global address family for all IPv4 unicast topologies in the default VRF instance and how to enable topology accounting for all IPv4 unicast topologies in the VRF instance associated with a particular interface.

Prerequisites

- CEF must be enabled.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **global-address-family ipv4** [**multicast** | **unicast**]
4. **topology-accounting**
5. **exit**
6. **interface** *type number*
7. **ip topology-accounting**
8. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. - Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**global-address-family ipv4** [**multicast** | **unicast**] **Example:** `Router(config)# global-address-family ipv4`	Enters global address family configuration mode.
Step 4	**topology accounting** **Example:** `Router(config-af)# topology accounting`	Enables topology accounting on all of the interfaces in the global address family for all IPv4 unicast topologies in the default VRF instance.
Step 5	**exit** **Example:** `Router(config-af)# exit`	Exits global address family configuration mode.
Step 6	**interface** *type number* **Example:** `Router(config)# interface FastEthernet 1/10`	Enters interface configuration mode.
Step 7	**ip topology-accounting** **Example:** `Router(config-if)# ip topology-accounting`	Enables topology accounting for all IPv4 unicast topologies in the VPN VRF associated with a particular interface. - This topology accounting is supported only for the default VRF.

Step 8	**end**
	Example:
	`Router(config-if)# end`
		Exits interface configuration mode and enters privileged EXEC mode.

Monitoring Interface and Topology IP Traffic Statistics for MTR

This section describes how to display and clear IP traffic statistics.

SUMMARY STEPS

1. **enable**
2. **show ip interface** [*type number*] [**topology** {*name* | **all** | **base**}] [**stats**]
3. **show ip traffic** [**topology** {*name* | **all** | **base**}]

4. **clear ip interface** *type number* [**topology** {*name* | **all** | **base**}] [**stats**]
5. **clear ip traffic** [**topology** {*name* | **all** | **base}]**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**show ip interface** [*type number*] [**topology** {*name* | **all** | **base**}] [**stats**] **Example:** `Router# show ip interface FastEthernet 1/10 stats`	(Optional) Displays IP traffic statistics for all interfaces or statistics related to a particular interface. • If you specify an interface type and number, you see information for that specific interface. If you specify no optional arguments, you see information for all the interfaces. • If the **topology** *name* keyword and argument are used, then statistics are limited to the IP traffic for that specific topology. • The **base** keyword is reserved for IPv4 unicast base topology.
Step 3	**show ip traffic** [**topology** {*name* | **all** | **base**}] **Example:** `Router# show ip traffic topology VOICE`	(Optional) Displays global IP traffic statistics (an aggregation of all the topologies when MTR is enabled) or statistics related to a particular topology. • The **base** keyword is reserved for the IPv4 unicast base topology.
Step 4	**clear ip interface** *type number* [**topology** {*name* | **all** | **base**}] [**stats**] **Example:** `Router# clear ip interface FastEthernet 1/10 topology all`	(Optional) Resets interface-level IP traffic statistics. • If the **topology** keyword and a related keyword are not used, only the interface-level aggregate statistics are reset. • If all topologies need to be reset, use the **all** keyword as the topology name.
Step 5	**clear ip traffic** [**topology** {*name* | **all** | **base**}] **Example:** `Router# clear ip traffic topology all`	(Optional) Resets IP traffic statistics. • If no topology name is specified, global statistics are cleared.

Testing Network Connectivity for MTR

Ping and traceroute have been enhanced to support MTR in Cisco IOS Release 12.2(33)SRB. You can configure a standard or extended ping using the topology name in place of a hostname or IP address. Traceroute has been similarly enhanced.

SUMMARY STEPS

1. **enable**
2. **ping** [**vrf** *vrf-name* | **topology** *topology-name] protocol* [*target-address*] [*source-address*]
3. **traceroute** [**vrf** *vrf-name* | **topology** *topology-name*] [*protocol*] *destination*

DETAILED STEPS

	Command or Action	Purpose

Step 1	`enable`
	Example:
	`Router> enable`
		Enables privileged EXEC mode.
		• Enter your password if prompted.

Step 2	**`ping`** `[`**`vrf`** *`vrf-name`* `|` **`topology`** *`topology-name`*`]` *`protocol`* `[`*`target-address`*`] [`*`source-address`*`]`
	Example:
	`Router# ping topology VOICE`
		Configures the router to transmit ping messages to the target host in a topology.
		• An extended ping is configured by entering this command with only the topology name.

Step 3	**`traceroute`** `[`**`vrf`** *`vrf-name`* `|` **`topology`** *`topology-name`*`] [`*`protocol`*`]` *`destination`*
	Example:
	`Router# traceroute VOICE`
		Configures the router to trace the specified host in a topology.
		• An extended trace is configured by entering this command with only the topology name.
		• If the **vrf** *vrf-name* keyword and argument are used, the **topology** option is not displayed because only the default VRF is supported. The **topology** *topology-name* keyword and argument and the DSCP option in the extended traceroute system dialog are displayed only if there is a topology configured on the router.

Configuration Examples for Multi-Topology Routing

This section provides the following example configurations for MTR:

- Unicast Topology for MTR: Examples, page 51
- Multicast Topology for MTR: Examples, page 52
- MTR Traffic Classification: Examples, page 54
- Activating an MTR Topology Using OSPF: Examples, page 55
- Activating an MTR Topology Using EIGRP: Examples, page 56
- Activating an MTR Topology Using IS-IS: Examples, page 57
- Activating an MTR Topology Using BGP: Examples, page 59
- Importing Routes from an MTR Topology Using BGP: Example, page 61
- MTR Topology in Interface Configuration Mode: Examples, page 61
- MTR OSPF Topology in Interface Configuration Mode: Examples, page 61
- MTR EIGRP Topology in Interface Configuration Mode: Examples, page 62

- MTR IS-IS Topology in Interface Configuration Mode: Examples, page 63
- SNMP Support for MTR: Examples, page 63
- Monitoring Interface and Topology IP Traffic Statistics: Examples, page 64
- Testing Network Connectivity for MTR: Examples, page 64

Unicast Topology for MTR: Examples

The section contains the following configuration examples:

- Global Interface Configuration Example, page 51
- Incremental Forwarding Configuration Example, page 51
- Unicast Topology Verification Example, page 51

Global Interface Configuration Example

The following example shows how to create a topology instance named VOICE. This topology is configured to use all operational interfaces on the router. Per the default forwarding rule (strict), only packets destined for routes in the VOICE topology RIB are forwarded. Packets that do not have a topology-specific forwarding entry are dropped.

```
global-address-family ipv4
 topology VOICE
 all-interfaces
 end
```

Incremental Forwarding Configuration Example

The following example shows how to create a topology instance named VIDEO. This topology is configured to accept and install a maximum of 1000 routes in the VIDEO topology RIB. Incremental forwarding mode is configured so that the router forwards packets over the base topology if no forwarding entry is found in the class-specific RIB.

```
global-address-family ipv4
 topology VIDEO
 forward-base
 maximum routes 1000 90
 end
```

Unicast Topology Verification Example

The output of the **show topology detail** command displays information about class-specific and base topologies. This information includes the address family, associated interfaces, interface and topology status, topology name, and associated VRF.

```
Router# show topology detail

Topology: base
  Address-family: ipv4
  Associated VPN VRF is default
  Topology state is UP
  Associated interfaces:
    Ethernet0/0, operation state: UP
    Ethernet0/1, operation state: DOWN
    Ethernet0/2, operation state: DOWN
    Ethernet0/3, operation state: DOWN
    Loopback0, operation state: UP

Topology: VIDEO
  Address-family: ipv4
  Associated VPN VRF is default
  Topology state is UP
  Topology fallback is enabled
  Topology maximum route limit 1000, warning limit 90% (900)
  Associated interfaces:

Topology: VOICE
  Address-family: ipv4
  Associated VPN VRF is default
  Topology state is UP
  Topology is enabled on all interfaces
  Associated interfaces:
    Ethernet0/0, operation state: UP
    Ethernet0/1, operation state: DOWN
    Ethernet0/2, operation state: DOWN
    Ethernet0/3, operation state: DOWN
    Loopback0, operation state: UP

Topology: base
  Address-family: ipv4 multicast
  Associated VPN VRF is default
  Topology state is DOWN
  Route Replication Enabled:
    from unicast all
  Associated interfaces:
```

Multicast Topology for MTR: Examples

This section contains the following configuration examples:

- Route Replication Configuration Example, page 52
- Using a Unicast RIB for Multicast RPF Configuration Example, page 53
- Multicast Verification Example, page 53

Route Replication Configuration Example

The following example shows how to enable multicast support for MTR and to configure a separate multicast topology:

```
ip multicast-routing
ip multicast rpf multitopology
!
global-address-family ipv4 multicast
 topology base
 end
```

The following example shows how to configure the multicast topology to replicate OSPF routes from the VOICE topology. The routes are filtered through the BLUE route map before they are installed in the multicast routing table.

```
ip multicast-routing
ip multicast rpf multitopology
```

```
!
access-list 1 permit 192.168.1.0 0.0.0.255
!
route-map BLUE
 match ip address 1
 exit
!
global-address-family ipv4 multicast
 topology base
 route-replicate from unicast topology VOICE ospf route-map BLUE
```

Using a Unicast RIB for Multicast RPF Configuration Example

The following example shows how to configure the multicast topology to perform RPF calculations on routes in the VIDEO topology RIB to build multicast distribution trees:

```
ip multicast-routing
ip multicast rpf multitopology
!
global-address-family ipv4 multicast
 topology base
 use-topology unicast VIDEO
 end
```

Multicast Verification Example

The following example shows that the multicast topology is configured to replicate routes from the RIB of the VOICE topology:

```
Router# show topology detail

Topology: base
  Address-family: ipv4
  Associated VPN VRF is default
  Topology state is UP
  Associated interfaces:
    Ethernet0/0, operation state: UP
    Ethernet0/1, operation state: DOWN
    Ethernet0/2, operation state: DOWN
    Ethernet0/3, operation state: DOWN
    Loopback0, operation state: UP

Topology: VIDEO
  Address-family: ipv4
  Associated VPN VRF is default
  Topology state is UP
  Topology fallback is enabled
  Topology maximum route limit 1000, warning limit 90% (900)
  Associated interfaces:

Topology: VOICE
  Address-family: ipv4
  Associated VPN VRF is default
  Topology state is UP
  Topology is enabled on all interfaces
  Associated interfaces:
    Ethernet0/0, operation state: UP
    Ethernet0/1, operation state: DOWN
    Ethernet0/2, operation state: DOWN
    Ethernet0/3, operation state: DOWN
    Loopback0, operation state: UP
```

```
Topology: base
  Address-family: ipv4 multicast
  Associated VPN VRF is default
  Topology state is DOWN
  Multicast multi-topology mode is enabled.
  Route Replication Enabled:
    from unicast topology VOICE all route-map BLUE
  Associated interfaces:
```

MTR Traffic Classification: Examples

The following example shows how to configure classification and activate MTR for two topologies:

```
global-address-family ipv4
 topology VOICE
  all-interfaces
  exit
 topology VIDEO
  forward-base
  maximum routes 1000 90
  exit
 exit
class-map match-any VOICE-CLASS
 match ip dscp 9
 exit
class-map match-any VIDEO-CLASS
 match ip dscp af11
 exit
policy-map type class-routing ipv4 unicast MTR
 class VOICE-CLASS
  select-topology VOICE
  exit
 class VIDEO-CLASS
  select-topology VIDEO
  exit
 exit
global-address-family ipv4
 service-policy type class-routing MTR
end
```

The following example shows how to display detailed information about the VOICE and VIDEO topologies:

```
Router# show topology detail

Topology: base
  Address-family: ipv4
  Associated VPN VRF is default
  Topology state is UP
  Associated interfaces:
    Ethernet0/0, operation state: UP
    Ethernet0/1, operation state: DOWN
    Ethernet0/2, operation state: DOWN
    Ethernet0/3, operation state: DOWN
    Loopback0, operation state: UP

Topology: VIDEO
  Address-family: ipv4
  Associated VPN VRF is default
  Topology state is UP
  Topology fallback is enabled
  Topology maximum route limit 1000, warning limit 90% (900)
  Associated interfaces:

Topology: VOICE
  Address-family: ipv4
  Associated VPN VRF is default
  Topology state is UP
  Topology is enabled on all interfaces
  Associated interfaces:
    Ethernet0/0, operation state: UP
    Ethernet0/1, operation state: DOWN
    Ethernet0/2, operation state: DOWN
    Ethernet0/3, operation state: DOWN
    Loopback0, operation state: UP

Topology: base
  Address-family: ipv4 multicast
  Associated VPN VRF is default
  Topology state is DOWN
  Multicast multi-topology mode is enabled.
  Route Replication Enabled:
    from unicast topology VOICE all route-map BLUE
  Associated interfaces:
    Ethernet0/0, operation state: UP
    Ethernet0/1, operation state: DOWN
    Ethernet0/2, operation state: DOWN
    Ethernet0/3, operation state: DOWN
    Loopback0, operation state: UP
```

The following example shows how to display the classification values for the VOICE and VIDEO topologies:

```
Router# show mtm table

MTM Table for VRF: default, ID:0

Topology                Address Family   Associated VRF         Topo-ID

base                    ipv4              default                 0

VOICE                    ipv4             default                 2051
Classifier: ClassID:3
DSCP: cs1
DSCP: 9

VIDEO                    ipv4             default                 2054
Classifier: ClassID:4
DSCP: af11
```

Activating an MTR Topology Using OSPF: Examples

The following example shows how to configure the VOICE topology in an OSPF routing process and set the priority of the VOICE topology to the highest priority:

```
router ospf 1
 address-family ipv4
  topology VOICE tid 10
  priority 127
  end
```

In the following example, the **show ip ospf** command is used with the **topology-info** and **topology** keywords to display OSPF information about the topology named VOICE.

```
Router# show ip ospf 1 topology-info topology VOICE

OSPF Router with ID (10.0.0.1) (Process ID 1)

VOICE Topology (MTID 66)

Topology priority is 64
Redistributing External Routes from,
isis
Number of areas transit capable is 0
Initial SPF schedule delay 5000 msecs
Minimum hold time between two consecutive SPFs 10000 msecs
Maximum wait time between two consecutive SPFs 10000 msecs
Area BACKBONE(0) (Inactive)
SPF algorithm last executed 16:45:18.984 ago
SPF algorithm executed 3 times
Area ranges are
Area 1
SPF algorithm last executed 00:00:21.584 ago
SPF algorithm executed 1 times
Area ranges are
```

Activating an MTR Topology Using EIGRP: Examples

The following example shows how to activate the VIDEO topology using EIGRP:

```
router eigrp MTR
 address-family ipv4 autonomous-system 1
  network 10.0.0.0 0.0.0.255
  topology VIDEO tid 10
   redistribute connected
   end
```

The following example shows how to display the status of routing protocols configured in the VIDEO topology. EIGRP information is shown in the output.

```
Router# show ip protocols topology VIDEO

*** IP Routing is NSF aware ***

Routing Protocol is "eigrp 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Default networks flagged in outgoing updates
  Default networks accepted from incoming updates
  EIGRP metric weight K1=1, K2=0, K3=1, K4=0, K5=0
  EIGRP maximum hopcount 100
  EIGRP maximum metric variance 1
  Redistributing: eigrp 1
  EIGRP graceful-restart disabled
  EIGRP NSF-aware route hold timer is 240s
  Topologies : 100(VOICE) 0(base)

  Automatic network summarization is in effect
  Maximum path: 4
  Routing for Networks:
  Routing Information Sources:
    Gateway         Distance      Last Update
  Distance: internal 90 external 170
```

The following example shows the EIGRP routing table configured under the VIDEO topology:

```
Router# show ip eigrp topology VIDEO

EIGRP-IPv4 Topology Table for AS(1)/ID(10.1.1.2) Routing Table: VOICE

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 10.1.1.0/24, 1 successors, FD is 281600
        via Connected, Ethernet0/0
```

Activating an MTR Topology Using IS-IS: Examples

The following example shows how to configure both the MTR topologies DATA and VIDEO and IS-IS support for MTR. The DATA and VIDEO topologies are enabled on three IS-IS neighbors in a network.

Router1

```
global-address-family ipv4
 topology DATA
 topology VOICE
 end

interface Ethernet 0/0
 ip address 192.168.128.2 255.255.255.0
 ip router isis
 topology ipv4 DATA
 isis topology disable
 topology ipv4 VOICE
 end

router isis
 net 33.3333.3333.3333.00
 metric-style wide
 address-family ipv4
  topology DATA tid 100
  topology VOICE tid 200
  end
```

Router2

```
global-address-family ipv4
 topology DATA
 topology VOICE
 all-interfaces
  forward-base
  maximum routes 1000 warning-only
  shutdown
  end

interface Ethernet 0/0
 ip address 192.168.128.1 255.255.255.0
 ip router isis
 topology ipv4 DATA
  isis topology disable
  topology ipv4 VOICE
  end

interface Ethernet 1/0
 ip address 192.168.130.1 255.255.255.0
 ip router isis
 topology ipv4 DATA
  isis topology disable
  topology ipv4 VOICE
  end

router isis
 net 32.3232.3232.3232.00
 metric-style wide
 address-family ipv4
  topology DATA tid 100
  topology VOICE tid 200
  end
```

Router 3

```
global-address-family ipv4
 topology DATA
  topology VOICE
  all-interfaces
  forward-base
  maximum routes 1000 warning-only
  shutdown
  end

interface Ethernet 1/0
 ip address 192.168.131.1 255.255.255.0
 ip router isis
 topology ipv4 DATA
  isis topology disable
  topology ipv4 VOICE
  end

router isis
 net 31.3131.3131.3131.00
 metric-style wide
 address-family ipv4
  topology DATA tid 100
  topology VOICE tid 200
  end
```

Entering the **show isis neighbors detail** command verifies topology translation with the IS-IS neighbor Router1:

```
Router# show isis neighbors detail

System Id      Type Interface IP Address      State Holdtime Circuit Id
R1             L2   Et0/0     192.168.128.2   UP    28       R5.01
  Area Address(es): 33
  SNPA: aabb.cc00.1f00
  State Changed: 00:07:05
  LAN Priority: 64
  Format: Phase V
  Remote TID:  100, 200
  Local TID:   100, 200
```

Activating an MTR Topology Using BGP: Examples

This section contains the following configuration examples:

- BGP Topology Translation Configuration, page 59
- BGP Scope Global and VRF Configuration, page 59
- BGP Topology Verification, page 60

BGP Topology Translation Configuration

The following example shows how to configure 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
```

BGP Scope Global and VRF Configuration

The following example shows how to configure a global scope for a unicast topology and also for a multicast topology. After exiting the router scope configuration mode, a scope is configured for the VRF 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
```

BGP Topology Verification

The following example shows summary output for the **show ip bgp topology** command. Information is displayed about BGP neighbors configured to use the MTR topology named VIDEO.

```
Router# 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:

```
Router# 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
.
.
.
```

Importing Routes from an MTR Topology Using BGP: Example

The following example shows how to configure an access list to be used by a route map named BLUE to filter routes imported from the 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 BLUE
     end
clear ip bgp topology VIDEO 50000
```

MTR Topology in Interface Configuration Mode: Examples

The following example shows how to disable the VOICE topology on Ethernet interface 0/0.

```
interface Ethernet 0/0
 topology ipv4 VOICE disable
```

MTR OSPF Topology in Interface Configuration Mode: Examples

The following example shows how to disable OSPF routing on interface Ethernet 0/0 without removing the interface from the global topology configuration:

```
interface Ethernet 0/0
 topology ipv4 VOICE
  ip ospf cost 100
  ip ospf topology disable
  end
```

In the following example, the **show ip ospf interface** command is used with the **topology** keyword to display information about the topologies configured for OSPF in interface configuration mode.

```
Router# show ip ospf 1 interface topology VOICE

VOICE Topology (MTID 66)

Serial3/0 is up, line protocol is up
   Internet Address 10.0.0.5/30, Area 1
   Process ID 1, Router ID 44.44.44.44, Network Type POINT_TO_POINT
   Topology-MTID    Cost    Disabled    Shutdown      Topology Name
         4           77        no          no            grc
   Transmit Delay is 1 sec, State POINT_TO_POINT
   Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
     oob-resync timeout 40
     Hello due in 00:00:05
   Supports Link-local Signaling (LLS)
   Cisco NSF helper support enabled
   IETF NSF helper support enabled
   Index 1/4, flood queue length 0
   Next 0x0(0)/0x0(0)
   Last flood scan length is 1, maximum is 1
   Last flood scan time is 0 msec, maximum is 0 msec
   Neighbor Count is 1, Adjacent neighbor count is 1
     Adjacent with neighbor 10.2.2.2
   Suppress hello for 0 neighbor(s)
```

In the following example, the **show ip ospf interface** command is used with the **brief** and **topology** keywords to display information about the topologies configured for OSPF in interface configuration mode.

```
Router# show ip ospf 1 interface brief topology VOICE

VOICE Topology (MTID 66)

Interface PID Area IP Address/Mask Cost State Nbrs F/C
Se3/0 1 1 10.0.0.5/30 1 UP 0/0
Se2/0 1 1 10.0.0.1/30 1 UP 0/0
```

MTR EIGRP Topology in Interface Configuration Mode: Examples

The following example shows how to set the EIGRP delay calculation on interface Ethernet 0/0 to 100 milliseconds:

```
interface Ethernet 0/0
 topology ipv4 VOICE
  eigrp 1 delay 100000
  eigrp 1 next-hop-self
  eigrp 1 shutdown
  eigrp 1 split-horizon
  eigrp 1 summary-address 10.1.1.0 0.0.0.255
  end
```

The following example shows how to display EIGRP information about interfaces in the VOICE topology:

```
Router# show ip eigrp topology VOICE interfaces

EIGRP-IPv4 interfaces for process 1

                        Xmit Queue   Mean   Pacing Time   Multicast    Pending
Interface        Peers  Un/Reliable  SRTT   Un/Reliable   Flow Timer   Routes
Et0/0              1        0/0        20       0/2            0           0
```

The following example shows how to display EIGRP information about links in the VOICE topology:

```
Router# show ip eigrp topology VOICE detail-links

EIGRP-IPv4 Topology Table for AS(1)/ID(10.1.1.1) Routing Table: VOICE

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 10.1.1.0/24, 1 successors, FD is 25856000, serno 5
        via Connected, Ethernet0/0
```

MTR IS-IS Topology in Interface Configuration Mode: Examples

The following example shows how to prevent the IS-IS process from advertising interface Ethernet 1/0 as part of the DATA topology:

```
interface Ethernet 1/0
 ip address 192.168.130.1 255.255.255.0
 ip router isis
 topology ipv4 DATA
  isis topology disable
  topology ipv4 VOICE
  end
```

SNMP Support for MTR: Examples

In the following example, the context string “context-vrfA” is configured to be associated with vrfA and will be passed on to the MIB access function during SNMP transactions:

```
snmp-server community public
ip vrf vrfA
 snmp context context-vrfA
 exit
```

In the following example, the context string “context-voice” is configured to be associated with the data topology named voice and will be passed on to the MIB access function during SNMP transactions:

```
global-address-family ipv4
 topology voice
  snmp context context-voice
  exit
```

In the following example, the context strings “context-ospf” and “context-voice” are configured to be associated with the OSPF process and topology named voice and will be passed on to the MIB access function during SNMP transactions:

```
router ospf 3
 snmp context context-ospf
 address-family ipv4
 topology voice tid 10
  snmp context ospf-voice
  end
```

The following example shows how the context strings are mapped to the specified VRF, address family, topology, or protocol instance:

```
Router# show snmp context mapping

Context: ospf-voice
  VRF Name:
  Address Family Name: ipv4
  Topology Name: voice
  Protocol Instance: OSPF-3 Router

Context: context-ospf
  VRF Name:
  Address Family Name:
  Topology Name:
  Protocol Instance: OSPF-3 Router

Context: context-vrfA
  VRF Name: vrfA
  Address Family Name:
  Topology Name:
  Protocol Instance:

Context: context-voice
  VRF Name:
  Address Family Name: ipv4
  Topology Name: voice
  Protocol Instance:
```

Monitoring Interface and Topology IP Traffic Statistics: Examples

In the following example, the **show ip interface** command is used with the *type number* arguments to display IP traffic statistics for the Fast Ethernet interface 1/10:

```
Router# show ip interface FastEthernet 1/10 stats

FastEthernet1/10
    5 minutes input rate 0 bits/sec, 0 packet/sec,
    5 minutes output rate 0 bits/sec, 0 packet/sec,
    201 packets input, 16038 bytes
    588 packets output, 25976 bytes
```

In this example, the **show ip traffic** command is used with the **topology** *instance* keyword and argument to display statistics related to a particular topology:

```
Router# show ip traffic topology VOICE

  Topology: VOICE
  5 minute input rate 0 bits/sec, 0 packet/sec,
  5 minute output rate 0 bits/sec, 0 packet/sec,
  100 packets input, 6038 bytes,
  88 packets output, 5976 bytes.
```

Testing Network Connectivity for MTR: Examples

The following example shows how to send a ping to the 10.1.1.2 neighbor in the VOICE topology:

```
Router# ping topology VOICE 10.1.1.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/4 ms
```

The following example shows how to trace the 10.1.1.4 host in the VOICE topology:

```
Router# traceroute VOICE ip 10.1.1.4

Type escape sequence to abort.
Tracing the route to 10.1.1.4

  1 10.1.1.2 4 msec *  0 msec
  2 10.1.1.3 4 msec *  2 msec
  3 10.1.1.4 4 msec *  4 msec
```

Additional References

The following sections provide references related to MTR.

Related Documents

Related Topic	Document Title
MTR commands: complete command syntax, command modes, command history, defaults, usage guidelines, and examples	*Cisco IOS Multi-Topology Routing Command Reference*
IP routing protocol commands: complete command syntax, command modes, command history, defaults, usage guidelines, and examples	*Cisco IOS IP Routing Protocols Command Reference*
IP multicast commands: complete command syntax, command modes, command history, defaults, usage guidelines, and examples	*Cisco IOS IP Multicast Command Reference*
QoS commands: complete command syntax, command modes, command history, defaults, usage guidelines, and examples	*Cisco IOS IP Quality of Service Solutions Command Reference*
IP routing protocols concepts and tasks	*Cisco IOS IP Routing Protocols Configuration Guide*
IP multicast concepts and tasks	*Cisco IOS IP Multicast Configuration Guide*
QoS concepts and tasks	*Cisco IOS Quality of Service Solutions Configuration Guide*
Configuring Multitopology IS-IS for IPv6	"Implementing IS-IS for IPv6" module in the *Cisco IOS IPv6 Configuration Library*
Cisco IOS In Service Software Upgrade Process	*Cisco IOS In Service Software Upgrade Process* module

Standards

Standard	Title
No new or modified standards are supported, and support for existing standards has not been modified.	—

MIBs

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

RFCs

RFC	Title
No new or modified RFCs are supported, and support for existing RFCs has not been modified.	—

Technical Assistance

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

Feature Information for Multi-Topology Routing

Table 1 lists the features in this module and provides links to specific configuration information. Only features that were introduced or modified in 12.2(33)SRB or a later release appear in the table.

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 Feature Information for Multi-Topology Routing

Feature Name	Releases	Feature Information
Multi-Topology Routing	12.2(33)SRB	MTR introduces the capability to configure service differentiation through class-based forwarding. MTR provides multiple logical topologies over a single physical network. Service differentiation can be achieved by forwarding different traffic types over different logical topologies that could take different paths to the same destination. MTR can be used, for example, to define separate topologies for voice, video, and data traffic classes. The following commands were introduced or modified: **all-interfaces**, **clear ip interface**, **clear ip route topology**, **clear ip traffic**, **debug topology**, **exit-global-af**, **exit-if-topology**, **exit-topo**, **forward-base**, **global-address-family ipv4**, **ip route topology**, **ip topology accounting**, **maximum routes**, **ping**, **route replicate**, **show ip interface**, **show ip protocols topology**, **show ip route topology**, **show ip static route**, **show ip static route summary**, **show ip traffic**, **show topology**, **shutdown**, **topology**, **topology accounting**, **traceroute**.
BGP Support for MTR	12.2(33)SRB	This feature provides BGP support for multiple logical topologies over a single physical network. The following sections provide information about this feature: • BGP Routing Protocol Support for MTR, page 8 • Activating an MTR Topology Using BGP, page 28 • Importing Routes from an MTR Topology Using BGP, page 32 • Activating an MTR Topology Using BGP: Examples, page 59 • Importing Routes from an MTR Topology Using BGP: Example, page 61 The following commands were introduced or modified: **address-family ipv4**, **bgp tid**, **clear ip bgp topology**, **import topology**, **neighbor translate-topology**, **neighbor transport**, **show ip bgp topology**, **scope**, **topology**,

Table 1 Feature Information for Multi-Topology Routing (continued)

Feature Name	Releases	Feature Information
EIGRP Support for MTR	12.2(33)SRB	This feature provides EIGRP support for multiple logical topologies over a single physical network. The following sections provide information about this feature: • Routing Protocol Support for MTR, page 7 • Activating an MTR Topology Using EIGRP, page 24 • Activating an MTR Topology in Interface Configuration Mode Using EIGRP, page 39 • Activating an MTR Topology Using EIGRP: Examples, page 56 • MTR EIGRP Topology in Interface Configuration Mode: Examples, page 62 The following commands were introduced or modified: **address-family ipv4**, **eigrp delay**, **clear ip eigrp neighbor**, **eigrp next-hop-self**, **eigrp shutdown**, **eigrp split-horizon**, **eigrp summary-address**, **router eigrp**, **show ip eigrp topology**, **topology**.
IS-IS Support for MTR	12.2(33)SRB	This feature provides IS-IS support for multiple logical topologies over a single physical network. The following sections provide information about this feature: • Routing Protocol Support for MTR, page 7 • Activating an MTR Topology Using IS-IS, page 26 • Activating an MTR Topology in Interface Configuration Mode Using IS-IS, page 41 • Activating an MTR Topology Using IS-IS: Examples, page 57 • MTR IS-IS Topology in Interface Configuration Mode: Examples, page 63 The following commands were introduced or modified: **address-family ipv4**, **isis topology disable**, **show isis neighbors**, **topology**,
ISSU—MTR	12.2(33)SRB1	All protocols and applications that support MTR and also support ISSU have extended their ISSU support to include the MTR functionality. The following section provides information about this feature: • ISSU—MTR, page 10 No commands were introduced or modified in this feature.

Table 1 Feature Information for Multi-Topology Routing (continued)

Feature Name	Releases	Feature Information
MTR Support for Multicast	12.2(33)SRB 15.0(1)M	This feature provides MTR support for multicast and allows the user to control the path of multicast traffic in the network. The following sections provide information about this feature: • Multicast Topology Configuration for MTR, page 6 • Configuring a Multicast Topology for MTR, page 16 • Multicast Topology for MTR: Examples, page 52 The following commands were introduced or modified: **clear ip route multicast**, **ip multicast rpf multitopology**, **show ip route multicast**, **use-topology**.
OSPF Support for MTR	12.2(33)SRB	This feature provides OSPF support for multiple logical topologies over a single physical network. The following sections provide information about this feature: • Routing Protocol Support for MTR, page 7 • Activating an MTR Topology Using OSPF, page 22 • Activating an MTR Topology in Interface Configuration Mode Using OSPF, page 37 • Activating an MTR Topology Using OSPF: Examples, page 55 • MTR OSPF Topology in Interface Configuration Mode: Examples, page 61 The following commands were introduced or modified: **address-family ipv4**, **area capability default-exclusion**, **ip ospf cost**, **ip ospf topology disable**, **priority**, **router ospf**, **show ip ospf interface**, **show ip ospf topology-info**, **topology**.

Table 1 Feature Information for Multi-Topology Routing (continued)

Feature Name	Releases	Feature Information
QoS/MQC Support for MTR	12.2(33)SRB	This feature enables MTR traffic classification. Traffic classification is used to associate different classes of traffic with different topologies when multiple topologies are configured on the same router. A subset of DSCP bits is used to encode classification values in the IP packet header and mark the packet for classification. When MTR traffic classification is enabled, MTR is activated and ready for the routing protocols to start contributing to the topologies. The following sections provide information about this feature: • MTR Traffic Classification, page 9 • Configuring MTR Traffic Classification, page 19 • MTR Traffic Classification: Examples, page 54 The following commands were introduced or modified: **policy-map type class-routing ipv4 unicast**, **select topology**, **service-policy type class-routing**, **show mtm table**, **show policy-map type class-routing ipv4 unicast**.
SNMP Support for MTR	12.2(33)SRB 12.2(33)SB	Context-based SNMP functionality has been integrated into Cisco IOS software and can be used to support MTR. SNMP support for MTR leverages context-based SNMP to extend support for existing MIBs from representing the management information for just the base topology to representing the same information for multiple topologies. The following sections provide information about this feature: • Network Management Support for MTR, page 10 • Configuring SNMP Support for MTR, page 43 • SNMP Support for MTR: Examples, page 63 The following commands were introduced or modified: **show snmp context mapping**, **snmp context**.

Glossary

base topology—The entire network for which the usual set of routes are calculated. This topology is the same as the default global routing table that exists today without MTR being used.

class-specific topology—New topologies that are defined over and above the existing base topology; each class-specific topology is represented by its own RIB and FIB.

classification—Selection and matching of traffic that needs to be provided with a different treatment based on its mark. Classification is a read-only operation.

DSCP—DiffServ Code Point. Six bits in the ToS. (Two bits are now used for Explicit Congestion Notification.) These are the bits used to mark the packet.

incremental forwarding mode—Incremental forwarding mode is designed to support transitional or incremental deployment of MTR, where there are routers in the network that are not MTR enabled. In this mode, the router will look for a forwarding entry first in the class-specific FIB. If an entry is not found, the router will then look for the longest match in the base topology FIB. If an entry is found in the base topology FIB, the packet will be forwarded on the base topology. If a forwarding entry is not found in the base topology FIB, the packet is dropped.

marking—Setting a value in the packet or frame. Marking is a read and write operation.

multi-topology—Multi-topology means that each topology will route/forward a subset of the traffic as defined by the classification criteria.

NLRI—Network Layer Reachability Information.

strict forwarding mode—Strict forwarding mode is the default forwarding mode for MTR. Only routes in the topology specific routing table are considered. Among these, the longest match for the destination address is used. If no route containing the destination address can be found in the topology specific table, the packet is dropped.

TID—Topology Identifier. Each topology is configured with a unique topology ID. The topology ID is configured under the routing protocol and is used to identify and group NLRI for each topology in updates for a given protocol.

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.