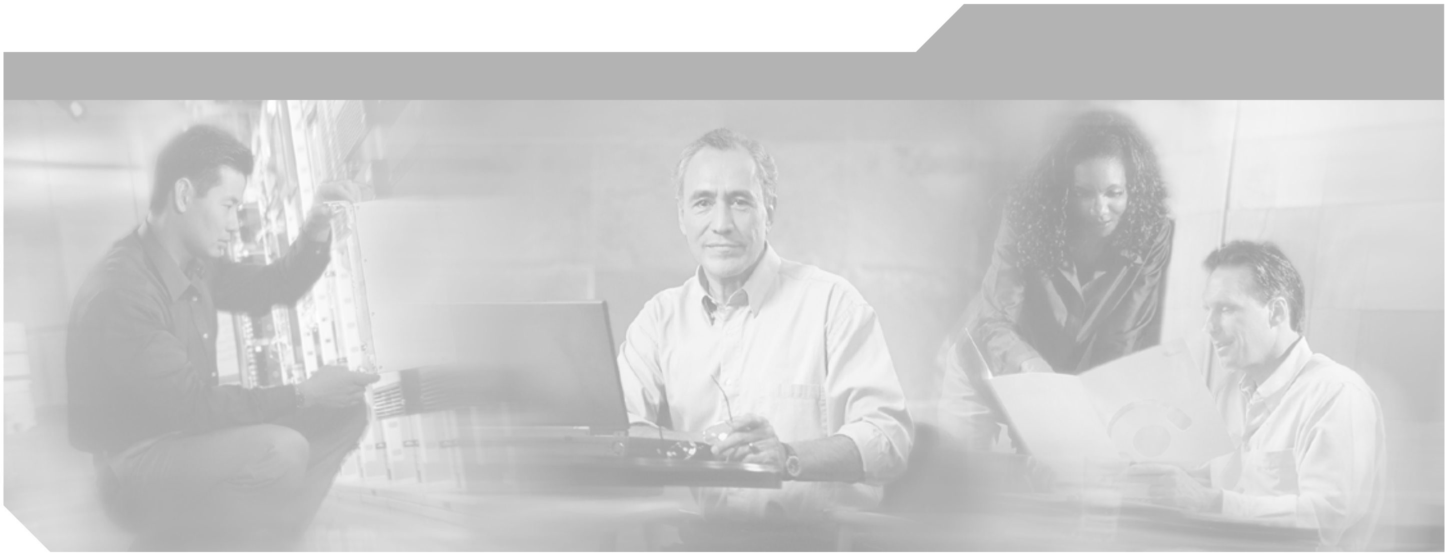

Cisco IOS Network Management Configuration Guide

Release 12.4

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Cisco IOS Network Management Configuration Guide

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About Cisco IOS Software Documentation for Release 12.4

This chapter describes the objectives, audience, organization, and conventions of Cisco IOS software documentation. It also provides sources for obtaining documentation, technical assistance, and additional publications and information from Cisco Systems. It contains the following sections:

Documentation Objectives

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

Audience

The Cisco IOS software documentation set is intended primarily 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 software commands necessary to perform particular tasks. The Cisco IOS software 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 software release.

Documentation Organization for Cisco IOS Release 12.4

The Cisco IOS Release 12.4 documentation set consists of the configuration guide and command reference pairs listed in Table 1 and the supporting documents listed in Table 2. The configuration guides and command references are organized by technology. For the configuration guides:

- Some technology documentation, such as that for DHCP, contains features introduced in Releases 12.2T and 12.3T and, in some cases, Release 12.2S. To assist you in finding a particular feature, a roadmap document is provided.
- Other technology documentation, such as that for OSPF, consists of a chapter and accompanying Release 12.2T and 12.3T feature documents.

Note In some cases, information contained in Release 12.2T and 12.3T feature documents augments or supersedes content in the accompanying documentation. Therefore it is important to review all feature documents for a particular technology.

Table 1 lists the Cisco IOS Release 12.4 configuration guides and command references.

Table 1 Cisco IOS Release 12.4 Configuration Guides and Command References

Configuration Guide and Command Reference Titles	Description
IP	
Cisco IOS IP Addressing Services Configuration Guide, Release 12.4 *Cisco IOS IP Addressing Services Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to configuring IP addressing and services, including Network Address Translation (NAT), Domain Name System (DNS), and Dynamic Host Configuration Protocol (DHCP). The command reference provides detailed information about the commands used in the configuration guide.
Cisco IOS IP Application Services Configuration Guide, Release 12.4 *Cisco IOS IP Application Services Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to configuring IP application services, including IP access lists, Web Cache Communication Protocol (WCCP), Gateway Load Balancing Protocol (GLBP), Server Load Balancing (SLB), Hot Standby Router Protocol (HSRP), and Virtual Router Redundancy Protocol (VRRP). The command reference provides detailed information about the commands used in the configuration guide.
Cisco IOS IP Mobility Configuration Guide, Release 12.4 *Cisco IOS IP Mobility Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to configuring Mobile IP and Cisco Mobile Networks. The command reference provides detailed information about the commands used in the configuration guide.
Cisco IOS IP Multicast Configuration Guide, Release 12.4 *Cisco IOS IP Multicast Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to configuring IP multicast, including Protocol Independent Multicast (PIM), Internet Group Management Protocol (IGMP), Distance Vector Multicast Routing Protocol (DVMRP), and Multicast Source Discovery Protocol (MSDP). The command reference provides detailed information about the commands used in the configuration guide.
Cisco IOS IP Routing Protocols Configuration Guide, Release 12.4 *Cisco IOS IP Routing Protocols Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to configuring IP routing protocols, including Border Gateway Protocol (BGP), Intermediate System-to-Intermediate System (IS-IS), and Open Shortest Path First (OSPF). The command reference provides detailed information about the commands used in the configuration guide.

Table 1 Cisco IOS Release 12.4 Configuration Guides and Command References (continued)

Configuration Guide and Command Reference Titles	Description
Cisco IOS IP Switching Configuration Guide, Release 12.4 *Cisco IOS IP Switching Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to configuring IP switching features, including Cisco Express Forwarding, fast switching, and Multicast Distributed Switching (MDS). The command reference provides detailed information about the commands used in the configuration guide.
Cisco IOS IPv6 Configuration Guide, Release 12.4 *Cisco IOS IPv6 Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to configuring IP version 6 (IPv6), including IPv6 broadband access, IPv6 data-link layer, IPv6 multicast routing, IPv6 quality of service (QoS), IPv6 routing, IPv6 services and management, and IPv6 tunnel services. The command reference provides detailed information about the commands used in the configuration guide.
Cisco IOS Optimized Edge Routing Configuration Guide, Release 12.4 *Cisco IOS Optimized Edge Routing Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to configuring Optimized Edge Routing (OER) features, including OER prefix learning, OER prefix monitoring, OER operational modes, and OER policy configuration. The command reference provides detailed information about the commands used in the configuration guide.
Security and VPN	
Cisco IOS Security Configuration Guide, Release 12.4 *Cisco IOS Security Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to configuring various aspects of security, including terminal access security, network access security, accounting, traffic filters, router access, and network data encryption with router authentication. The command reference provides detailed information about the commands used in the configuration guide.
QoS	
Cisco IOS Quality of Service Solutions Configuration Guide, Release 12.4 *Cisco IOS Quality of Service Solutions Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to configuring quality of service (QoS) features, including traffic classification and marking, traffic policing and shaping, congestion management, congestion avoidance, and signaling. The command reference provides detailed information about the commands used in the configuration guide.
LAN Switching	
Cisco IOS LAN Switching Configuration Guide, Release 12.4 *Cisco IOS LAN Switching Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to local-area network (LAN) switching features, including configuring routing between virtual LANs (VLANs) using Inter-Switch Link (ISL) encapsulation, IEEE 802.10 encapsulation, and IEEE 802.1Q encapsulation. The command reference provides detailed information about the commands used in the configuration guide.
Multiprotocol Label Switching (MPLS)	
Cisco IOS Multiprotocol Label Switching Configuration Guide, Release 12.4 *Cisco IOS Multiprotocol Label Switching Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to configuring Multiprotocol Label Switching (MPLS), including MPLS Label Distribution Protocol, MPLS traffic engineering, and MPLS Virtual Private Networks (VPNs). The command reference provides detailed information about the commands used in the configuration guide.
Network Management	
Cisco IOS IP SLAs Configuration Guide, Release 12.4 *Cisco IOS IP SLAs Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to configuring the Cisco IOS IP Service Level Assurances (IP SLAs) feature. The command reference provides detailed information about the commands used in the configuration guide.

Table 1 Cisco IOS Release 12.4 Configuration Guides and Command References (continued)

Configuration Guide and Command Reference Titles	Description
Cisco IOS NetFlow Configuration Guide, Release 12.4 *Cisco IOS NetFlow Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to NetFlow features, including configuring NetFlow to analyze network traffic data, configuring NetFlow aggregation caches and export features, and configuring Simple Network Management Protocol (SNMP) and NetFlow MIB features. The command reference provides detailed information about the commands used in the configuration guide.
Cisco IOS Network Management Configuration Guide, Release 12.4 *Cisco IOS Network Management Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to network management features, including performing basic system management, performing troubleshooting and fault management, configuring Cisco Discovery Protocol, configuring Cisco Networking Services (CNS), configuring DistributedDirector, and configuring Simple Network Management Protocol (SNMP). The command reference provides detailed information about the commands used in the configuration guide.
Voice	
Cisco IOS Voice Configuration Library, Release 12.4 *Cisco IOS Voice Command Reference*, Release 12.4	The configuration library is a task-oriented collection of configuration guides, application guides, a troubleshooting guide, feature documents, a library preface, a voice glossary, and more. It also covers Cisco IOS support for voice call control protocols, interoperability, physical and virtual interface management, and troubleshooting. In addition, the library includes documentation for IP telephony applications. The command reference provides detailed information about the commands used in the configuration library.
Wireless/Mobility	
Cisco IOS Mobile Wireless Gateway GPRS Support Node Configuration Guide, Release 12.4 *Cisco IOS Mobile Wireless Gateway GPRS Support Node Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to understanding and configuring a Cisco IOS Gateway GPRS Support Node (GGSN) in a 2.5G General Packet Radio Service (GPRS) and 3G Universal Mobile Telecommunication System (UMTS) network. The command reference provides detailed information about the commands used in the configuration guide.
Cisco IOS Mobile Wireless Home Agent Configuration Guide, Release 12.4 *Cisco IOS Mobile Wireless Home Agent Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to understanding and configuring the Cisco Mobile Wireless Home Agent, which is an anchor point for mobile terminals for which Mobile IP or Proxy Mobile IP services are provided. The command reference provides detailed information about the commands used in the configuration guide.
Cisco IOS Mobile Wireless Packet Data Serving Node Configuration Guide, Release 12.4 *Cisco IOS Mobile Wireless Packet Data Serving Node Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to understanding and configuring the Cisco Packet Data Serving Node (PDSN), a wireless gateway between the mobile infrastructure and standard IP networks that enables packet data services in a Code Division Multiple Access (CDMA) environment. The command reference provides detailed information about the commands used in the configuration guide.

Table 1 Cisco IOS Release 12.4 Configuration Guides and Command References (continued)

Configuration Guide and Command Reference Titles	Description
Cisco IOS Mobile Wireless Radio Access Networking Configuration Guide, Release 12.4 *Cisco IOS Mobile Wireless Radio Access Networking Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to understanding and configuring Cisco IOS Radio Access Network products. The command reference provides detailed information about the commands used in the configuration guide.
Long Reach Ethernet (LRE) and Digital Subscriber Line (xDSL)	
Cisco IOS Broadband and DSL Configuration Guide, Release 12.4 *Cisco IOS Broadband and DSL Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to configuring broadband access aggregation and digital subscriber line features. The command reference provides detailed information about the commands used in the configuration guide.
Cisco IOS Service Selection Gateway Configuration Guide, Release 12.4 *Cisco IOS Service Selection Gateway Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to configuring Service Selection Gateway (SSG) features, including subscriber authentication, service access, and accounting. The command reference provides detailed information about the commands used in the configuration guide.
Dial—Access	
Cisco IOS Dial Technologies Configuration Guide, Release 12.4 *Cisco IOS Dial Technologies Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to configuring lines, modems, and ISDN services. This guide also contains information about configuring dialup solutions, including solutions for remote sites dialing in to a central office, Internet service providers (ISPs), ISP customers at home offices, enterprise WAN system administrators implementing dial-on-demand routing, and other corporate environments. The command reference provides detailed information about the commands used in the configuration guide.
Cisco IOS VPDN Configuration Guide, Release 12.4 *Cisco IOS VPDN Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to configuring Virtual Private Dialup Networks (VPDNs), including information about Layer 2 tunneling protocols, client-initiated VPDN tunneling, NAS-initiated VPDN tunneling, and multihop VPDN. The command reference provides detailed information about the commands used in the configuration guide.
Asynchronous Transfer Mode (ATM)	
Cisco IOS Asynchronous Transfer Mode Configuration Guide, Release 12.4 *Cisco IOS Asynchronous Transfer Mode Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to configuring Asynchronous Transfer Mode (ATM), including WAN ATM, LAN ATM, and multiprotocol over ATM (MPOA). The command reference provides detailed information about the commands used in the configuration guide.
WAN	
Cisco IOS Wide-Area Networking Configuration Guide, Release 12.4 *Cisco IOS Wide-Area Networking Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to configuring wide-area network (WAN) features, including Layer 2 Tunneling Protocol Version 3 (L2TPv3); Frame Relay; Link Access Procedure, Balanced (LAPB); and X.25. The command reference provides detailed information about the commands used in the configuration guide.

Table 1 Cisco IOS Release 12.4 Configuration Guides and Command References (continued)

Configuration Guide and Command Reference Titles	Description
System Management	
Cisco IOS Configuration Fundamentals Configuration Guide, Release 12.4 *Cisco IOS Configuration Fundamentals Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to using Cisco IOS software to configure and maintain Cisco routers and access servers, including information about using the Cisco IOS command-line interface (CLI), loading and maintaining system images, using the Cisco IOS file system, using the Cisco IOS Web browser user interface (UI), and configuring basic file transfer services. The command reference provides detailed information about the commands used in the configuration guide.
Cisco IOS Interface and Hardware Component Configuration Guide, Release 12.4 *Cisco IOS Interface and Hardware Component Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to configuring and managing interfaces and hardware components, including dial shelves, LAN interfaces, logical interfaces, serial interfaces, and virtual interfaces. The command reference provides detailed information about the commands used in the configuration guide.
IBM Technologies	
Cisco IOS Bridging and IBM Networking Configuration Guide, Release 12.4 *Cisco IOS Bridging Command Reference*, Release 12.4 *Cisco IOS IBM Networking Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to configuring: • Bridging features, including transparent and source-route transparent (SRT) bridging, source-route bridging (SRB), Token Ring Inter-Switch Link (TRISL), and Token Ring Route Switch Module (TRRSM). • IBM network features, including data-link switching plus (DLSw+), serial tunnel (STUN), and block serial tunnel (BSTUN); Logical Link Control, type 2 (LLC2), and Synchronous Data Link Control (SDLC); IBM Network Media Translation, including SDLC Logical Link Control (SDLLC) and Qualified Logical Link Control (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. The two command references provide detailed information about the commands used in the configuration guide.
Additional and Legacy Protocols	
Cisco IOS AppleTalk Configuration Guide, Release 12.4 *Cisco IOS AppleTalk Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to configuring the AppleTalk protocol. The command reference provides detailed information about the commands used in the configuration guide.
Cisco IOS DECnet Configuration Guide, Release 12.4 *Cisco IOS DECnet Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to configuring the DECnet protocol. The command reference provides detailed information about the commands used in the configuration guide.
Cisco IOS ISO CLNS Configuration Guide, Release 12.4 *Cisco IOS ISO CLNS Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to configuring International Organization for Standardization (ISO) Connectionless Network Service (CLNS). The command reference provides detailed information about the commands used in the configuration guide.

Table 1 Cisco IOS Release 12.4 Configuration Guides and Command References (continued)

Configuration Guide and Command Reference Titles	Description
Cisco IOS Novell IPX Configuration Guide, Release 12.4 *Cisco IOS Novell IPX Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to configuring the Novell Internetwork Packet Exchange (IPX) protocol. The command reference provides detailed information about the commands used in the configuration guide.
Cisco IOS Terminal Services Configuration Guide, Release 12.4 *Cisco IOS Terminal Services Command Reference*, Release 12.4	The configuration guide is a task-oriented guide to configuring terminal services, including DEC, local-area transport (LAT), and X.25 packet assembler/disassembler (PAD). The command reference provides detailed information about the commands used in the configuration guide.

Table 2 lists the documents and resources that support the Cisco IOS Release 12.4 software configuration guides and command references.

Table 2 Cisco IOS Release 12.4 Supporting Documents and Resources

Document Title	Description
Cisco IOS Master Commands List, Release 12.4	An alphabetical listing of all the commands documented in the Cisco IOS Release 12.4 command references.
Cisco IOS New, Modified, Replaced, and Removed Commands, Release 12.4	A listing of all the new, modified, replaced and removed commands since Cisco IOS Release 12.3, grouped by Release 12.3T maintenance release and ordered alphabetically within each group.
Cisco IOS New and Modified Commands, Release 12.3	A listing of all the new, modified, and replaced commands since Cisco IOS Release 12.2, grouped by Release 12.2T maintenance release and ordered alphabetically within each group.
Cisco IOS System Messages, Volume 1 of 2 *Cisco IOS System Messages, Volume 2 of 2*	Listings and descriptions of Cisco IOS system messages. Not all system messages indicate problems with your system. Some are purely informational, and others may help diagnose problems with communications lines, internal hardware, or the system software.
Cisco IOS Debug Command Reference, Release 12.4	An alphabetical listing of the **debug** commands and their descriptions. Documentation for each command includes a brief description of its use, command syntax, and usage guidelines.
Release Notes, Release 12.4	A description of general release information, including information about supported platforms, feature sets, platform-specific notes, and Cisco IOS software defects.
Internetworking Terms and Acronyms	Compilation and definitions of the terms and acronyms used in the internetworking industry.

Table 2 Cisco IOS Release 12.4 Supporting Documents and Resources (continued)

Document Title	Description
RFCs	RFCs are standards documents maintained by the Internet Engineering Task Force (IETF). Cisco IOS software documentation references supported RFCs when applicable. The full text of referenced RFCs may be obtained at the following URL: http://www.rfc-editor.org/
MIBs	MIBs are used for network monitoring. 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

Document Conventions

Within Cisco IOS software documentation, the term *router* is generally used to refer to a variety of Cisco products (for example, routers, access servers, and switches). Routers, access servers, and other networking devices that support Cisco IOS software are shown interchangeably within examples. These products are used only for illustrative purposes; that is, an example that shows one product does not necessarily indicate that other products are not supported.

The Cisco IOS documentation set uses the following conventions:

Convention	Description
^ or Ctrl	The ^ and Ctrl symbols represent the Control key. For example, the key combination ^D or Ctrl-D means 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 an SNMP community string to *public*, do not use quotation marks around the string or the string will include the quotation marks.

Command syntax descriptions use the following conventions:

Convention	Description
bold	Bold text indicates commands and keywords that you enter literally as shown.
italics	Italic text indicates arguments for which you supply values.
[x]	Square brackets enclose an optional element (keyword or argument).
|	A vertical line indicates a choice within an optional or required set of keywords or arguments.
[x | y]	Square brackets enclosing keywords or arguments separated by a vertical line indicate an optional choice.
{x | y}	Braces enclosing keywords or arguments separated by a vertical line indicate a required choice.

Nested sets of square brackets or braces indicate optional or required choices within optional or required elements. For example:

Convention	Description
[x {y | z}]	Braces and a vertical line within square brackets indicate a required choice within an optional element.

Examples use the following conventions:

Convention	Description
`screen`	Examples of information displayed on the screen are set in Courier font.
`bold screen`	Examples of text that you must enter are set in Courier bold font.
< >	Angle brackets enclose text that is not printed to the screen, such as passwords, and are used in contexts in which the italic document convention is not available, such as ASCII text.
!	An exclamation point at the beginning of a line indicates a comment line. (Exclamation points are also displayed by the Cisco IOS software for certain processes.)
[ ]	Square brackets enclose default responses to system prompts.

The following conventions are used to attract the attention of the reader:

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 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.

Obtaining Documentation

Cisco documentation and additional literature are available on Cisco.com. Cisco also provides several ways to obtain technical assistance and other technical resources. These sections explain how to obtain technical information from Cisco Systems.

Cisco.com

You can access the most current Cisco documentation and technical support at this URL:

http://www.cisco.com/techsupport

You can access the Cisco website at this URL:

http://www.cisco.com

You can access international Cisco websites at this URL:

http://www.cisco.com/public/countries_languages.shtml

Product Documentation DVD

Cisco documentation and additional literature are available in the Product Documentation DVD package, which may have shipped with your product. The Product Documentation DVD is updated regularly and may be more current than printed documentation.

The Product Documentation DVD is a comprehensive library of technical product documentation on portable media. The DVD enables you to access multiple versions of hardware and software installation, configuration, and command guides for Cisco products and to view technical documentation in HTML. With the DVD, you have access to the same documentation that is found on the Cisco website without being connected to the Internet. Certain products also have .pdf versions of the documentation available.

The Product Documentation DVD is available as a single unit or as a subscription. Registered Cisco.com users (Cisco direct customers) can order a Product Documentation DVD (product number DOC-DOCDVD=) from Cisco Marketplace at this URL:

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

Ordering Documentation

Beginning June 30, 2005, registered Cisco.com users may order Cisco documentation at the Product Documentation Store in the Cisco Marketplace at this URL:

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

Nonregistered Cisco.com users can order technical documentation from 8:00 a.m. to 5:00 p.m. (0800 to 1700) PDT by calling 1 866 463-3487 in the United States and Canada, or elsewhere by calling 011 408 519-5055. You can also order documentation by e-mail at tech-doc-store-mkpl@external.cisco.com or by fax at 1 408 519-5001 in the United States and Canada, or elsewhere at 011 408 519-5001.

Documentation Feedback

You can rate and provide feedback about Cisco technical documents by completing the online feedback form that appears with the technical documents on Cisco.com.

You can send comments about Cisco documentation to bug-doc@cisco.com.

You can submit comments by using the response card (if present) behind the front cover of your document or by writing to the following address:

Cisco Systems
Attn: Customer Document Ordering
170 West Tasman Drive
San Jose, CA 95134-9883

We appreciate your comments.

Cisco Product Security Overview

Cisco provides a free online Security Vulnerability Policy portal at this URL:

http://www.cisco.com/en/US/products/products_security_vulnerability_policy.html

From this site, you can perform these tasks:

- Report security vulnerabilities in Cisco products.
- Obtain assistance with security incidents that involve Cisco products.
- Register to receive security information from Cisco.

A current list of security advisories and notices for Cisco products is available at this URL:

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

If you prefer to see advisories and notices as they are updated in real time, you can access a Product Security Incident Response Team Really Simple Syndication (PSIRT RSS) feed from this URL:

http://www.cisco.com/en/US/products/products_psirt_rss_feed.html

Reporting Security Problems in Cisco Products

Cisco is committed to delivering secure products. We test our products internally before we release them, and we strive to correct all vulnerabilities quickly. If you think that you might have identified a vulnerability in a Cisco product, contact PSIRT:

- Emergencies—security-alert@cisco.com

  An emergency is either a condition in which a system is under active attack or a condition for which a severe and urgent security vulnerability should be reported. All other conditions are considered nonemergencies.
- Nonemergencies—psirt@cisco.com

In an emergency, you can also reach PSIRT by telephone:

- 1 877 228-7302
- 1 408 525-6532

Tip We encourage you to use Pretty Good Privacy (PGP) or a compatible product to encrypt any sensitive information that you send to Cisco. PSIRT can work from encrypted information that is compatible with PGP versions 2.*x* through 8.*x*.

Never use a revoked or an expired encryption key. The correct public key to use in your correspondence with PSIRT is the one linked in the Contact Summary section of the Security Vulnerability Policy page at this URL:

http://www.cisco.com/en/US/products/products_security_vulnerability_policy.html

The link on this page has the current PGP key ID in use.

Obtaining Technical Assistance

Cisco Technical Support provides 24-hour-a-day award-winning technical assistance. The Cisco Technical Support & Documentation website on Cisco.com features extensive online support resources. In addition, if you have a valid Cisco service contract, Cisco Technical Assistance Center (TAC) engineers provide telephone support. If you do not have a valid Cisco service contract, contact your reseller.

Cisco Technical Support & Documentation Website

The Cisco Technical Support & Documentation website provides online documents and tools for troubleshooting and resolving technical issues with Cisco products and technologies. The website is available 24 hours a day, at this URL:

http://www.cisco.com/techsupport

Access to all tools on the Cisco Technical Support & Documentation website requires a Cisco.com user ID and password. If you have a valid service contract but do not have a user ID or password, you can register at this URL:

http://tools.cisco.com/RPF/register/register.do

Note Use the Cisco Product Identification (CPI) tool to locate your product serial number before submitting a web or phone request for service. You can access the CPI tool from the Cisco Technical Support & Documentation website by clicking the **Tools & Resources** link. Choose **Cisco Product Identification Tool** from the Alphabetical Index drop-down list, or click the **Cisco Product Identification Tool** link under Alerts & RMAs. The CPI tool offers three search options: by product ID or model name; by tree view; or for certain products, by copying and pasting **show** command output. Search results show an illustration of your product with the serial number label location highlighted. Locate the serial number label on your product and record the information before placing a service call.

Submitting a Service Request

Using the online TAC Service Request Tool is the fastest way to open S3 and S4 service requests. (S3 and S4 service requests are those in which your network is minimally impaired or for which you require product information.) After you describe your situation, the TAC Service Request Tool provides recommended solutions. If your issue is not resolved using the recommended resources, your service request is assigned to a Cisco engineer. The TAC Service Request Tool is located at this URL:

http://www.cisco.com/techsupport/servicerequest

For S1 or S2 service requests or if you do not have Internet access, contact the Cisco TAC by telephone. (S1 or S2 service requests are those in which your production network is down or severely degraded.) Cisco engineers are assigned immediately to S1 and S2 service requests to help keep your business operations running smoothly.

To open a service request by telephone, use one of the following numbers:

Asia-Pacific: +61 2 8446 7411 (Australia: 1 800 805 227)
EMEA: +32 2 704 55 55
USA: 1 800 553-2447

For a complete list of Cisco TAC contacts, go to this URL:

http://www.cisco.com/techsupport/contacts

Definitions of Service Request Severity

To ensure that all service requests are reported in a standard format, Cisco has established severity definitions.

Severity 1 (S1)—Your network is "down," or there is a critical impact to your business operations. You and Cisco will commit all necessary resources around the clock to resolve the situation.

Severity 2 (S2)—Operation of an existing network is severely degraded, or significant aspects of your business operation are negatively affected by inadequate performance of Cisco products. You and Cisco will commit full-time resources during normal business hours to resolve the situation.

Severity 3 (S3)—Operational performance of your network is impaired, but most business operations remain functional. You and Cisco will commit resources during normal business hours to restore service to satisfactory levels.

Severity 4 (S4)—You require information or assistance with Cisco product capabilities, installation, or configuration. There is little or no effect on your business operations.

Obtaining Additional Publications and Information

Information about Cisco products, technologies, and network solutions is available from various online and printed sources.

- Cisco Marketplace provides a variety of Cisco books, reference guides, documentation, and logo merchandise. Visit Cisco Marketplace, the company store, at this URL:

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Using Cisco IOS Software for Release 12.4

This chapter provides tips for understanding and configuring Cisco IOS software using the command-line interface (CLI). It contains the following sections:

- Understanding Command Modes, page xliii
- Getting Help, page xliv
- Using the no and default Forms of Commands, page xlviii
- Saving Configuration Changes, page xlviii
- Filtering Output from the show and more Commands, page xlix
- Finding Additional Feature Support Information, page xlix

For an overview of Cisco IOS software configuration, see the *Cisco IOS Configuration Fundamentals Configuration Guide.*

For information on the conventions used in the Cisco IOS software documentation set, see the "About Cisco IOS Software Documentation for Release 12.4" chapter.

Understanding Command Modes

You use the CLI to access Cisco IOS software. Because the CLI is divided into many different modes, the commands available to you at any given time depend on the mode that you are currently in. Entering a question mark (**?**) at the CLI prompt allows you to obtain a list of commands available for each command mode.

When you log in to a Cisco device, the device is initially in user EXEC mode. User EXEC mode contains only a limited subset of commands. To have access to all commands, you must enter privileged EXEC mode by entering the **enable** command and a password (when required). From privileged EXEC mode you have access to both user EXEC and privileged EXEC commands. Most EXEC commands are used independently to observe status or to perform a specific function. For example, **show** commands are used to display important status information, and **clear** commands allow you to reset counters or interfaces. The EXEC commands are not saved when the software reboots.

Configuration modes allow you to make changes to the running configuration. If you later save the running configuration to the startup configuration, these changed commands are stored when the software is rebooted. To enter specific configuration modes, you must start at global configuration mode. From global configuration mode, you can enter interface configuration mode and a variety of other modes, such as protocol-specific modes.

ROM monitor mode is a separate mode used when the Cisco IOS 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.

Table 1 describes how to access and exit various common command modes of the Cisco IOS software. It also shows examples of the prompts displayed for each mode.

Table 1 Accessing and Exiting Command Modes

Command Mode	Access Method	Prompt	Exit Method
User EXEC	Log in.	`Router>`	Use the **logout** command.
Privileged EXEC	From user EXEC mode, use the **enable** command.	`Router#`	To return to user EXEC mode, use the **disable** command.
Global configuration	From privileged EXEC mode, use the **configure terminal** command.	`Router(config)#`	To return to privileged EXEC mode from global configuration mode, use the **exit** or **end** command.
Interface configuration	From global configuration mode, specify an interface using an **interface** command.	`Router(config-if)#`	To return to global configuration mode, use the **exit** command. To return to privileged EXEC mode, use the **end** command.
ROM monitor	From privileged EXEC mode, use the **reload** command. Press the **Break** key during the first 60 seconds while the system is booting.	`>`	To exit ROM monitor mode, use the **continue** command.

For more information on command modes, see the “Using the Cisco IOS Command-Line Interface” chapter in the *Cisco IOS Configuration Fundamentals Configuration Guide*.

Getting Help

Entering a question mark (**?**) at the CLI prompt displays a list of commands available for each command mode. You can also get a list of keywords and arguments associated with any command by using the context-sensitive help feature.

To get help specific to a command mode, a command, a keyword, or an argument, use one of the following commands:

Command	Purpose
help	Provides a brief description of the help system in any command mode.
abbreviated-command-entry<b>?</b>	Provides a list of commands that begin with a particular character string. (No space between command and question mark.)
abbreviated-command-entry<**Tab**>	Completes a partial command name.

Command	Purpose
`?`	Lists all commands available for a particular command mode.
`command ?`	Lists the keywords or arguments that you must enter next on the command line. (Space between command and question mark.)

Example: How to Find Command Options

This section provides an example of how to display syntax for a command. The syntax can consist of optional or required keywords and arguments. To display keywords and arguments for a command, enter a question mark (**?**) at the configuration prompt or after entering part of a command followed by a space. The Cisco IOS software displays a list and brief description of available keywords and arguments. For example, if you were in global configuration mode and wanted to see all the keywords or arguments for the **arap** command, you would type **arap ?**.

The <cr> symbol in command help output stands for "carriage return." On older keyboards, the carriage return key is the Return key. On most modern keyboards, the carriage return key is the Enter key. The <cr> symbol at the end of command help output indicates that you have the option to press **Enter** to complete the command and that the arguments and keywords in the list preceding the <cr> symbol are optional. The <cr> symbol by itself indicates that no more arguments or keywords are available and that you must press **Enter** to complete the command.

Table 2 shows examples of how you can use the question mark (**?**) to assist you in entering commands. The table steps you through configuring an IP address on a serial interface on a Cisco 7206 router that is running Cisco IOS Release 12.0(3).

Table 2 How to Find Command Options

Command	Comment

`Router> enable`
`Password: <password>`
`Router#`
	Enter the **enable** command and password to access privileged EXEC commands. You are in privileged EXEC mode when the prompt changes to `Router#`.

`Router# configure terminal`
`Enter configuration commands, one per line. End with CNTL/Z.`
`Router(config)#`
	Enter the **configure terminal** privileged EXEC command to enter global configuration mode. You are in global configuration mode when the prompt changes to `Router(config)#`.

Table 2 How to Find Command Options (continued)

<table>
<tr><th>Command</th><th>Comment</th></tr>
<tr><td><pre>
Router(config)# interface serial ?
  <0-6>   Serial interface number
Router(config)# interface serial 4 ?
  /
Router(config)# interface serial 4/ ?
  <0-3>   Serial interface number
Router(config)# interface serial 4/0 ?
<cr>
Router(config)# interface serial 4/0
Router(config-if)#
</pre></td><td>Enter interface configuration mode by specifying the serial interface that you want to configure using the <b>interface serial</b> global configuration command.
Enter <b>?</b> to display what you must enter next on the command line. In this example, you must enter the serial interface slot number and port number, separated by a forward slash.
When the <cr> symbol is displayed, you can press <b>Enter</b> to complete the command.
You are in interface configuration mode when the prompt changes to <code>Router(config-if)#</code>.</td></tr>
<tr><td><pre>
Router(config-if)# ?
Interface configuration commands:
  .
  .
  .
  ip   Interface Internet Protocol config commands
  keepalive   Enable keepalive
  lan-name   LAN Name command
  llc2   LLC2 Interface Subcommands
  load-interval   Specify interval for load calculation for an
                      interface
  locaddr-priority   Assign a priority group
  logging   Configure logging for interface
  loopback   Configure internal loopback on an interface
  mac-address   Manually set interface MAC address
  mls   mls router sub/interface commands
  mpoa   MPOA interface configuration commands
  mtu   Set the interface Maximum Transmission Unit (MTU)
  netbios   Use a defined NETBIOS access list or enable
                      name-caching
  no   Negate a command or set its defaults
  nrzi-encoding   Enable use of NRZI encoding
  ntp   Configure NTP
  .
  .
  .
Router(config-if)#
</pre></td><td>Enter <b>?</b> to display a list of all the interface configuration commands available for the serial interface. This example shows only some of the available interface configuration commands.</td></tr>
</table>

Table 2 How to Find Command Options (continued)

<table>
<tr><th>Command</th><th>Comment</th></tr>
<tr><td><pre>
Router(config-if)# ip ?
Interface IP configuration subcommands:
  access-group   Specify access control for packets
  accounting   Enable IP accounting on this interface
  address   Set the IP address of an interface
  authentication   authentication subcommands
  bandwidth-percent   Set EIGRP bandwidth limit
  broadcast-address   Set the broadcast address of an interface
  cgmp   Enable/disable CGMP
  directed-broadcast Enable forwarding of directed broadcasts
  dvmrp   DVMRP interface commands
  hello-interval   Configures IP-EIGRP hello interval
  helper-address   Specify a destination address for UDP broadcasts
  hold-time   Configures IP-EIGRP hold time
  .
  .
  .
Router(config-if)# ip
</pre></td><td>Enter the command that you want to configure for the interface. This example uses the **ip** command.

Enter **?** to display what you must enter next on the command line. This example shows only some of the available interface IP configuration commands.</td></tr>
<tr><td><pre>
Router(config-if)# ip address ?
  A.B.C.D   IP address
  negotiated   IP Address negotiated over PPP
Router(config-if)# ip address
</pre></td><td>Enter the command that you want to configure for the interface. This example uses the **ip address** command.

Enter **?** to display what you must enter next on the command line. In this example, you must enter an IP address or the **negotiated** keyword.

A carriage return (<cr>) is not displayed; therefore, you must enter additional keywords or arguments to complete the command.</td></tr>
<tr><td><pre>
Router(config-if)# ip address 172.16.0.1 ?
  A.B.C.D   IP subnet mask
Router(config-if)# ip address 172.16.0.1
</pre></td><td>Enter the keyword or argument that you want to use. This example uses the 172.16.0.1 IP address.

Enter **?** to display what you must enter next on the command line. In this example, you must enter an IP subnet mask.

A <cr> is not displayed; therefore, you must enter additional keywords or arguments to complete the command.</td></tr>
</table>

Table 2 How to Find Command Options (continued)

Command	Comment
Router(config-if)# **ip address 172.16.0.1 255.255.255.0 ?** secondary Make this IP address a secondary address <cr> Router(config-if)# **ip address 172.16.0.1 255.255.255.0**	Enter the IP subnet mask. This example uses the 255.255.255.0 IP subnet mask. Enter **?** to display what you must enter next on the command line. In this example, you can enter the **secondary** keyword, or you can press **Enter**. A <cr> is displayed; you can press **Enter** to complete the command, or you can enter another keyword.
Router(config-if)# **ip address 172.16.0.1 255.255.255.0** Router(config-if)#	In this example, Enter is pressed to complete the command.

Using the no and default Forms of Commands

Almost every configuration command has a **no** form. In general, use the **no** form to disable a function. Use the command without the **no** keyword to reenable a disabled function or to enable a function that is disabled by default. For example, IP routing is enabled by default. To disable IP routing, use the **no ip routing** command; to reenable IP routing, use the **ip routing** command. The Cisco IOS software command reference publications provide the complete syntax for the configuration commands and describe what the **no** form of a command does.

Configuration commands can also have a **default** form, which returns the command settings to the default values. Most commands are disabled by default, so in such cases using the **default** form has the same result as using the **no** form of the command. However, some commands are enabled by default and have variables set to certain default values. In these cases, the **default** form of the command enables the command and sets the variables to their default values. The Cisco IOS software command reference publications describe the effect of the **default** form of a command if the command functions differently than the **no** form.

Saving Configuration Changes

Use the **copy system:running-config nvram:startup-config** command or the **copy running-config startup-config** command to save your configuration changes to the startup configuration so that the changes will not be lost if the software reloads or a power outage occurs. For example:

```
Router# copy system:running-config nvram:startup-config
Building configuration...
```

It might take a minute or two to save the configuration. After the configuration has been saved, the following output appears:

```
[OK]
Router#
```

On most platforms, this task saves the configuration to NVRAM. On the Class A flash file system platforms, this task saves the configuration to the location specified by the CONFIG_FILE environment variable. The CONFIG_FILE variable defaults to NVRAM.

Filtering Output from the show and more Commands

You can search and filter the output of **show** and **more** commands. This functionality is useful if you need to sort through large amounts of output or if you want to exclude output that you need not see.

To use this functionality, enter a **show** or **more** command followed by the "pipe" character (|); one of the keywords **begin**, **include**, or **exclude**; and a regular expression on which you want to search or filter (the expression is case-sensitive):

command | {**begin** | **include** | **exclude**} *regular-expression*

The output matches certain lines of information in the configuration file. The following example illustrates how to use output modifiers with the **show interface** command when you want the output to include only lines in which the expression "protocol" appears:

```
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
```

For more information on the search and filter functionality, see the "Using the Cisco IOS Command-Line Interface" chapter in the *Cisco IOS Configuration Fundamentals Configuration Guide*.

Finding Additional Feature Support Information

If you want to use a specific Cisco IOS software feature, you will need to determine in which Cisco IOS software images that feature is supported. Feature support in Cisco IOS software images depends on three main factors: the software version (called the "Release"), the hardware model (the "Platform" or "Series"), and the "Feature Set" (collection of specific features designed for a certain network environment). Although the Cisco IOS software documentation set documents feature support information for Release 12.4 as a whole, it does not generally provide specific hardware and feature set information.

To determine the correct combination of Release (software version), Platform (hardware version), and Feature Set needed to run a particular feature (or any combination of features), use Feature Navigator.

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.

Software features may also have additional limitations or restrictions. For example, a minimum amount of system memory may be required. Or there may be known issues for features on certain platforms that have not yet been resolved (called "Caveats"). For the latest information about these limitations, see the release notes for the appropriate Cisco IOS software release. Release notes provide detailed installation instructions, new feature descriptions, system requirements, limitations and restrictions, caveats, and troubleshooting information for a particular software release.

Performing Basic System Management

This chapter describes the basic tasks that you can perform to manage the general system features of the Cisco IOS software—those features that are generally not specific to a particular protocol.

This document applies to Cisco IOS Release 12.2.

For a complete description of the basic system management commands in this chapter, refer to the "Basic System Management Commands" chapter in the "Cisco IOS System Management Commands" part of the Release 12.2 *Cisco IOS Configuration Fundamentals Command Reference*. To locate documentation of other commands that appear in this chapter, use the *Cisco IOS Command Reference Master Index* or search online.

To identify hardware or software image support for a specific feature, use Feature Navigator on Cisco.com or refer to the software release notes for a specific release. For more information, see the "Finding Additional Feature Support Information" section on page xlix section in the ""Using Cisco IOS Software for Release 12.4"" chapter.

Basic System Management Task List

To customize the general functionality of your system, perform any of the tasks in the following sections. All tasks in this chapter are optional, though some, such as setting time and calendar services, are highly recommended.

- Configuring the System Name (Recommended)
- Customizing the CLI Prompt
- Creating and Displaying Command Aliases
- Controlling Minor Services (Recommended)
- Hiding Telnet Addresses
- Setting Time and Calendar Services (Recommended)
- Delaying EXEC Startup
- Handling an Idle Telnet Connection
- Setting the Interval for Load Data
- Limiting the Number of TCP Transactions
- Configuring Switching and Scheduling Priorities
- Modifying the System Buffer Size

See the end of this chapter for the "Basic System Management Examples" section.

Configuring the System Name

The most basic system management task is to assign a name to your system (router, access server, switch, and so on). The system name, also called the host name, is used to uniquely identify the system in your network. The system name is displayed at the CLI prompt. If no name is configured, the system default name is `Router`. To configure a name for your device, use the following command in global configuration mode:

Command	Purpose
`Router(config)#` **`hostname`** *`name`*	Sets the host name.

For an example of configuring a system name, see the section "System Configuration File Example" at the end of this chapter.

Customizing the CLI Prompt

By default, the CLI prompt consists of the system name followed by an angle bracket (>) for EXEC mode or a pound sign (#) for privileged EXEC mode. To customize the CLI prompt for your system, use either of the following commands in global configuration mode, as needed:

Command	Purpose
`Router(config)#` **`prompt`** *`string`*	Customizes the CLI prompt.
`Router(config)#` **`no service prompt config`**	Disables the display of the CLI prompt.

Creating and Displaying Command Aliases

Command aliases allow you to configure alternative syntax for commands. You may want to create aliases for commonly used or complex commands. For example, you could assign the alias **save config** to the **copy running-config startup-config** command to reduce the amount of typing you have to perform, or if your users might find a **save config** command easier to remember. Use word substitutions or abbreviations to tailor command syntax for you and your user community.

To create a command alias, use the following command in global configuration mode:

Command	Purpose
`Router(config)#` **`alias`** *`mode alias-name alias-command-line`*	Configures a command alias.

To display a list of command aliases currently configured on your system, and the original command syntax for those aliases, use the following command in EXEC mode:

Command	Purpose
`Router# show aliases [mode]`	Displays all command aliases and original command syntax, or displays the aliases for only a specified command mode.

Keep in mind that any aliases you configure will only be effective on your system, and that the original command syntax will appear in the configuration file.

Controlling Minor Services

The minor services are "small servers" that run on your routing device and are useful for basic system testing and for providing basic network functions. Minor services are useful for testing connections from another host on the network.

Cisco small servers are conceptually equivalent to daemons.

Small servers provided by Cisco IOS software-based devices include TCP, UDP, HTTP, BOOTP, and Finger. For information about the HTTP server, see the "Using the Cisco Web Browser User Interface"chapter in this book.

The TCP small server provides the following minor services:

- Echo—Echoes back whatever you type. To test this service, issue the **telnet** *a.b.c.d* **echo** command from a remote host.
- Chargen—Generates a stream of ASCII data. To test this service, issue the **telnet** *a.b.c.d* **chargen** command from a remote host.
- Discard—Discards whatever you type. To test this service, issue the **telnet** *a.b.c.d* **discard** command from a remote host.
- Daytime—Returns system date and time if you have configured NTP or have set the date and time manually. To test this service, issue the **telnet** *a.b.c.d* **daytime** command from a remote host.

The User Datagram Protocol (UDP) small server provides the following minor services:

- Echo—Echoes the payload of the datagram you send.
- Chargen—Discards the datagram you send and responds with a 72 character string of ASCII characters terminated with a CR+LF (carriage return and line feed).
- Discard—Silently discards the datagram you send.

To enable TCP or UDP services, use the following commands in global configuration mode, as needed:

Command	Purpose
`Router(config)# service tcp-small-servers`	Enables the minor TCP services echo, chargen, discard, and daytime.
`Router(config)# service udp-small-servers`	Enables the minor UDP services echo, chargen, and discard.

Because the minor services can be misused, these commands are disabled by default.

Caution Enabling minor services creates the potential for certain types of denial-of-service attacks, such as the UDP diagnostic port attack. Therefore, any network device that has UDP, TCP, BOOTP, or Finger services should be protected by a firewall or have the services disabled. For information on preventing UDP diagnostic port attacks, see the white paper titled *Defining Strategies to Protect Against UDP Diagnostic Port Denial of Service Attacks*, available on Cisco.com.

Note that the **no** form of the **service tcp-small-servers** and **service udp-small-servers** commands will appear in the configuration file to inform you when these basic services are disabled.

Controlling the BOOTP Server

You can enable or disable an async line Bootstrap Protocol (BOOTP) service on your routing device. This small server is enabled by default. Due to security considerations, this service should be disabled if you are not using it. To disable the BOOTP server on your platform, use the following command in global configuration mode:

Command	Purpose
`Router(config)# no ip bootp server`	Disables the BOOTP server.

Because Dynamic Host Configuration Protocol (DHCP) is based on the Bootstrap Protocol, both of these service share the "well-known" UDP server port of 67 (per the internet standards and RFCs). For more information about DHCP configuration in Cisco IOS software, see the *Cisco IOS IP Configuration Guide*. For more information about BOOTP, see RFC 951. Interoperation between BOOTP and DHCP is defined in RFC 1534. DHCP is defined in RFC 2131.

Controlling the Finger Protocol

The Finger protocol allows users throughout the network to get a list of the users currently using a particular routing device. The information displayed includes the processes running on the system, the line number, connection name, idle time, and terminal location. This information is provided through the Cisco IOS software **show users** EXEC command.

To enable a Cisco device to respond to Finger (port 79) requests, use the following command in global configuration mode:

Command	Purpose
`Router(config)# ip finger`	Enables the Finger protocol service, which allows the system to respond to finger requests.

To configure the finger protocol to be compliant with RFC 1288, use the following command in global configuration mode:

Command	Purpose
`Router(config)# ip finger rfc-compliant`	Configures the device to wait for "Return" or "/W" input when processing Finger requests.

The **rfc-compliant** form of this command should not be configured for devices with more than 20 simultaneous users (see caveat CSCds92731 on Cisco.com for details). The difference between the two forms of this command is as follows: when the **ip finger** command is configured, the router will respond to a **telnet** *a.b.c.d* **finger** command from a remote host by immediately displaying the output of the **show users** command and then closing the connection. When the **ip finger rfc-compliant** command is configured, the router will wait for input before displaying anything. The remote user can then press the Return key to display the output of the **show users** command, or enter **/W** to display the output of the **show users wide** command. After this information is displayed, the connection is closed.

Hiding Telnet Addresses

You can hide addresses while attempting to establish a Telnet session. To configure the router to suppress Telnet addresses, use the following command in global configuration mode:

Command	Purpose
`Router(config)# service hide-telnet-address`	Hides addresses while establishing a Telnet session.

The hide feature suppresses the display of the address and continues to display all other messages that normally would be displayed during a connection attempt, such as detailed error messages if the connection failed.

Use the **busy-message** line configuration command with the **service hide-telnet-address** command to customize the information displayed during Telnet connection attempts. If the connection attempt fails, the router suppresses the address and displays the message specified with the **busy-message** command.

Setting Time and Calendar Services

All Cisco routers provide an array of time-of-day services. These services allow the products to accurately keep track of the current time and date, to synchronize multiple devices to the same time, and to provide time services to other systems. The following sections describe the concepts and task associated with time and calendar services:

Understanding Time Sources

Most Cisco routers have two clocks: a battery-powered hardware clock (referenced in CLI commands as the “calendar”) and a software clock (referenced in CLI commands as the “clock”). These two clocks are managed separately.

The primary source for time data on your system is the software clock. This clock runs from the moment the system starts up and keeps track of the current date and time. The software clock can be set from a number of sources and in turn can be used to distribute the current time through various mechanisms to other systems. When a router with a hardware clock is initialized or rebooted, the software clock is initially set based on the time in the hardware clock. The software clock can then be updated from the following sources:

- Network Time Protocol (NTP)
- Simple Network Time Protocol (SNTP)
- VINES Time Service
- Manual configuration (using the hardware clock)

Because the software clock can be dynamically updated it has the potential to be more accurate than the hardware clock.

The software clock can provide time to the following services:

- Access lists
- NTP
- VINES time service
- User **show** commands
- Logging and debugging messages
- The hardware clock

Note The software clock cannot provide time to the NTP or VINES Time Service if it was set using SNTP.

The software clock keeps track of time internally based on Coordinated Universal Time (UTC), also known as Greenwich Mean Time (GMT). You can configure information about the local time zone and summer time (daylight savings time) so that the time is displayed correctly relative to the local time zone.

The software clock keeps track of whether the time is “authoritative” (that is, whether it has been set by a time source considered to be authoritative). If it is not authoritative, the time will be available only for display purposes and will not be redistributed.

Network Time Protocol

The Network Time Protocol (NTP) is a protocol designed to time-synchronize a network of machines. NTP runs over UDP, which in turn runs over IP. NTP Version 3 is documented in RFC 1305.

An NTP network usually gets its time from an authoritative time source, such as a radio clock or an atomic clock attached to a time server. NTP then distributes this time across the network. NTP is extremely efficient; no more than one packet per minute is necessary to synchronize two machines to the accuracy of within a millisecond of one another.

NTP uses the concept of a “stratum” to describe how many NTP “hops” away a machine is from an authoritative time source. A “stratum 1” time server typically has an authoritative time source (such as a radio or atomic clock, or a GPS time source) directly attached, a “stratum 2” time server receives its time via NTP from a “stratum 1” time server, and so on.

NTP avoids synchronizing to a machine whose time may not be accurate in two ways. First, NTP will never synchronize to a machine that is not in turn synchronized itself. Second, NTP will compare the time reported by several machines, and will not synchronize to a machine whose time is significantly different than the others, even if its stratum is lower. This strategy effectively builds a self-organizing tree of NTP servers.

The Cisco implementation of NTP does not support stratum 1 service; in other words, it is not possible to connect to a radio or atomic clock (for some specific platforms, however, you can connect a GPS time-source device). We recommend that time service for your network be derived from the public NTP servers available in the IP internet.

If the network is isolated from the internet, the Cisco implementation of NTP allows a machine to be configured so that it acts as though it is synchronized via NTP, when in fact it has determined the time using other means. Other machines can then synchronize to that machine via NTP.

A number of manufacturers include NTP software for their host systems, and a publicly available version for systems running UNIX and its various derivatives is also available. This software also allows UNIX-derivative servers to acquire the time directly from an atomic clock which would subsequently propagate time information along to Cisco routers.

The communications between machines running NTP (known as “associations”) are usually statically configured; each machine is given the IP address of all machines with which it should form associations. Accurate timekeeping is made possible by exchanging NTP messages between each pair of machines with an association.

However, in a LAN environment, NTP can be configured to use IP broadcast messages instead. This alternative reduces configuration complexity because each machine can simply be configured to send or receive broadcast messages. However, the accuracy of timekeeping is marginally reduced because the information flow is one-way only.

The time kept on a machine is a critical resource, so we strongly recommend that you use the security features of NTP to avoid the accidental or malicious setting of incorrect time. Two mechanisms are available: an access list-based restriction scheme and an encrypted authentication mechanism.

When multiple sources of time (VINES, hardware clock, manual configuration) are available, NTP is always considered to be more authoritative. NTP time overrides the time set by any other method.

Simple Network Time Protocol

Simple Network Time Protocol (SNTP) is a simplified, client-only version of NTP for use on Cisco 1003, Cisco 1004, Cisco 1005, Cisco 1600, Cisco 1720, and Cisco 1750 routers. SNTP can receive only the time from NTP servers; it cannot be used to provide time services to other systems.

SNTP typically provides time within 100 milliseconds of the accurate time, but it does not provide the complex filtering and statistical mechanisms of NTP. In addition, SNTP does not authenticate traffic, although you can configure extended access lists to provide some protection. An SNTP client is more vulnerable to misbehaving servers than an NTP client and should be used only in situations where strong authentication is not required.

You can configure SNTP to request and accept packets from configured servers or to accept NTP broadcast packets from any source. When multiple sources are sending NTP packets, the server with the best stratum is selected. (See the "Network Time Protocol" section for a description of strata.) If multiple servers are at the same stratum, a configured server is preferred over a broadcast server. If multiple servers pass both tests, the first one to send a time packet is selected. SNTP will choose a new server only if it stops receiving packets from the currently selected server, or if a better server (according to the above criteria) is discovered.

VINES Time Service

Time service is available when Banyan VINES is configured. This protocol is a standard part of VINES. The Cisco implementation allows the VINES time service to be used in two ways. First, if the system has learned the time from some other source, it can act as a VINES time server and provide time to other machines running VINES. Second, it can use the VINES time service to set the software clock if no other form of time service is available.

Note Support for Banyan VINES and XNS is removed from Cisco IOS software in Cisco IOS Release 12.2(13)T and later.

Hardware Clock

Some routers contain a battery-powered hardware clock that tracks the date and time across system restarts and power outages. The hardware clock is always used to initialize the software clock when the system is restarted.

Note Within the CLI command syntax, the hardware clock is referred to as the "system calendar."

If no other source is available, the hardware clock can be considered to be an authoritative source of time and be redistributed via NTP or VINES time service. If NTP is running, the hardware clock can be updated periodically from NTP, compensating for the inherent drift in the hardware clock.

Configuring NTP

NTP services are disabled on all interfaces by default. The following sections contain optional tasks that you can perform on your networking device:

- Configuring Poll-Based NTP Associations
- Configuring Broadcast-Based NTP Associations
- Configuring an NTP Access Group
- Configuring NTP Authentication
- Disabling NTP Services on a Specific Interface

- Configuring the Source IP Address for NTP Packets
- Configuring the System as an Authoritative NTP Server
- Updating the Hardware Clock
- Configuring an External Reference Clock

Configuring Poll-Based NTP Associations

Networking devices running NTP can be configured to operate in variety of association modes when synchronizing time with reference time sources. There are two ways that a networking device can obtain time information on a network: by polling host servers and by listening to NTP broadcasts. In this section, we will focus on the poll-based association modes. Broadcast-based NTP associations will be discussed in the next section.

The following are two most commonly used, poll-based association modes:

- Client mode
- Symmetric active mode

The *client* and the *symmetric active* modes should be used when NTP is required to provide a high level of time accuracy and reliability.

When a networking device is operating in the *client mode*, it polls its assigned time serving hosts for the current time. The networking device will then pick a host from all the polled time servers to synchronize with. Since the relationship that is established in this case is a client-host relationship, the host will not capture or use any time information sent by the local client device. This mode is most suited for file-server and workstation clients that are not required to provide any form of time synchronization to other local clients. Use the **ntp server** command to individually specify the time serving hosts that you want your networking device to consider synchronizing with and to set your networking device to operate in the *client mode*.

When a networking device is operating in the *symmetric active mode*, it polls its assigned time serving hosts for the current time and it responds to polls by its hosts. Since this is a peer-to-peer relationship, the host will also retain time-related information about the local networking device that it is communicating with. This mode should be used when there is a number of mutually redundant servers that are interconnected via diverse network paths. Most Stratum 1 and stratum 2 servers on the Internet today adopt this form of network setup. Use the **ntp peer** command to individually specify the time serving hosts that you want your networking device to consider synchronizing with and to set your networking device to operate in the *symmetric active mode*.

The specific mode that you should set each of your networking devices to depends primarily on the role that you want it to assume as a timekeeping device (server or client) and its proximity to a stratum 1 timekeeping server.

A networking device engages in polling when it is operating as a client or a host in the *client mode* or when it is acting as a peer in the *symmetric active mode*. Although polling does not usually exact a toll on memory and CPU resources such as bandwidth, an exceedingly large number of ongoing and simultaneous polls on a system can seriously impact the performance of a system or slow the performance of a given network. To avoid having an excessive number of ongoing polls on a network, you should limit the number of direct, peer-to-peer or client-to-server associations. Instead, you should consider using NTP broadcasts to propagate time information within a localized network.

Command	Purpose
Router(config)# **ntp peer** *ip-address* [**normal-sync**] [**version** *number*] [**key** *keyid*] [**source** *interface*] [**prefer**]	Forms a peer association with another system.
Router(config)# **ntp server** *ip-address* [**version** *number*] [**key** *keyid*] [**source** *interface*] [**prefer**]	Forms a server association with another system.

Note that only one end of an association needs to be configured; the other system will automatically establish the association.

Caution The **ntp clock-period** command is automatically generated to reflect the constantly changing *correction factor* when the **copy running-configuration startup-configuration** command is entered to save the configuration to NVRAM. Do not attempt to manually use the **ntp clock-period** command. Ensure that you remove this command line when copying configuration files to other devices.

For an example of configuring an NTP server-peer relationship, see the "Clock, Calendar, and NTP Configuration Examples" section at the end of this chapter.

Configuring Broadcast-Based NTP Associations

Broadcast-based NTP associations should be used when time accuracy and reliability requirements are modest and if your network is localized and has a large number of clients (more than 20). Broadcast-based NTP associations is also recommended for use on networks that have limited bandwidth, system memory, or CPU resources.

When a networking device is operating in the *broadcastclient mode*, it does not engage in any polling. Instead, it listens for NTP broadcast packets transmitted by broadcast time servers. Consequently, time accuracy can be marginally reduced since time information flows only one way.

Use the **ntp broadcast client** command to set your networking device to listen for NTP broadcast packets propagated through a network. In order for *broadcastclient mode* to work, the broadcast server and its clients must be located on the same subnet. The time server that is transmitting NTP broadcast packets will also have to be enabled on the interface of the given device using the **ntp broadcast** command.

To configure an interface to send NTP broadcasts, use the following command in interface configuration mode:

Command	Purpose
Router(config-if)# **ntp broadcast** [**version** *number*]	Configures the specified interface to send NTP broadcast packets.

To configure an interface to receive NTP broadcasts, use the following command in interface configuration mode:

Command	Purpose
Router(config-if)# **ntp broadcast client**	Configures the specified interface to receive NTP broadcast packets.

To manually set the estimated round-trip delay between the device and the NTP broadcast server, use the following command in global configuration mode:

Command	Purpose
`Router(config)# ntp broadcastdelay microseconds`	Adjusts the estimated round-trip delay for NTP broadcasts.

Caution The **ntp clock-period** command is automatically generated to reflect the constantly changing *correction factor* when the **copy running-configuration startup-configuration** command is entered to save the configuration to NVRAM. Do not attempt to manually use the **ntp clock-period** command. Ensure that you remove this command line when copying configuration files to other devices.

For an example of configuring broadcast-based NTP associations, see the "Clock, Calendar, and NTP Configuration Examples" section at the end of this chapter.

Configuring an NTP Access Group

The access list-based restriction scheme allows you to grant or deny certain access privileges to an entire network, a subnet within a network, or a host within a subnet. To define an NTP access group, use the following command in global configuration mode:

Command	Purpose
`Router(config)# ntp access-group {query-only	serve-only	serve	peer} access-list-number`	Creates an access group and applies a basic IP access list to it.

The access group options are scanned in the following order, from least restrictive to most restrictive:

1. **peer**—Allows time requests and NTP control queries and allows the system to synchronize itself to a system whose address passes the access list criteria.
2. **serve**—Allows time requests and NTP control queries, but does not allow the system to synchronize itself to a system whose address passes the access list criteria.
3. **serve-only**—Allows only time requests from a system whose address passes the access list criteria.
4. **query-only**—Allows only NTP control queries from a system whose address passes the access list criteria.

If the source IP address matches the access lists for more than one access type, the first type is granted. If no access groups are specified, all access types are granted to all systems. If any access groups are specified, only the specified access types will be granted.

For details on NTP control queries, see RFC 1305 (NTP version 3).

Configuring NTP Authentication

The encrypted NTP authentication scheme should be used when a reliable form of access control is required. Unlike the access list-based restriction scheme which is based on IP addresses, the encrypted authentication scheme uses authentication keys and an authentication process to determine if NTP synchronization packets sent by designated peers or servers on a local network are deemed as trusted before the time information that it carries along with it, is accepted.

The authentication process begins from the moment an NTP packet is created. Cryptographic checksum keys are generated using the MD5 Message Digest Algorithm and are embedded into the NTP synchronization packet that is sent to a receiving client. Once a packet is received by a client, its cryptographic checksum key is decrypted and checked against a list of trusted keys. If the packet contains a matching authenticator key, the timestamp information that is contained within it is accepted by the receiving client. NTP synchronization packets that do not contain a matching authenticator key will be ignored.

It is important to note that the encryption and decryption processes used in NTP authentication can be very CPU-intensive and can seriously degrade the accuracy of the time that is propagated within a network. If your network setup permits a more comprehensive model of access control, you should consider the use of the access list-based form of control instead.

After NTP authentication is properly configured, your networking device will only synchronize with and provide synchronization to trusted time sources. To enable your networking device to send and receive encrypted synchronization packets, use the following commands in global configuration mode:

	Command	Purpose
Step 1	Router(config)# **ntp authenticate**	Enables the NTP authentication feature.
Step 2	Router(config)# **ntp authentication-key** *number* **md5** *value*	Defines the authentication keys. Each key has a key number, a type, and a value. Currently the only key type supported is **md5**.
Step 3	Router(config)# **ntp trusted-key** *key-number*	Defines trusted authentication keys. If a key is trusted, this system will be ready to synchronize to a system that uses this key in its NTP packets.

Note In Cisco IOS software versions previous to release 12.0, the cryptotype value is displayed along with the ntp authentication key md5 value when the **show running-configuration** command is entered. Avoid copying and pasting the string cryptotype value that is displayed with the authentication-key as it will result in authentication failure.

Disabling NTP Services on a Specific Interface

NTP services are disabled on all interfaces by default.

NTP is enabled globally when any NTP commands are entered. you can selectively prevent NTP packets from being received through a specific interface by using the following command in interface configuration mode to turn off NTP on a given interface:

Command	Purpose
`Router(config-if)# ntp disable`	Disables NTP services on a specific interface.

Configuring the Source IP Address for NTP Packets

When the system sends an NTP packet, the source IP address is normally set to the address of the interface through which the NTP packet is sent. Use the following command in global configuration mode if you want to configure a specific interface from which the IP source address will be taken:

Command	Purpose
`Router(config)# ntp source interface`	Configures an interface from which the IP source address will be taken.

This interface will be used for the source address for all packets sent to all destinations. If a source address is to be used for a specific association, use the **source** parameter on the **ntp peer** or **ntp server** command shown earlier in this chapter.

Configuring the System as an Authoritative NTP Server

Use the following command in global configuration mode if you want the system to be an authoritative NTP server, even if the system is not synchronized to an outside time source:

Command	Purpose
`Router(config)# ntp master [stratum]`	Makes the system an authoritative NTP server.

Note Use the **ntp master** command with caution. It is very easy to override valid time sources using this command, especially if a low stratum number is configured. Configuring multiple machines in the same network with the **ntp master** command can cause instability in timekeeping if the machines do not agree on the time.

For an example of configuring an authoritative NTP server, see the "Clock, Calendar, and NTP Configuration Examples" section at the end of this chapter.

Updating the Hardware Clock

On devices that have hardware clocks (system calendars), you can configure the hardware clock to be periodically updated from the software clock. This is advisable for any device using NTP, because the time and date on the software clock (set using NTP) will be more accurate than the hardware clock, because the time setting on the hardware clock has the potential to drift slightly over time.

Use the following command in global configuration mode if a routing device is synchronized to an outside time source via NTP and you want the hardware clock to be synchronized to NTP time:

Command	Purpose
Router(config)# **ntp update-calendar**	Configures the system to update its hardware clock from the software clock at periodic intervals.

For an example of configuring NTP to update the calendar, see the section "Clock, Calendar, and NTP Configuration Examples" at the end of this chapter.

Configuring an External Reference Clock

Because Cisco's implementation of NTP does not support stratum 1 service, it is not possible to connect to a radio or atomic clock (for some specific platforms however, you can connect a GPS timesource device). However, certain Cisco devices allow you to connect a external GPS-based time-source device for the purposes of distributing a time signal to your network using NTP.

For example, the Trimble Palisade NTP Synchronization Kit can be connected to the auxiliary port of a Cisco 7200 Series router. Also, selected platforms support the use of GPS clocks from Symmetricom (formerly Telecom-Solutions). The refclock (reference clock) drivers provided on these platforms provides the ability to receive an RTS time-stamp signal on the auxiliary port of your routing device.

To configure a Trimble Palisade GPS product connected to the auxiliary port of a Cisco 7200 series router as the NTP reference clock, use the following commands, beginning in global configuration mode:

	Command	Purpose
Step 1	Router(config)# **line aux 0**	Enters line configuration mode for the auxiliary port 0.
Step 2	Router(config-line)# **ntp refclock trimble pps none stratum 1**	Enables the driver that allows the Trimble Palisade NTP Synchronization Kit to be used as the NTP reference clock source (Cisco 7200 series routers only).

To configure a Symmetricom GPS product connected to the auxiliary port of a supported router or switch as the NTP reference clock, use the following commands beginning in global configuration mode:

	Command	Purpose
Step 1	Router(config)# **line aux 0**	Enters line configuration mode for the auxiliary port zero.
Step 2	Router(config-line)# **ntp refclock telecom-solutions pps cts stratum 1**	Enables the driver that allows the Symmetricom GPS product to be used as the NTP reference clock source.

To configure a PPS signal as the source for NTP synchronization, use the following form of the **ntp refclock** command in line configuration mode:

Command	Purpose
Router(config-line)# **ntp refclock pps** {**cts** | **ri**} [**inverted**] [**pps-offset** *number*] [**stratum** *number*] [**timestamp-offset** *number*]	Configures a PPS signal as the source for NTP synchronization.

Verifying the Status of the External Reference Clock

To verify the status of NTP components, use the following commands in privileged EXEC mode:

Command	Purpose
`Router# show ntp associations`	Displays the status of NTP associations, including the status of the GPS reference clock.
`Router# show ntp status`	Displays the status of NTP.
`Router# debug ntp refclock`	Allows advanced monitoring of reference clock activities for the purposes of debugging.

Configuring SNTP

SNTP generally is supported on those platforms that do not provide support for NTP, such as the Cisco 1000 series, 1600 series, and 1700 series platforms. SNTP is disabled by default. In order to enable SNTP, use one or both of the following commands in global configuration mode:

Command	Purpose
`Router(config)# sntp server {address	hostname} [version number]`	Configures SNTP to request NTP packets from an NTP server.
`Router(config)# sntp broadcast client`	Configures SNTP to accept NTP packets from any NTP broadcast server.

Enter the **sntp server** command once for each NTP server. The NTP servers must be configured to respond to the SNTP messages from the router.

If you enter both the **sntp server** command and the **sntp broadcast client** command, the router will accept time from a broadcast server but prefer time from a configured server, assuming that the strata are equal. To display information about SNTP, use the **show sntp** EXEC command.

Configuring VINES Time Service

Note Support for Banyan VINES and XNS has been removed from Cisco IOS software, beginning in Cisco IOS Release 12.2(13)T. The following VINES commands are not available in releases derived from 12.2(13)T, such as the 12.3 mainline release.

To distribute the system time and date to other devices on the network using VINES time services, use the following command in global configuration mode:

Command	Purpose
`Router(config)# vines time use-system`	Distributes the system software clock time to other VINES systems.

To set the system time and date from received VINES time services, use the following command in global configuration mode:

Command	Purpose
`Router(config)# vines time set-system`	Sets the software clock system time from received VINES time services.

Configuring Time and Date Manually

If no other source of time is available, you can manually configure the current time and date after the system is restarted. The time will remain accurate until the next system restart. We recommend that you use manual configuration only as a last resort.

To set up time services, complete the tasks in the following sections as needed. If you have an outside source to which the router can synchronize, you do not need to manually set the software clock.

- Configuring the Time Zone
- Configuring Summer Time (Daylight Savings Time)
- Manually Setting the Software Clock
- Using the Hardware Clock

Configuring the Time Zone

To manually configure the time zone used by the Cisco IOS software, use the following command in global configuration mode :

Command	Purpose
`Router(config)# clock timezone zone hours-offset [minutes-offset]`	Sets the time zone. The *zone* argument is the name of the time zone (typically a standard acronym). The *hours-offset* argument is the number of hours the time zone is different from UTC. The *minutes-offset* argument is the number of minutes the time zone is different from UTC.

Tip The *minutes-offset* argument of the **clock timezone** command is available for those cases where a local time zone is a percentage of an hour different from UTC/GMT. For example, the time zone for some sections of Atlantic Canada (AST) is UTC -3.5. In this case, the necessary command would be **clock timezone AST -3 30**.

For an example of configuring the time zone, see the section “Clock, Calendar, and NTP Configuration Examples” at the end of this chapter.

Configuring Summer Time (Daylight Savings Time)

To configure summer time (daylight savings time) in areas where it starts and ends on a particular day of the week each year, use the following command in global configuration mode:

Command	Purpose
Router(config)# **clock summer-time** *zone* **recurring** [*week day month hh*:*mm week day month hh*:*mm* [*offset*]]	Configures a recurring summer time start and end date. The *offset* argument is used to indicate the number of minutes to add to the clock during summer time.

If summer time in your area does not follow this pattern, you can configure the exact date and time of the next summer time event by using one of the following commands in global configuration mode:

Command	Purpose
Router(config)# **clock summer-time** *zone* **date** *month date year hh*:*mm month date year hh*:*mm* [*offset*] or Router(config)# **clock summer-time** *zone* **date** *date month year hh*:*mm date month year hh*:*mm* [*offset*]	Configures a specific summer time start and end date. The *offset* argument is used to indicate the number of minutes to add to the clock during summer time.

For an example of configuring summer time, see the section "Clock, Calendar, and NTP Configuration Examples" at the end of this chapter.

Manually Setting the Software Clock

Generally, if the system is synchronized by a valid outside timing mechanism, such as an NTP or VINES clock source, or if you have a router with a hardware clock, you need not set the software clock. Use this command if no other time sources are available. The time specified in this command is relative to the configured time zone. To set the software clock manually, use the following command in privileged EXEC mode:

Command	Purpose
Router# **clock set** *hh*:*mm*:*ss date month year* or Router# **clock set** *hh*:*mm*:*ss month date year*	Sets the software clock.

Using the Hardware Clock

Most Cisco devices have a separate hardware-based clock in addition to the software-based clock. The hardware clock is a chip with a rechargeable backup battery that can retain the time and date information across reboots of the device.

To maintain the most accurate time update from an authoritative time source on the network, the software clock should receive time updates from an authoritative time on the network. The hardware clock should in turn be updated at regular intervals from the software clock while the system is running.

To customize the use of the hardware clock on your system, perform any of the following optional tasks:

- Setting the Hardware Clock
- Configuring the Router as a Network Time Source

- Setting the Software Clock from the Hardware Clock
- Setting the Hardware Clock from the Software Clock

Setting the Hardware Clock

The hardware clock (system calendar) maintains time separately from the software clock. The hardware clock continues to run when the system is restarted or when the power is turned off. Typically, the hardware clock needs to be manually set only once, when the system is first installed.

You should avoid setting the hardware clock manually if you have access to a reliable external time source. Time synchronization should instead be established using NTP.

If you do not have access to an external time source, use one of the forms of the following command in EXEC mode to set the hardware clock:

Command	Purpose

`Router> `**`calendar set`** *`hh:mm:ss day month year`*
or
`Router> `**`calendar set`** *`hh:mm:ss month day year`*
	Sets the hardware clock manually.

Configuring the Router as a Network Time Source

By default, the time maintained on the software clock is not considered to be authoritative and will not be redistributed with NTP or VINES Time Service. To classify the hardware clock as authoritative, use the following command in global configuration mode:

Command	Purpose
`Router(config)# `**`clock calendar-valid`**	Enables the router to act as a valid time source to which network peers can synchronize.

For an example of making the hardware clock authoritative, see the "Clock, Calendar, and NTP Configuration Examples" section at the end of this chapter.

Setting the Software Clock from the Hardware Clock

To set the software clock to the new hardware clock setting, use the following command in EXEC mode:

Command	Purpose
`Router# `**`clock read-calendar`**	Sets the software clock from the hardware clock.

Setting the Hardware Clock from the Software Clock

To update the hardware clock with a new software clock setting, use the following command in EXEC mode:

Command	Purpose
Router# **clock update-calendar**	Sets the hardware clock from the software clock.

Monitoring Time and Calendar Services

To monitor clock, calendar, and NTP EXEC services, use the following commands in EXEC mode, as needed:

Command	Purpose
Router# **show calendar**	Displays the current hardware clock time.
Router# **show clock** [**detail**]	Displays the current software clock time.
Router# **show ntp associations** [**detail**]	Displays the status of NTP associations.
Router# **show ntp status**	Displays the status of NTP.
Router# **show sntp**	Displays information about SNTP (Cisco 1003, Cisco 1004, Cisco 1005, Cisco 1600, Cisco 1720, or Cisco 1750 routers only).

Configuring Time Ranges

Cisco IOS allows implementation of features based on the time of day. The **time-range** global configuration command defines specific times of the day and week, which then can be referenced by a function, so that those time restrictions are imposed on the function itself.

In Cisco IOS Release 12.2, IP and IPX extended access lists are the only functions that can use time ranges. The time range allows the network administrator to define when the **permit** or **deny** statements in the access list are in effect. Prior to the introduction of this feature, access list statements were always in effect once they were applied. Both named or numbered access lists can reference a time range.

Benefits of time ranges include the following:

- The network administrator has more control over permitting or denying a user access to resources. These resources could be an application (identified by an IP address/mask pair and a port number), policy routing, or an on-demand link (identified as interesting traffic to the dialer).
- Network administrators can set a time-based security policy, including the following:
  - Perimeter security using the Cisco IOS Firewall feature set or access lists
  - Data confidentiality with Cisco Encryption Technology or IPSec
- Policy-based routing and queueing functions are enhanced.
- When provider access rates vary by time of day, it is possible to automatically reroute traffic cost effectively.
- Service providers can dynamically change a committed access rate (CAR) configuration to support the quality of service (QoS) service level agreements (SLAs) that are negotiated for certain times of day.
- Network administrators can control logging messages. Access list entries can log traffic at certain times of the day, but not constantly. Therefore, administrators can simply deny access without needing to analyze many logs generated during peak hours.

Defining a Time Range

Note The time range relies on the system's software clock. For the time range feature to work the way you intend, you need a reliable clock source. We recommend that you use NTP to synchronize the system's software clock.

To define a time range, use the following commands beginning in global configuration mode.

	Command	Purpose
Step 1	`Router(config)# time-range time-range-name`	Assigns a name to the time range to be configured and enters time-range configuration mode.

Step 2	`Router(config-time-range)# absolute [start time date] [end time date]`
	or
	`Router(config-time-range)# periodic days-of-the-week hh:mm to [days-of-the-week] hh:mm`
		Specifies when the time range will be in effect. Use some combination of these commands; multiple **periodic** statements are allowed; only one **absolute** statement is allowed.

Repeat these tasks if you have multiple items you want in effect at different times. For example, repeat the steps to include multiple **permit** or **deny** statements in an access list in effect at different times. For more information about these commands, refer to the "Basic System Management Commands" chapter in the "Cisco IOS System Management Commands" part of the Release 12.2 *Cisco IOS Configuration Fundamentals Command Reference*.

Referencing the Time Range

In order for a time range to be applied, you must reference it by name in a feature that can implement time ranges. You can reference the time range in the following Cisco IOS software features:

- IP Extended Access Lists
  - Refer to the "Configuring IP Services" chapter of the Release 12.2 *Cisco IOS IP Configuration Guide* for instructions on creating an IP Extended Access List and referencing a time range.
- IPX Extended Access Lists
  - Refer to the "Configuring Novell IPX" chapter of the Release 12.2 *Cisco IOS AppleTalk and Novell IPX Configuration Guide* for instructions on creating an IPX Extended Access List and referencing a time range.

Delaying EXEC Startup

To delay the startup of the EXEC process on noisy lines until the line has been idle for 3 seconds, use the following command in global configuration mode:

Command	Purpose
`Router(config)# service exec-wait`	Delays startup of the EXEC.

This command is useful on noisy modem lines or when a modem attached to the line is configured to ignore MNP or V.42 negotiations, and MNP or V.42 modems may be dialing in. In these cases, noise or MNP/V.42 packets might be interpreted as usernames and passwords, causing authentication failure before the user can type a username or password. The command is not useful on nonmodem lines or lines without some kind of login configured.

Handling an Idle Telnet Connection

To configure the Cisco IOS software to set the TCP window to zero (0) when the Telnet connection is idle, use the following command in global configuration mode:

Command	Purpose
`Router(config)# service telnet-zero-idle`	Sets the TCP window to zero when the Telnet connection is idle.

Normally, data sent to noncurrent Telnet connections is accepted and discarded. When **service telnet-zero-idle** is enabled, if a session is suspended (that is, some other connection is made active), the TCP window is set to zero. This action prevents the remote host from sending any more data until the connection is resumed. Use this command when it is important that all messages sent by the host be seen by the users and the users are likely to use multiple sessions. Do not use this command if your host will eventually time out and log out a TCP user whose window is zero.

Setting the Interval for Load Data

You can change the period of time over which a set of data is used for computing load statistics. Decisions, such as for dial backup, depend on these statistics. If you decrease the load interval, the average statistics are computed over a shorter period of time and are more responsive to bursts of traffic.

To change the length of time for which a set of data is used to compute load statistics, use the following command in interface configuration mode:

Command	Purpose
`Router(config-if)# load-interval seconds`	Sets the length of time for which data is used for load calculations.

Limiting the Number of TCP Transactions

When using a standard TCP implementation to send keystrokes between machines, TCP tends to send one packet for each keystroke typed, which can use up bandwidth and contribute to congestion on larger networks.

John Nagle’s algorithm (RFC 896) helps alleviate the small-packet problem in TCP. The first character typed after connection establishment is sent in a single packet, but TCP holds any additional characters typed until the receiver acknowledges the previous packet. Then the second, larger packet is sent, and additional typed characters are saved until the acknowledgment comes back. The effect is to accumulate characters into larger chunks, and pace their transmission to the network at a rate matching the round-trip time of the given connection. This method is usually preferable for all TCP-based traffic.

By default, the Nagle algorithm is not enabled. To enable the Nagle algorithm and thereby reduce the number of TCP transactions, use the following command in global configuration mode:

Command	Purpose
`Router(config)#` **`service nagle`**	Enables the Nagle slow packet avoidance algorithm.

Configuring Switching and Scheduling Priorities

The normal operation of the network server allows the switching operations to use as much of the central processor as is required. If the network is running unusually heavy loads that do not allow the processor the time to handle the routing protocols, you may need to give priority to the system process scheduler. To do so, use the following command in global configuration mode:

Command	Purpose
`Router(config)#` **`scheduler interval`** *`milliseconds`*	Defines the maximum amount of time that can elapse without running the lowest-priority system processes.

To change the amount of time that the CPU spends on fast-switching and process-level operations on the Cisco 7200 series and Cisco 7500 series routers, use the following command in global configuration mode:

Command	Purpose
`Router(config)#` **`scheduler allocate`** *`network-microseconds process-microseconds`*	For the Cisco 7200 series and Cisco 7500 series routers, changes the default time the CPU spends on process tasks and fast switching.

Caution We recommend that you do not change the default values of the **scheduler allocate** command.

To configure the characteristics for a looping process, use the following command in global configuration mode:

Command	Purpose
`Router(config)#` **`scheduler process-watchdog`** {**`hang`** | **`normal`** | **`reload`** | **`terminate`**}	Configures an action for a looping process.

Modifying the System Buffer Size

You can adjust initial buffer pool settings and the limits at which temporary buffers are created and destroyed. To do so, use the following commands in global configuration mode, as needed:

Command	Purpose
`Router(config)#` **buffers** {**small** | **middle** | **big** | **verybig** | **large** | **huge** | *type number*} {**permanent** | **max-free** | **min-free** | **initial**} *number*	Adjusts the system buffer sizes.
`Router(config)#` **buffers huge size** *number*	Dynamically resizes all huge buffers to the value that you supply.

Caution Normally you need not adjust these parameters; do so only after consulting with technical support personnel. Improper settings can adversely impact system performance.

During normal system operation, there are two sets of buffer pools: public and interface. They behave as follows:

- The buffers in the public pools grow and shrink based upon demand. Some public pools are temporary and are created and destroyed as needed. Other public pools are permanently allocated and cannot be destroyed. Public buffer pools are labeled as small, middle, big, large, very big, and huge.
- Interface pools are static—that is, they are all permanent. One interface pool exists for each interface. For example, a Cisco 4000 1E 4T configuration has one Ethernet buffer pool and four serial buffer pools. In the **buffers** EXEC command, the *type* and *number* arguments allow the user to tune the interface pools.

See the section “Buffer Modification Examples” at the end of this chapter for more information.

The server has one pool of queueing elements and six public pools of packet buffers of different sizes. For each pool, the server keeps count of the number of buffers outstanding, the number of buffers in the free list, and the maximum number of buffers allowed in the free list. To display statistics about the buffer pool on the system, use the following commands in EXEC mode, as needed:

Command	Purpose
`Router>` **show buffers**	Displays all public pool information.
`Router>` **show buffers address** *hex-addr*	Displays buffer information for an address.
`Router>` **show buffers all** [**dump** | **header** | **packet**]	Displays all public and interface pool information.
`Router>` **show buffers assigned** [**dump** | **header** | **packet**]	Displays a listing of all buffers in use.
`Router>` **show buffers failures** [**dump** | **header** | **packet**]	Displays buffer allocation failures.
`Router>` **show buffers free** [**dump** | **header** | **packet**]	Displays buffers available for use.
`Router>` **show buffers old** [**dump** | **header** | **packet**]	Displays buffers older than one minute.
`Router>` **show buffers input-interface** *interface-type identifier*	Displays buffer information for an input interface.
`Router>` **show buffers pool** *pool name*	Displays all interface pool information.

Basic System Management Examples

This section provides the following system management examples:

- System Configuration File Example
- Clock, Calendar, and NTP Configuration Examples
- Buffer Modification Examples

System Configuration File Example

The following is an example of a typical system configuration file:

```
! Define line password
line 0 4
 password secret
 login
!
! Define privileged-level password
enable-password Secret Word
!
! Define a system hostname
hostname TIP
! Specify a configuration file to load at system startup
boot host host1-confg 192.168.1.111
boot host host2-confg 192.168.1.111
! Specify the system image to boot at startup
boot system sys1-system 192.168.13.111
boot system sys2-system 192.168.1.111
boot system rom
!
! Enable SNMP
snmp-server community red
snmp-server enable traps snmp authentication
snmp-server host 192.168.1.27 public
snmp-server host 192.168.1.111 public
snmp-server host 192.168.2.63 public
!
! Define TACACS server hosts
tacacs-server host 192.168.1.27
tacacs-server host 192.168.13.33
tacacs-server host 192.168.1.33
!
! Define a message-of-the-day banner
banner motd ^C
The Information Place welcomes you

Please call 1-800-555-2222 for a login account, or enter
your password at the prompt.
^C
```

Clock, Calendar, and NTP Configuration Examples

In the following example, a router with a hardware clock has server associations with two other systems, sends broadcast NTP packets, periodically updates the hardware clock, and redistributes time into VINES:

```
clock timezone PST -8
clock summer-time PDT recurring
ntp update-calendar
ntp server 192.168.13.57
ntp server 192.168.11.58
interface Ethernet 0/0
 ntp broadcast
vines time use-system
```

In the following example, a router with a hardware clock has no outside time source, so it uses the hardware clock as an authoritative time source and distributes the time via NTP broadcast packets:

```
clock timezone MET 2
clock calendar-valid
ntp master
interface fddi 0/0
 ntp broadcast
```

Buffer Modification Examples

The following example instructs the system to keep at least 50 small buffers free:

```
Router> buffers small min-free 50
```

The following example instructs the system to keep no more than 200 middle buffers free:

```
Router> buffers middle max-free 200
```

The following example instructs the system to create one large temporary extra buffer, just after a reload:

```
Router> buffers large initial 1
```

The following example instructs the system to create one permanent huge buffer:

```
Router> buffers huge permanent 1
```

Troubleshooting and Fault Management

This chapter describes basic tasks that you can perform to troubleshoot your system and the network. For detailed troubleshooting procedures and scenarios, refer to the *Internetwork Troubleshooting Guide*. For complete details on all **debug** commands, refer to the *Cisco IOS Debug Command Reference*.

For a complete description of the troubleshooting commands in this chapter, refer to the "Troubleshooting and Fault Management Commands" chapter in "Cisco IOS System Management Commands" part of the Release 12.2 *Cisco IOS Configuration Fundamentals Command Reference*. To locate documentation of other commands that appear in this chapter, use the *Cisco IOS Command Reference Master Index* or search online.

To identify hardware or software image support for a specific feature, use Feature Navigator on Cisco.com to search for information about the feature or refer to the software release notes for a specific release. For more information, see the "Finding Additional Feature Support Information" section on page xlix section in the "Using Cisco IOS Software for Release 12.4" chapter.

Troubleshooting and Fault Management Task List

To manage network faults, you need to discover, isolate, and correct problems. You can discover problems with the system monitoring commands, isolate problems with the system test commands, and resolve problems with other commands, including **debug** commands.

To perform general fault management, perform the tasks described in the following sections:

- Displaying System Information Using show Commands
- Testing Network Connectivity
- Logging System Messages
- Using Field Diagnostics on Line Cards
- Troubleshooting Specific Line Cards
- Storing Line Card Crash Information
- Creating Core Dumps for System Exceptions
- Enabling Debug Operations
- Enabling Conditionally Triggered Debugging
- Using the Environmental Monitor

In addition to the material presented in this chapter, many chapters in the Cisco IOS software configuration guides include fault management tasks specific to certain technologies and features. You can find these tasks in the "Monitoring and Maintaining" sections.

Displaying System Information Using show Commands

To provide information about system processes, the Cisco IOS software includes an extensive list of EXEC commands that begin with the word **show**, which, when executed, display detailed tables of system information. Following is a partial list of system management **show** commands. To display the information described, use the following commands in EXEC mode, as needed:

Command	Purpose
`Router# show c2600`	Displays information about the Cisco 2600 platform, including interrupts, IOS Priority Masks, and IDMA status, for troubleshooting.
`Router# show c7200`	Displays information about the CPU and midplane for the Cisco 7200 series routers.
`Router# show context`	Displays information stored in NVRAM when the router crashes. This command is only useful to your technical support representative. This command is supported on the Cisco 2600 and 7000 series routers.
`Router# show controllers`	Displays information specific to the hardware on a line card.
`Router# show controllers logging`	Displays logging information about a line card.
`Router# show controllers tech-support`	Displays general information about a line for use when reporting a problem.
`Router# show controllers vip slot-number tech-support`	Displays information about the Versatile Interface Processor (VIP) card for use when reporting a problem
`Router# show diag`	Displays hardware information (including DRAM and static RAM details) for line cards.
`Router# show environment [all | last | table]`	Displays a message indicating whether an environmental warning condition currently exists, the temperature and voltage information, the last measured value from each of the six test points stored in nonvolatile memory, or environmental specifications. Examples of systems that support this command include the Cisco 7000 and the Cisco 12000 series routers.
`Router# show gsr`	Displays hardware information on the Cisco 12000 series Gigabit Switch Router (GSR).
`Router# show gt64010`	Displays all GT64010 internal registers and interrupt status on the Cisco 7200 series routers.
`Router# show memory [memory-type] [free] [summary]`	Displays memory pool statistics including summary information about the activities of the system memory allocator and a block-by-block listing of memory use.

Command	Purpose
Router# **show pci** {**hardware** | **bridge** [*register*]}	Displays information about the peripheral component interconnect (PCI) hardware registers or bridge registers for the Cisco 2600 and 7000 series routers.
Router# **show processes** [**cpu**]	Displays information about all active processes.
Router# **show processes memory**	Displays information about memory usage.
Router# **show protocols**	Displays the configured protocols.
Router# **show stacks**	Displays stack usage of processes and interrupt routines, including the reason for the last system reboot. This command is only useful to your technical support representative.
Router# **show subsys** [**class** *class* | **name** *name*]	Displays subsystem information.
Router# **show tcp** [*line-number*]	Displays the status of TCP connections.
Router# **show tcp brief** [**all**]	Displays a concise description of TCP connection endpoints.
Router# **show tdm connections** [**motherboard** | **slot** *number*]	Displays a snapshot of the time-division multiplexing (TDM) bus connection or data memory in a Cisco AS5200 access server.
Router# **show tech-support** [**page**] [**password**]	Displays information about the system for use when reporting a problem.

Refer to specific **show** commands in the tables of configuration commands found throughout the chapters in Cisco IOS software configuration guides. Refer to the Cisco IOS software command reference publications for detailed descriptions of the commands.

Testing Network Connectivity

To test basic network connectivity, perform the tasks described in the following sections:

- Configuring the TCP Keepalive Packet Service
- Testing Connections with the ping Command
- Tracing Packet Routes

Configuring the TCP Keepalive Packet Service

The TCP keepalive capability allows a router to detect when the host with which it is communicating experiences a system failure, even if data stops being sent (in either direction). This capability is most useful on incoming connections. For example, if a host failure occurs while the router is communicating with a printer, the router might never notice, because the printer does not generate any traffic in the opposite direction. If keepalives are enabled, they are sent once every minute on otherwise idle connections. If 5 minutes pass and no keepalives are detected, the connection is closed. The connection is also closed if the host replies to a keepalive packet with a reset packet. This will happen if the host crashes and comes back up again.

To generate the TCP keepalive packet service, use the following command in global configuration mode:

Command	Purposes
`Router(config)# service {tcp-keepalives-in | tcp-keepalives-out}`	Generates TCP keepalive packets on idle network connections, either incoming connections initiated by a remote host, or outgoing connections initiated by a user.

Testing Connections with the ping Command

As an aid to diagnosing basic network connectivity, many network protocols support an echo protocol. The protocol involves sending a special datagram to the destination host, then waiting for a reply datagram from that host. Results from this echo protocol can help in evaluating the path-to-host reliability, delays over the path, and whether the host can be reached or is functioning.

To invoke the echo protocol, use the following command in either user or privileged EXEC mode:

Command	Purposes
`Router# ping [protocol] {host | address}`	Invokes a diagnostic tool for testing connectivity.

Refer to specific **ping** commands in the tables of configuration commands found throughout the chapters in Cisco IOS software configuration guides. Refer to the Cisco IOS software command reference publications for detailed descriptions of the command.

Tracing Packet Routes

To trace the routes that packets will actually take when traveling to their destinations, use the following command in either user or privileged EXEC mode:

Command	Purposes
`Router# trace [protocol] [destination]`	Traces packet routes through the network (privileged level).

Logging System Messages

By default, routers send logging messages (including debug command output) a logging process. The logging process controls the distribution of logging messages to various destinations, such as the logging buffer, terminal lines, or a UNIX syslog server, depending on your configuration. The process also sends messages to the console. When the logging process is on, the messages are displayed on the console after the process that generated them has finished.

When the logging process is disabled, messages are sent only to the console. The messages are sent as they are generated, so error and debug output will be interspersed with prompts or output from the command.

You can set the severity level of the messages to control the type of messages displayed for the console and each destination. You can time-stamp log messages or set the syslog source address to enhance real-time debugging and management.

System logging messages are traditionally referred to as System Error Messages. Refer to the *Cisco IOS Software System Error Messages* publication for detailed information on specific system logging messages.

Enabling System Message Logging

System message logging is enabled by default. It must be enabled in order to send messages to any destination other than the console.

To disable message logging, use the **no logging on** command. Note that disabling the logging process can slow down the router because a process cannot continue until the messages are written to the console.

To reenable message logging after it has been disabled, use the following command in global configuration mode:

Command	Purposes
`Router(config)#` **`logging on`**	Enables message logging.

Enabling Message Logging for a Slave Card

To enable slave VIP cards to log status messages to the console (print the messages to the screen), use the following command in global configuration mode:

Command	Purposes
`Router(config)#` **`service slave-log`**	Enables slave message logging.

Setting the Syslog Destination

If message logging is enabled, you can send messages to specified locations, in addition to the console.

To set the locations that receive messages, use the following commands in global configuration mode, as needed:

Command	Purposes
`Router(config)#` **`logging buffered`** `[`*`size`*`]`	Logs messages to an internal buffer.
`Router(config)#` **`terminal monitor`**	Logs messages to a nonconsole terminal.
`Router(config)#` **`logging`** *`host`*	Logs messages to a syslog server host.

The **logging buffered** command copies logging messages to an internal buffer. The buffer is circular, so newer messages overwrite older messages after the buffer is full. To display the messages that are logged in the buffer, use the **show logging** EXEC command. The first message displayed is the oldest message in the buffer. To clear the current contents of the buffer, use the **clear logging** privileged EXEC command.

The **terminal monitor** EXEC command locally accomplishes the task of displaying the system logging messages to a terminal.

The **logging** command identifies a syslog server host to receive logging messages. The *host* argument is the name or IP address of the host. By issuing this command more than once, you build a list of syslog servers that receive logging messages. The **no logging** command deletes the syslog server with the specified address from the list of syslogs.

Configuring Synchronization of Logging Messages

You can configure the system to synchronize unsolicited messages and **debug** command output with solicited device output and prompts for a specific line. You can identify the types of messages to be output asynchronously based on the level of severity. You can also determine the maximum number of buffers for storing asynchronous messages for the terminal after which messages are dropped.

When synchronous logging of unsolicited messages and **debug** command output is turned on, unsolicited device output is displayed on the console or printed after solicited device output is displayed or printed. Unsolicited messages and **debug** command output is displayed on the console after the prompt for user input is returned. Therefore, unsolicited messages and **debug** command output are not interspersed with solicited device output and prompts. After the unsolicited messages are displayed, the console displays the user prompt again.

To configure for synchronous logging of unsolicited messages and **debug** command output with solicited device output and prompts, use the following commands beginning in global configuration mode:

	Command	Purposes
Step 1	`Router(config)# line [aux	console	vty] beginning-line-number [ending-line-number]`	Specifies the line to be configured for synchronous logging of messages.
Step 2	`Router(config-line)# logging synchronous [level severity-level	all] [limit number-of-buffers]`	Enables synchronous logging of messages.

Enabling Time-Stamps on Log Messages

By default, log messages are not time-stamped. To enable time-stamping of log messages, use either of the following commands in global configuration mode:

Command	Purposes

`Router(config)# service timestamps log uptime`
or
`Router(config)# service timestamps log datetime [msec] [localtime] [show-timezone]`
	Enables log time stamps.

Limiting the Error Message Severity Level and Facilities

You can limit the number of messages displayed to the selected device by specifying the severity level of the error message (see Table 3 for level descriptions). To do so, use the following commands in global configuration mode, as needed:

Command	Purposes
`Router(config)# logging console level`	Limits the number of messages logged to the console.
`Router(config)# logging monitor level`	Limits the number of messages logged to the terminal lines.
`Router(config)# logging trap level`	Limits the number of messages logged to the syslog servers.

If you have enabled syslog messages traps to be sent to a Simple Network Management Protocol (SNMP) network management station with the **snmp-server enable trap** command, you can change the level of messages sent and stored in a history table on the router. You can also change the number of messages that get stored in the history table.

Messages are stored in the history table because SNMP traps are not guaranteed to reach their destination. By default, one message of the level warning and above (see Table 3) is stored in the history table even if syslog traps are not enabled.

To change level and table size defaults, use the following commands in global configuration mode:

	Command	Purposes
Step 1	`Router(config)# logging history level`	Changes the default level of syslog messages stored in the history file and sent to the SNMP server.
Step 2	`Router(config)# logging history size number`	Changes the number of syslog messages that can be stored in the history table.

Note Table 3 lists the level keywords and severity level. For SNMP usage, the severity level values use +1. For example, **emergency** equals 1 not 0 and **critical** equals 3 not 2.

The **logging console** command limits the logging messages displayed on the console terminal to messages with a level number at or below the specified severity level, which is specified by the *level* argument. Table 3 lists the error message *level* keywords and corresponding UNIX syslog definitions in order from the most severe level to the least severe level.

Table 3 System Logging Message Severity Levels

Level Keyword	Level	Description	Syslog Definition
emergencies	0	System unusable	LOG_EMERG
alerts	1	Immediate action needed	LOG_ALERT
critical	2	Critical conditions	LOG_CRIT
errors	3	Error conditions	LOG_ERR
warnings	4	Warning conditions	LOG_WARNING
notifications	5	Normal but significant condition	LOG_NOTICE
informational	6	Informational messages only	LOG_INFO
debugging	7	Debugging messages	LOG_DEBUG

The **no logging console** command disables logging to the console terminal.

The default is to log messages to the console at the **debugging** level and those level numbers that are lower, which means all levels. The **logging monitor** command defaults to **debugging** also. The **logging trap** command defaults to the **informational** level.

To display logging messages on a terminal, use the **terminal monitor** EXEC command.

Current software generates the following four categories of error messages:

- Error messages about software or hardware malfunctions, displayed at levels **warnings** through **emergencies**
- Output from the **debug** commands, displayed at the **debugging** level
- Interface up/down transitions and system restart messages, displayed at the **notifications** level
- Reload requests and low-process stack messages, displayed at the **informational** level

Defining the UNIX System Logging Facility

You can log messages produced by UNIX system utilities. To do this, enable this type logging and define the UNIX system facility from which you want to log messages. Table 4 lists the UNIX system facilities supported by the Cisco IOS software. Consult the operator manual for your UNIX operating system for more information about these UNIX system facilities. The syslog format is compatible with Berkeley Standard Distribution (BSD) UNIX version 4.3.

To define UNIX system facility message logging, use the following command in global configuration mode:

Command	Purposes
`Router(config)# logging facility facility-type`	Configures system log facilities.

Table 4 Logging Facility Type Keywords

Facility Type Keyword	Description
auth	Indicates the authorization system.
cron	Indicates the cron facility.
daemon	Indicates the system daemon.
kern	Indicates the Kernel.
local0–7	Reserved for locally defined messages.
lpr	Indicates line printer system.
mail	Indicates mail system.
news	Indicates USENET news.
sys9	Indicates system use.
sys10	Indicates system use.
sys11	Indicates system use.
sys12	Indicates system use.
sys13	Indicates system use.
sys14	Indicates system use.

Table 4 Logging Facility Type Keywords (continued)

Facility Type Keyword	Description
syslog	Indicates the system log.
user	Indicates user process.
uucp	Indicates UNIX-to-UNIX copy system.

Displaying Logging Information

To display logging information, use the following commands in EXEC mode, as needed:

Command	Purposes
`Router# show logging`	Displays the state of syslog error and event logging, including host addresses, whether console logging is enabled, and other logging statistics.
`Router# show controllers vip slot-number logging`	Displays the state of syslog error and event logging of a VIP card, including host addresses, whether console logging is enabled, and other logging statistics.
`Router# show logging history`	Displays information in the syslog history table such as the table size, the status of messages, and the text of the messages stored in the table.

Logging Errors to a UNIX Syslog Daemon

To configure the syslog daemon on a 4.3 BSD UNIX system, include a line such as the following in the /etc/syslog.conf file:

```
local7.debugging /usr/adm/logs/cisco.log
```

The **debugging** keyword specifies the syslog level; see Table 3 for a general description of other keywords. The **local7** keyword specifies the logging facility to be used; see Table 4 for a general description of other keywords.

The syslog daemon sends messages at this level or at a more severe level to the file specified in the next field. The file must already exist, and the syslog daemon must have permission to write to it.

Setting the Syslog Source Address

By default, a syslog message contains the IP address of the interface it uses to leave the router. To set all syslog messages to contain the same IP address, regardless of which interface they use, use the following command in global configuration mode:

Command	Purposes
`Router(config)# logging source-interface type number`	Sets the syslog source address.

Using Field Diagnostics on Line Cards

Each line card on the Cisco 12000 series routers can perform field diagnostic testing to isolate faulty hardware without disrupting normal operation of the system. However, performing field diagnostic testing on a line card does halt all activity on the line card for the duration of the testing. After successful completion of the field diagnostic testing, the Cisco IOS software is automatically reloaded on the line card.

Note The field diagnostic **diag** command must be executed from the Gigabit Route Processor (GRP) main console port.

To perform field diagnostic testing on a line card, use the following command in privileged EXEC mode:

Command	Purposes
`Router# diag slot-number [previous	post	verbose	wait]`	Specifies the line card on which you want to perform diagnostic testing. Optionally, specifies that previous test results are displayed, that only extended power-on self-tests (POST) be performed, that the maximum messages are displayed, or that the Cisco IOS software not be reloaded on the line card after successful completion of the tests. The following prompt is displayed: `Running Diags will halt ALL activity on the requested slot. [confirm]` At the prompt, press **Return** to confirm that you want to perform field diagnostic testing on the specified line card, or type **no** to stop the testing.

To stop field diagnostic testing on a line card, use either of the following commands in privileged EXEC mode:

Command	Purpose

`Router# diag slot-number halt`
or
`Router# no diag slot-number`
	Specifies the line card on which you want to stop diagnostic testing.

Note When you stop the field diagnostic test, the line card remains down (that is, in an unbooted state). In most cases, you stopped the testing because you need to remove the line card or replace the line card. If that is not the case and you want to bring the line card back up (that is, online), you must use the **microcode reload** global configuration command or power cycle the line card.

Troubleshooting Specific Line Cards

Cisco IOS provides the **execute-on** command to allow you to issue Cisco IOS commands (such as **show** commands) to a specific line card for monitoring and maintenance. For example, you could show which Cisco IOS image is loaded on the card in slot 3 of a Cisco 12012 Gigabit Switch Router (GSR) by issuing the **execute-on slot 3 show version** command. You can also use this command for troubleshooting cards in the dial shelf of Cisco access servers. For complete documentation of this command, refer to the "Troubleshooting" chapter of the Release 12.2 *Cisco IOS Configuration Fundamentals Command Reference*.

Storing Line Card Crash Information

This section explains how to enable storing of crash information for a line card and optionally specify the type and amount of information stored. Technical support representatives need to be able to look at the crash information from the line card to troubleshoot serious problems on the line card. The crash information contains all the line card memory information, including the main memory and transmit and receive buffer information.

Caution Use the **exception linecard** global configuration command only when directed by a technical support representative, and only enable options that the technical support representative requests you to enable.

To enable and configure the crash information options for a line card, use the following command in global configuration mode:

Command	Purpose
`Router(config)#` **`exception linecard`** `{`**`all`** `|` **`slot`** *`slot-number`*`}` `[`**`corefile`** *`filename`* `|` **`main-memory`** *`size`* `[`**`k`** `|` **`m`**`]` `|` **`queue-ram`** *`size`* `[`**`k`** `|` **`m`**`]` `|` **`rx-buffer`** *`size`* `[`**`k`** `|` **`m`**`]` `|` **`sqe-register-rx`** `|` **`sqe-register-tx`** `|` **`tx-buffer`** *`size`* `[`**`k`** `|` **`m`**`]]`	Specifies the line card for which you want crash information when a line card resets. Optionally, specify the type and amount of memory to be stored.

Creating Core Dumps for System Exceptions

"System exceptions" are any unexpected system shutdowns or reboots (most frequently caused by a system failure, commonly referred to as a "system crash"). When an exception occurs, it is sometimes useful to obtain a full copy of the memory image (called a core dump) to identify the cause of the unexpected shutdown. Not all exception types will produce a core dump.

Core dumps are generally useful only to your technical support representative. The core dump file, which is a very large binary file, can be transferred to a Trivial File Transfer Protocol (TFTP), File Transfer Protocol (FTP), or Remote Copy Protocol (RCP) server, or (on limited platforms) saved to the flash disk, and subsequently interpreted by technical personnel who have access to source code and detailed memory maps.

Caution Use the **exception** commands only under the direction of a technical support representative. Creating a core dump while the router is functioning in a network can disrupt network operation.

Specifying the Destination for the Core Dump File

To configure the router to generate a core dump, you must enable exception dumps and configure a destination for the core dump file, as described in the following sections:

- Using TFTP for Core Dumps
- Using FTP for Core Dumps
- Using rcp for Core Dumps
- Using a Flash Disk for Core Dumps

Using TFTP for Core Dumps

Due to a limitation of most TFTP applications, the router will dump only the first 16 MB of the core file. Therefore, if your router's main memory is larger than 16 MB, do not use TFTP.

To configure a router for a core dump using TFTP, use the following commands in global configuration mode:

	Command or Action	Purpose
Step 1	`exception protocol tftp`	(Optional) Explicitly specifies TFTP as the protocol to be used for router exceptions (core dumps for unexpected system shutdowns). **Note** Because TFTP is the default exception protocol, the **exception protocol tftp** command does not need to be used unless the protocol has been previously changed to ftp or rcp in your system's configuration. To determine if the exception protocol has been changed, use the **show running-config** command in EXEC mode.
Step 2	**exception dump** *ip-address*	Configures the router to dump a core file to the specified server if the router crashes.
Step 3	**exception core-file** [*filepath/*]*filename*	(Optional) Specifies the name to be used for the core dump file. The file usually must pre-exist on the TFTP server, and be writable.

For example, the following command configures a router to send a core file to the server at the IP address 172.17.92.2. As the exception protocol is not specified, the default protocol of TFTP will be used.

```
Router(config)# exception dump 172.17.92.2
```

The core dump is written to a file named "*hostname*-core" on the TFTP server, where *hostname* is the name of the route (in the example above, the file would be named Router-core). You can change the name of the core file by adding the **exception core-file** *filename* configuration command.

Depending on the TFTP server application used, it may be necessary to create, on the TFTP server, the empty target file to which the router can write the core. Also, make sure there is enough memory on your TFTP server to hold the complete core dump.

Using FTP for Core Dumps

To configure the router for a core dump using FTP, use the following commands in global configuration mode:

	Command	Purposes
Step 1	`Router(config)# ip ftp username username`	(Optional) Configures the user name for FTP connections.
Step 2	`Router(config)# ip ftp password [type] password`	(Optional) Specifies the password to be used for FTP connections.
Step 3	`Router(config)# exception protocol ftp`	Specifies that FTP should be used for core dump file transfers.
Step 4	`Router(config)# exception dump ip-address`	Configures the router to dump a core file to a particular server if the router crashes.
Step 5	`Router(config)# exception core-file filename`	(Optional) Specifies the name to be used for the core dump file.

The following example configures a router to use FTP to dump a core file named "dumpfile" to the FTP server at 172.17.92.2 when it crashes.

```
ip ftp username red
ip ftp password blue
exception protocol ftp
exception dump 172.17.92.2
exception core-file dumpfile
```

Using rcp for Core Dumps

The remote copy protocol can also be used to send a core dump file. To configure the router to send core dump files using rcp, use the following commands:

	Command or Action	Purpose
Step 1	`ip rcmd remote-username username`	(Optional) Specifies the username sent by the router to the remote server with an rcp copy/write request. The remote rcp server must configured to grant write access to the specified username (in other words, an account must be defined on the network server for the username).
Step 2	`exception protocol rcp`	Configures the rcp as the protocol to use for sending core dump files.
Step 3	`exception dump ip-address`	Configures the router to dump a core file to the specified server if the router crashes.
Step 4	`exception core-file filename`	(Optional) Specifies the name to be used for the core dump file.

When an rcp username is not configured through the **ip rcmd remote-username** command, the rcp username defaults to the username associated with the current terminal (tty) connection. For example, if the user is connected to the router through Telnet and was authenticated through the username command, the router software sends the Telnet username as the rcp username. If the terminal username is not available, the router hostname will be used as the rcp username.

Using a Flash Disk for Core Dumps

Some router platforms support the Flash disk as an alternative to the linear Flash memory or PCMCIA Flash card. The large storage capacity of these Flash disks makes them good candidates for another means of capturing a core dump. To configure a router for a core dump using a Flash disk, use the following command in global configuration mode:

Command	Purpose

`Router(config)# `**`exception flash`**` [`**`procmem`**` |`**`iomem`**`	`**`all`**`]`
	`device-name``[`**`:`***`partition-number`*`] [`**`erase`**`
		`**`no_erase`**`]`	Configures the router for a core dump using a flash disk.

`Router(config)# `**`exception core-file`** *`filename`*	(Optional) Specifies the name to be used for the core dump file.

The **show flash all** EXEC command will list the devices you can use for the **exception flash** command.

Creating an Exception Memory Core Dump

To cause the router to create a core dump and reboot when certain memory size parameters are violated during the debugging process, use the following commands in global configuration mode:

As a debugging procedure, you can cause the router to create a core dump and reboot when certain memory size parameters are violated. The following **exception memory** commands are used to trigger a core dump:

Command	Purpose
`Router(config)# `**`exception memory minimum`** *`bytes`*	Triggers a core dump and system reload when the amount of free memory falls below the specified number of bytes. • Do not specify too low a memory value, as the router needs some amout of free memory to provide the core dump. • If you enter a size that is greater than the free memory (and the **exception dump** command has been configured), a core dump and router reload is generated after 60 seconds.
`Router(config)# `**`memory check-interval`** *`seconds`*	(Optional) Increases the interval at which memory will be checked. The default is 60 seconds, but much can happen in 60 seconds to mask the cause of corruption. Reducing the interval will increase CPU utilization (by around 12 %) which will be acceptable in most cases, but will also increase the chance of getting a usable core. To make sure CPU utilization doesn't hit 100%, you should gradually decrease the interval on busy routers. The ideal interval is as low as possible without causing other system problems.
`Router(config)# `**`exception memory fragment`** *`bytes`*	Triggers a core dump and system reload when the amount of contiguous (non-fragmented) free memory falls below the specified number of bytes.
`Router(config)# `**`exception core-file`** *`filename`*	(Optional) Specifies the name to be used for the core dump file. The file usually must exist on the TFTP server, and be writable. Note that the file will be the same size as the amount of processor memory on the router.

Note that the **exception memory minimum** command is primarily useful if you anticipate running out of memory before a core dump can be triggered or other debugging can be performed (rapid memory leak); if the memory leak is gradual (slow drift), you have generally have time to perform debugging before the system runs out of memory and must be reloaded.

By default, the number of free memory bytes is checked every 60 seconds when these commands are configured. The frequency of this checking can be increased using the **memory check-interval** *seconds* command.

The **exception dump** *ip-address* command must be configured with these commands. If the **exception dump** command is not configured, the router reloads without triggering a core dump.

The following example configures the router to monitor the free memory. If the memory falls below 250000 bytes, the core dump is created and the router reloads.

```
exception dump 172.18.92.2
exception core-file memory.overrun
exception memory minimum 250000
```

Setting a Spurious Interrupt Core Dump

During the debugging process, you can configure the router to create a spurious interrupt core dump and reboot when a specified number of interrupts have occurred.

⚠ **Caution** Use the **exception spurious-interrupt** global configuration command only when directed by a technical support representative and only enable options requested by the technical support representative.

To enable and configure the crash information for spurious interrupts, use the following commands in global configuration mode:

Command	Purpose
`Router(config)#` **`exception spurious-interrupt`** *`number`*	Sets the maximum number of spurious interrupts to include in the core dump before reloading.

`Router(config)#` **`exception dump`** *`ip-address`*
or
`Router(config)#` **`exception flash`**
	Specifies the destination for the core dump file.

The following example configures a router to create a core dump with a limit of two spurious interrupts:

```
exception spurious-interrupt 2
exception dump 209.165.200.225
```

Enabling Debug Operations

Your router includes hardware and software to aid in troubleshooting internal problems and problems with other hosts on the network. The **debug** privileged EXEC mode commands start the console display of several classes of network events. The following commands describe in general the system debug message feature. Refer to the *Cisco IOS Debug Command Reference* for all information regarding **debug** commands. Also refer to the *Internetwork Troubleshooting Guide* publication for additional information.

To enable debugging operations, use the following commands:

Command	Purposes
`Router# show debugging`	Displays the state of each debugging option.
`Router# debug ?`	Displays a list and brief description of all the **debug** command options.
`Router# debug command`	Begins message logging for the specified **debug** command.
`Router# no debug command`	Turns message logging off for the specified **debug** command.

Caution The system gives high priority to debugging output. For this reason, debugging commands should be turned on only for troubleshooting specific problems or during troubleshooting sessions with technical support personnel. Excessive debugging output can render the system inoperable.

You can configure time-stamping of system **debug** messages. Time-stamping enhances real-time debugging by providing the relative timing of logged events. This information is especially useful when customers send debugging output to your technical support personnel for assistance. To enable time-stamping of system **debug** messages, use either of the following commands in global configuration mode:

Command	Purposes

`Router(config)# service timestamps debug uptime`
or
`Router(config)# service timestamps debug datetime [msec] [localtime] [show-timezone]`
	Enables time-stamping of system **debug** messages.

Normally, the messages are displayed only on the console terminal. Refer to the section "Setting the Syslog Destination" earlier in this chapter to change the output device.

Enabling Conditionally Triggered Debugging

When the Conditionally Triggered Debugging feature is enabled, the router generates debugging messages for packets entering or leaving the router on a specified interface; the router will not generate debugging output for packets entering or leaving through a different interface. You can specify the interfaces explicitly. For example, you may only want to see debugging messages for one interface or subinterface. You can also turn on debugging for all interfaces that meet specified condition. This feature is useful on dial access servers, which have a large number of ports.

Normally, the router will generate debugging messages for every interface, resulting in a large number of messages. The large number of messages consumes system resources, and can affect your ability to find the specific information you need. By limiting the number of debugging messages, you can receive messages related to only the ports you wish to troubleshoot.

Conditionally Triggered Debugging controls the output from the following protocol-specific **debug** commands:

- **debug aaa** {**accounting** | **authorization** | **authentication**}
- **debug dialer** {**events** | **packets**}
- **debug isdn** {**q921** | **q931**}
- **debug modem** {**oob** | **trace**}
- **debug ppp** {**all** | **authentication** | **chap** | **error** | **negotiation** | **multilink events** | **packet**}

Although this feature limits the output of the commands listed, it does not automatically enable the generation of debugging output from these commands. Debugging messages are generated only when the protocol-specific **debug** command is enabled. The **debug** command output is controlled through two processes:

- The protocol-specific **debug** commands specify which protocols are being debugged. For example, the **debug dialer events** command generates debugging output related to dialer events.
- The **debug condition** commands limit these debugging messages to those related to a particular interface. For example, the **debug condition username bob** command generates debugging output only for interfaces with packets that specify a username of bob.

To configure Conditionally Triggered Debugging, perform the tasks described in the following sections:

- Enabling Protocol-Specific debug Commands
- Enabling Conditional Debugging Commands
- Specifying Multiple Debugging Conditions

Enabling Protocol-Specific debug Commands

In order to generate any debugging output, the protocol-specific **debug** command for the desired output must be enabled. Use the **show debugging** command to determine which types of debugging are enabled. To display the current debug conditions, use the **show debug condition** command. To enable the desired protocol-specific **debug** commands, use the following commands in privileged EXEC mode :

Command	Purpose
`Router# show debugging`	Determines which types of debugging are enabled.
`Router# show debug condition [condition-id]`	Displays the current **debug** conditions.
`Router# debug protocol`	Enables the desired debugging commands.
`Router# no debug protocol`	Disables the debugging commands that are not desired.

If you do not want output, disable all the protocol-specific **debug** commands.

Enabling Conditional Debugging Commands

If no **debug condition** commands are enabled, all debugging output, regardless of the interface, will be displayed for the enabled protocol-specific **debug** commands.

The first **debug condition** command you enter enables conditional debugging. The router will display only messages for interfaces that meet one of the specified conditions. If multiple conditions are specified, the interface must meet at least one of the conditions in order for messages to be displayed.

To enable messages for interfaces specified explicitly or for interfaces that meet certain conditions, perform the tasks described in the following sections:

- Displaying Messages for One Interface
- Displaying Messages for Multiple Interfaces
- Limiting the Number of Messages Based on Conditions

Displaying Messages for One Interface

To disable debugging messages for all interfaces except one, use the following command in privileged EXEC mode:

Command	Purpose
`Router# debug condition interface interface`	Enables debugging output for only the specified interface.

To reenable debugging output for all interfaces, use the **no debug interface** command.

Displaying Messages for Multiple Interfaces

To enable debugging messages for multiple interfaces, use the following commands in privileged EXEC mode:

	Command	Purposes
Step 1	`Router# debug condition interface interface`	Enables debugging output for only the specified interface
Step 2	`Router# debug condition interface interface`	Enable debugging messages for additional interfaces. Repeat this task until debugging messages are enabled for all desired interfaces.

If you specify more than one interface by entering this command multiple times, debugging output will be displayed for all of the specified interfaces. To turn off debugging on a particular interface, use the **no debug interface** command. If you use the **no debug interface all** command or remove the last **debug interface** command, debugging output will be reenabled for all interfaces.

Limiting the Number of Messages Based on Conditions

The router can monitor interfaces to learn if any packets contain the specified value for one of the following conditions:

- username
- calling party number
- called party number

If you enter a condition, such as calling number, debug output will be stopped for all interfaces. The router will then monitor every interface to learn if a packet with the specified calling party number is sent or received on any interfaces. If the condition is met on an interface or subinterface, **debug** command output will be displayed for that interface. The debugging output for an interface is "triggered" when the condition has been met. The debugging output continues to be disabled for the other interfaces. If, at some later time, the condition is met for another interface, the debug output also will become enabled for that interface.

Once debugging output has been triggered on an interface, the output will continue until the interface goes down. However, the session for that interface might change, resulting in a new username, called party number, or calling party number. Use the **no debug interface** command to reset the debug trigger mechanism for a particular interface. The debugging output for that interface will be disabled until the interface meets one of the specified conditions.

To limit the number of debugging messages based on a specified condition, use the following command in privileged EXEC mode:

Command	Purpose
`Router#` **`debug condition`** `{`**`username`** *`username`* `|` **`called`** *`dial-string`* `|` **`caller`** *`dial-string`*`}`	Enables conditional debugging. The router will display only messages for interfaces that meet this condition.

To reenable the debugging output for all interfaces, enter the **no debug condition all** command.

Specifying Multiple Debugging Conditions

To limit the number of debugging messages based on more than one condition, use the following commands in privileged EXEC mode:

	Command	Purposes
Step 1	`Router#` **`debug condition`** `{`**`username`** *`username`* `|` **`called`** *`dial-string`* `|` **`caller`** *`dial-string`*`}`	Enables conditional debugging, and specifies the first condition.
Step 2	`Router#` **`debug condition`** `{`**`username`** *`username`* `|` **`called`** *`dial-string`* `|` **`caller`** *`dial-string`*`}`	Specifies the second condition. Repeat this task until all conditions are specified.

If you enter multiple **debug condition** commands, debugging output will be generated if an interface meets at least one of the conditions. If you remove one of the conditions using the **no debug condition** command, interfaces that meet only that condition no longer will produce debugging output. However, interfaces that meet a condition other than the removed condition will continue to generate output. Only if no active conditions are met for an interface will the output for that interface be disabled.

Conditionally Triggered Debugging Configuration Examples

In this example, four conditions have been set by the following commands:

- **debug condition interface serial 0**
- **debug condition interface serial 1**
- **debug condition interface virtual-template 1**
- **debug condition username fred**

The first three conditions have been met by one interface. The fourth condition has not yet been met:

```
Router# show debug condition

Condition 1: interface Se0 (1 flags triggered)
        Flags: Se0
Condition 2: interface Se1 (1 flags triggered)
        Flags: Se1
Condition 3: interface Vt1 (1 flags triggered)
        Flags: Vt1
Condition 4: username fred (0 flags triggered)
```

When any **debug condition** command is entered, debugging messages for conditional debugging are enabled. The following debugging messages show conditions being met on different interfaces as the serial 0 and serial 1 interfaces come up. For example, the second line of output indicates that serial interface 0 meets the username fred condition.

```
*Mar  1 00:04:41.647: %LINK-3-UPDOWN: Interface Serial0, changed state to up
*Mar  1 00:04:41.715: Se0 Debug: Condition 4, username fred triggered, count 2
*Mar  1 00:04:42.963: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0, changed
state to up
*Mar  1 00:04:43.271: Vi1 Debug: Condition 3, interface Vt1 triggered, count 1
*Mar  1 00:04:43.271: %LINK-3-UPDOWN: Interface Virtual-Access1, changed state to up
*Mar  1 00:04:43.279: Vi1 Debug: Condition 4, username fred triggered, count 2
*Mar  1 00:04:43.283: Vi1 Debug: Condition 1, interface Se0 triggered, count 3
*Mar  1 00:04:44.039: %IP-4-DUPADDR: Duplicate address 172.27.32.114 on Ethernet 0,
sourced by 00e0.1e3e.2d41
*Mar  1 00:04:44.283: %LINEPROTO-5-UPDOWN: Line protocol on Interface Virtual-Access1,
changed state to up
*Mar  1 00:04:54.667: %LINK-3-UPDOWN: Interface Serial1, changed state to up
*Mar  1 00:04:54.731: Se1 Debug: Condition 4, username fred triggered, count 2
*Mar  1 00:04:54.735: Vi1 Debug: Condition 2, interface Se1 triggered, count 4
*Mar  1 00:04:55.735: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1, changed
state to up
```

After a period of time, the **show debug condition** command displays the revised list of conditions:

```
Router# show debug condition

Condition 1: interface Se0 (2 flags triggered)
        Flags: Se0 Vi1
Condition 2: interface Se1 (2 flags triggered)
        Flags: Se1 Vi1
Condition 3: interface Vt1 (2 flags triggered)
        Flags: Vt1 Vi1
Condition 4: username fred (3 flags triggered)
        Flags: Se0 Vi1 Se1
```

Next, the serial 1 and serial 0 interfaces go down. When an interface goes down, conditions for that interface are cleared.

```
*Mar  1 00:05:51.443: %LINK-3-UPDOWN: Interface Serial1, changed state to down
*Mar  1 00:05:51.471: Se1 Debug: Condition 4, username fred cleared, count 1
```

```
*Mar  1 00:05:51.479: Vi1 Debug: Condition 2, interface Se1 cleared, count 3
*Mar  1 00:05:52.443: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1, changed
state to down
*Mar  1 00:05:56.859: %LINK-3-UPDOWN: Interface Serial0, changed state to down
*Mar  1 00:05:56.887: Se0 Debug: Condition 4, username fred cleared, count 1
*Mar  1 00:05:56.895: Vi1 Debug: Condition 1, interface Se0 cleared, count 2
*Mar  1 00:05:56.899: Vi1 Debug: Condition 3, interface Vt1 cleared, count 1
*Mar  1 00:05:56.899: Vi1 Debug: Condition 4, username fred cleared, count 0
*Mar  1 00:05:56.903: %LINK-3-UPDOWN: Interface Virtual-Access1, changed state to down
*Mar  1 00:05:57.907: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0, changed
state to down
*Mar  1 00:05:57.907: %LINEPROTO-5-UPDOWN: Line protocol on Interface Virtual-Access1,
changed state to down
```

The final **show debug condition** output is the same as the output before the interfaces came up:

```
Router# show debug condition

Condition 1: interface Se0 (1 flags triggered)
        Flags: Se0
Condition 2: interface Se1 (1 flags triggered)
        Flags: Se1
Condition 3: interface Vt1 (1 flags triggered)
        Flags: Vt1
Condition 4: username fred (0 flags triggered)
```

Using the Environmental Monitor

Some routers and access servers have an environmental monitor that monitors the physical condition of the router. If a measurement exceeds acceptable margins, a warning message is printed to the system console. The system software collects measurements once every 60 seconds, but warnings for a given test point are printed at most once every 4 hours. If the temperature measurements are out of specification more than the shutdown, the software shuts the router down (the fan will remain on). The router must be manually turned off and on after such a shutdown. You can query the environmental monitor using the **show environment** command at any time to determine whether a measurement is out of tolerance. Refer to the *Cisco IOS System Error Messages* publication for a description of environmental monitor warning messages.

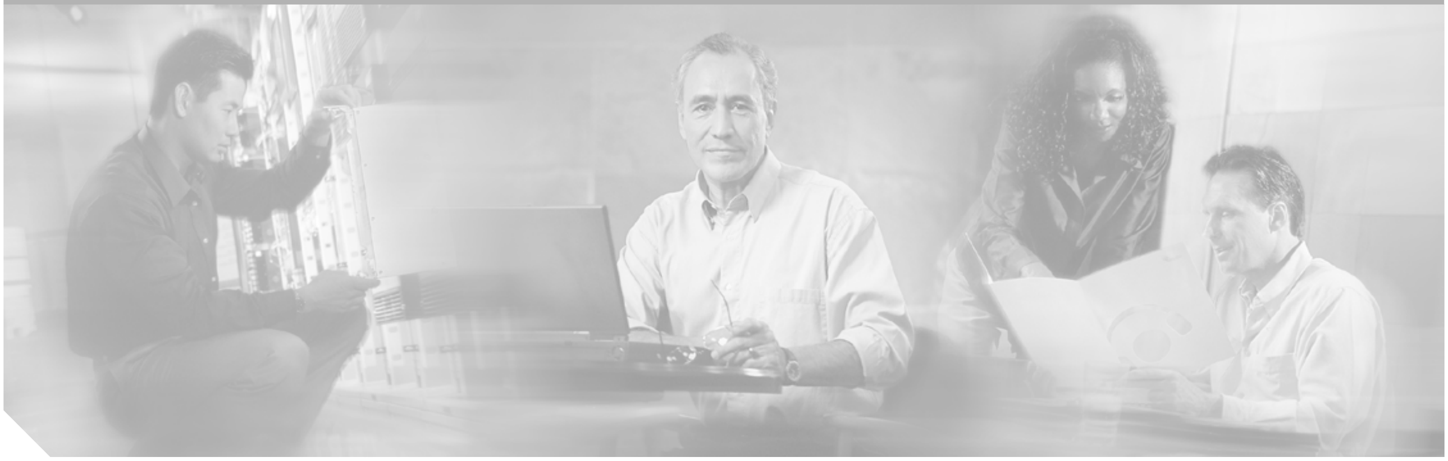
On routers with an environmental monitor, if the software detects that any of its temperature test points have exceeded maximum margins, it performs the following steps:

1. Saves the last measured values from each of the six test points to internal nonvolatile memory.
2. Interrupts the system software and causes a shutdown message to be printed on the system console.
3. Shuts off the power supplies after a few milliseconds of delay.

The system displays the following message if temperatures exceed maximum margins, along with a message indicating the reason for the shutdown:

```
Router#
%ENVM-1-SHUTDOWN: Environmental Monitor initiated shutdown
%ENVM-2-TEMP: Inlet temperature has reached SHUTDOWN level at 64(C)
```

Refer to the hardware installation and maintenance publication for your router for more information about environmental specifications.



Part 1: System Monitoring and Logging

Error Log Count Enhancement

Feature History

Release	Modification
12.2(8)T	This feature was introduced.

This document describes the error log count enhancement feature in Cisco IOS Release 12.2(8)T. It includes the following sections:

Feature Overview

The Cisco IOS logging facility allows you to save error messages locally or to a remote host. When these error messages exceed the capacity of the local buffer dedicated to storing them, the oldest messages are removed. To provide you with more information about messages that have occurred and may have been removed from the local buffer, an error log counter tabulates the occurrences of each error message, and time-stamps the most recent occurrence.

These messages are further sorted by message facility. Messages from each message facility are grouped together and totaled in the count. If a message is rate-limited, the count is incremented based on the actual messages that have occurred.

The **service timestamps** command configuration determines the format of the “Last Time” column in the **show logging** command output. Use the **service timestamps** command to configure the time-stamp format in the “Last Time” column.

Benefits

- Provides detailed information regarding system messages, including the most recent time the message occurred.

- Alerts you to a potential problem with the system if you see the same error message occurring repeatedly.

Related Features and Technologies

- Cisco IOS Logging

Related Documents

- *Cisco IOS Configuration Fundamentals Configuration Guide*, Cisco IOS Release 12.2
- *Cisco IOS Configuration Fundamentals Command Reference*, Cisco IOS Release 12.2

Supported Platforms

- Cisco 800 series
- Cisco 806
- Cisco 820 series
- Cisco 828
- Cisco 1400 series
- Cisco 1600 series
- Cisco 1700 series
- Cisco 2500 series
- Cisco 2600 series
- Cisco 3620 series
- Cisco 3640 series
- Cisco 3660 series
- Cisco 7100 series
- Cisco 7200 series
- Cisco 7500 series
- Cisco 7700 series
- Cisco Catalyst 4000 Gateway Module
- Cisco CVA120
- Cisco ONS 15104
- Cisco Route Processor Module (RPM)
- Cisco SOHO 70 series
- Cisco SOHO 78
- Cisco uBR925 series cable access routers
- Cisco uBR7200 series universal broadband routers

- Cisco Universal Router Module (URM)
- Cisco VG200

Determining Platform Support Through Cisco Feature Navigator

Cisco IOS software is packaged in feature sets that support specific platforms. To get updated information regarding platform support for this feature, access Cisco Feature Navigator. Cisco Feature Navigator dynamically updates the list of supported platforms as new platform support is added for the feature.

Cisco Feature Navigator is a web-based tool that enables you to quickly determine which Cisco IOS software images support a specific set of features and which features are supported in a specific Cisco IOS image. You can search by feature or release. Under the release section, you can compare releases side by side to display both the features unique to each software release and the features in common.

To access Cisco Feature Navigator, you must have an account on Cisco.com. If you have forgotten or lost your account information, send a blank e-mail to cco-locksmith@cisco.com. An automatic check will verify that your e-mail address is registered with Cisco.com. If the check is successful, account details with a new random password will be e-mailed to you. Qualified users can establish an account on Cisco.com by following the directions at http://www.cisco.com/register.

Cisco Feature Navigator is updated regularly when major Cisco IOS software releases and technology releases occur. For the most current information, go to the Cisco Feature Navigator home page at the following URL:

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

Supported Standards, MIBs, and RFCs

Standards

No new or modified standards are supported by this feature.

MIBs

No new MIBs are supported by this feature

To obtain lists of supported MIBs by platform and Cisco IOS release, and to download MIB modules, go to the Cisco MIB website on Cisco.com at the following URL:

http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml

RFCs

No new or modified RFCs are supported by this feature.

Configuration Tasks

See the following sections for configuration tasks for this feature. Each task in the list is identified as either required or optional.

- Enabling the Error Log Count Capability (required)

Enabling the Error Log Count Capability

To enable the error log count capability, use the following command in global configuration mode:

Command	Purpose
`Router(config)# logging count`	Enables the error log count capability.

Verifying the Error Log Count Capability

Enter the **show logging count** command to view information about syslog error messages.

```
Router# show logging count

Facility       Message Name                     Sev Occur   Last Time
=============================================================================
SYS            BOOTTIME                           6    1 00:00:12
SYS            RESTART                            5    1 00:00:11
SYS            CONFIG_I                           5    3 1d00h
-------------  -------------------------------  -----------------------------
SYS TOTAL                                              5

LINEPROTO      UPDOWN                             5   13 00:00:19
-------------  -------------------------------  -----------------------------
LINEPROTO TOTAL                                       13

LINK           UPDOWN                             3    1 00:00:18
LINK           CHANGED                            5   12 00:00:09
-------------  -------------------------------  -----------------------------
LINK TOTAL                                            13

SNMP           COLDSTART                          5    1 00:00:11
-------------  -------------------------------  -----------------------------
SNMP TOTAL                                             1
```

Configuration Examples

This section provides the following configuration example:

- Enabling the Error Log Count Capability Example

Enabling the Error Log Count Capability Example

In the following example, the error log count capability is enabled:

```
Router# logging count
```

```
Building configuration...
Current configuration : 2507 bytes
!
! Last configuration change at 14:53:38 UTC Tue Feb 5 2002
!
.
.
.
hostname router
!
logging count
logging buffered notifications
```

Command Reference

The following new and modified commands are pertinent to this feature. To see the command pages for these commands and other commands used with this feature, go to the *Cisco IOS Master Commands List*, Release 12.4, at http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124mindx/124index.htm.

New Command

- **logging count**

Modified Command

- **show logging**

CPU Thresholding Notification

The CPU Thresholding Notification feature notifies users when a predefined threshold of CPU usage is crossed by generating a Simple Network Management Protocol (SNMP) trap message for the top users of the CPU.

Feature History for the CPU Thresholding Notification Feature

Release	Modification
12.0(26)S	This feature was introduced.
12.3(4)T	This feature was integrated into Cisco IOS Release 12.3(4)T.
12.2(25)S	This feature was integrated into Cisco IOS Release 12.2(25)S.

Finding Support Information for Platforms and Cisco IOS Software Images

Use Cisco Feature Navigator to find information about platform support and Cisco IOS software image support. Access Cisco Feature Navigator at http://www.cisco.com/go/fn. You must have an account on Cisco.com. If you do not have an account or have forgotten your username or password, click **Cancel** at the login dialog box and follow the instructions that appear.

Contents

Restrictions for CPU Thresholding Notification

CPU utilization averages are computed by Cisco IOS software using a 4-millisecond Network-to-Management Interface (NMI) tick. In the unlikely event where the traffic rate is a multiple of this tick rate over a prolonged period of time, the CPU Thresholding Notification feature may not accurately measure the CPU load.

Information About CPU Thresholding Notification

The CPU Thresholding Notification feature allows you to configure CPU utilization thresholds that, when crossed, trigger a notification. Two types of CPU utilization threshold are supported:

- Rising Threshold, page 58
- Falling Threshold, page 58

Rising Threshold

A rising CPU utilization threshold specifies the percentage of CPU resources that, when exceeded for a configured period of time, triggers a CPU threshold notification.

Falling Threshold

A falling CPU utilization threshold specifies the percentage of CPU resources that, when CPU usage falls below this level for a configured period of time, triggers a CPU threshold notification.

How to Configure CPU Thresholding Notification

This section contains the following procedures:

- Enabling CPU Thresholding Notification, page 58
- Defining CPU Thresholding Notification, page 59
- Setting the Entry Limit and Size of CPU Utilization Statistics, page 60

Enabling CPU Thresholding Notification

To specify the recipient of SNMP notification operations and enable CPU thresholding notification, perform these steps:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **snmp-server enable traps cpu threshold**
4. **snmp-server host** *host-address* [**traps** | **informs**] [**version** {**1** | **2c** | **3** [**auth** | **noauth** | **priv**]}] *community-string* [**udp-port** *port*] **cpu** [*notification-type*] [**vrf** *vrf-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`
		Enables global configuration mode.

Step 3	**`snmp-server enable traps cpu threshold`**
	Example:
	`Router(config)# snmp-server enable traps cpu threshold`
		Enables CPU thresholding violation notification as traps and inform requests.

Step 4	**snmp-server host** *host-address* [**traps** | **informs**] [**version** {**1** | **2c** | **3** [**auth** | **noauth** | **priv**]}] *community-string* [**udp-port** *port*] **cpu** [*notification-type*] [**vrf** *vrf-name*] **Example:** `Router(config)# snmp-server host 192.168.0.0 traps public cpu`	Sends CPU traps to the specified address.

Defining CPU Thresholding Notification

To define a rising and a falling CPU threshold notification, perform these steps:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **process cpu threshold type** {**total** | **process** | **interrupt**} **rising** *percentage* **interval** *seconds* [**falling** *percentage* **interval** *seconds*]

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	**process cpu threshold type** {**total** | **process** | **interrupt**} **rising** *percentage* **interval** *seconds* [**falling** *percentage* **interval** *seconds*] **Example:** `Router(config)# process cpu threshold type total rising 80 interval 5 falling 20 interval 5`	Sets the CPU thresholding notifications types and values. • In this example, the CPU utilization threshold is set to 80 percent for a rising threshold notification and 20 percent for a falling threshold notification, with a 5-second polling interval.

Setting the Entry Limit and Size of CPU Utilization Statistics

To set the process entry limit and the size of the history table for CPU utilization statistics, perform these steps:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **process cpu statistics limit entry-percentage** *number* [**size** *seconds*]

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	**`process cpu statistics limit entry-percentage`** *`number`* `[`**`size`** *`seconds`*`]`
	Example:
	`Router(config)# process cpu statistics limit entry-percentage 40 size 300`
		Sets the process entry limit and the size of the history table for CPU utilization statistics.
		• In this example, to generate an entry in the history table, a process must exceed 40 percent CPU utilization.
		• In this example, the duration of time for which the most recent history is saved in the history table is 300 seconds.

Configuration Examples for CPU Thresholding Notification

The following examples show how to set a rising and a falling CPU thresholding notification:

- Setting a Rising CPU Thresholding Notification: Example, page 61
- Setting a Falling CPU Thresholding Notification: Example, page 62

Setting a Rising CPU Thresholding Notification: Example

The following example shows how to set a rising CPU thresholding notification for total CPU utilization. When total CPU utilization exceeds 80 percent for a period of 5 seconds or longer, a rising threshold notification is sent.

```
Router(config)# process cpu threshold type total rising 80 interval 5
```

Note When the optional **falling** arguments (*percentage* and *seconds*) are not specified, they take on the same values as the **rising** arguments (*percentage* and *seconds*).

Setting a Falling CPU Thresholding Notification: Example

The following example shows how to set a falling CPU thresholding notification for total CPU utilization. When total CPU utilization, which at one point had risen above 80 percent and triggered a rising threshold notification, falls below 70 percent for a period of 5 seconds or longer, a falling threshold notification is sent.

```
Router(config)# process cpu threshold type total rising 80 interval 5 falling 70
interval 5
```

Note When the optional **falling** arguments (*percentage* and *seconds*) are not specified, they take on the same values as the **rising** arguments (*percentage* and *seconds*).

Additional References

For additional information related to the CPU Thresholding Notification feature, refer to the following references:

Related Documents

Related Topic	Document Title
SNMP traps	*Configuration Fundamentals Command Reference*

Standards

Standards	Title
No new or modified standards are supported by this feature and support for existing standards has not been modified by this feature.	—

MIBs

MIBs	MIBs Link
CISCO-PROCESS-MIB	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

RFCs	Title
No new or modified RFCs are supported by this feature and support for existing RFCs has not been modified by this feature.	—

Technical Assistance

Description	Link
Technical Assistance Center (TAC) home page, containing 30,000 pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/public/support/tac/home.shtml

Command Reference

The following new and modified commands are pertinent to this feature. To see the command pages for these commands and other commands used with this feature, go to the *Cisco IOS Master Commands List*, Release 12.4, at http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124mindx/124index.htm.

- **process cpu statistics limit entry-percentage**
- **process cpu threshold type**
- **snmp-server enable traps cpu**
- **snmp-server host**

Memory Threshold Notifications

The Memory Threshold Notifications feature allows you to reserve memory for critical notifications and to configure a router to issue notifications when available memory falls below a specified threshold.

Feature History for the Memory Threshold Notifications Feature

Release	Modification
12.2(18)S	This feature was introduced.
12.0(26)S	This feature was integrated into Cisco IOS Release 12.0(26) S.
12.3(4)T	This feature was integrated into Cisco IOS Release 12.3(4)T.

Finding Support Information for Platforms and Cisco IOS Software Images

Use Cisco Feature Navigator to find information about platform support and Cisco IOS software image support. Access Cisco Feature Navigator at http://www.cisco.com/go/fn. You must have an account on Cisco.com. If you do not have an account or have forgotten your username or password, click **Cancel** at the login dialog box and follow the instructions that appear.

Contents

Information About Memory Threshold Notifications

The Memory Threshold Notifications feature provides two ways to mitigate low-memory conditions on a router: notifications can be sent to indicate that free memory has fallen below a configured threshold, and memory can be reserved to ensure that sufficient memory is available to issue critical notifications. To implement the Memory Threshold Notifications feature, you should understand the following concepts:

- Memory Threshold Notifications, page 66
- Memory Reservation, page 66

Memory Threshold Notifications

Notifications are messages issued by the router. When you specify a memory threshold using the **memory free low-watermark** command, for example, the router issues a notification when available free memory falls below the specified threshold, and again once available free memory rises to 5 percent above the specified threshold. The following are examples of memory threshold notifications:

Available Free Memory Less Than the Specified Threshold

```
000029: *Aug 12 22:31:19.559: %SYS-4-FREEMEMLOW: Free Memory has dropped below 2000k
Pool: Processor  Free: 66814056  freemem_lwm: 204800000
```

Available Free Memory Recovered to More Than the Specified Threshold

```
000032: *Aug 12 22:33:29.411: %SYS-5-FREEMEMRECOVER: Free Memory has recovered 2000k
Pool: Processor  Free: 66813960  freemem_lwm: 0
```

Memory Reservation

Memory reservation for critical operations ensures that management processes, such as event logging, continue to function even when router memory is exhausted.

How to Define Memory Threshold Notifications

This section contains the following procedures:

- Setting a Low Free Memory Threshold, page 67
- Reserving Memory for Critical Notifications, page 67

Setting a Low Free Memory Threshold

To set a low free memory threshold, perform the following steps:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **memory free low-watermark** {**processor** *threshold* | **io** *threshold*}

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	**`memory free low-watermark processor`** *`threshold`*
	or
	`memory free low-watermark io` *`threshold`*
	Example:
	`Router(config)#` **`memory free low-watermark processor 20000`**
	or
	Example:
	`Router(config)#` **`memory free low-watermark io 20000`**
		Specifies a threshold in kilobytes of free processor or input/output (I/O) memory. To view acceptable values for the memory threshold, enter the following command:
		• **memory free low-watermark processor ?**
		or
		• **memory free low-watermark io ?**

Reserving Memory for Critical Notifications

When a router is overloaded by processes, the amount of available memory might fall to levels insufficient for it to issue critical notifications. To reserve a region of memory to be used by the router for the issuing of critical notifications, perform the following steps:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **memory reserve critical** *kilobytes*

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	`memory reserve critical` *`kilobytes`*
	Example:
	`Router(config)# memory reserve critical 1000`
		Reserves the specified amount of memory in kilobytes so that the router can issue critical notifications.
		• The amount of memory reserved for critical notifications cannot exceed 25 percent of total available memory.

Configuration Examples for Memory Threshold Notifications

The following examples show how to configure a router to issue notifications when available memory falls below a specified threshold and how to reserve memory for critical notifications:

- Setting a Low Free Memory Threshold: Examples, page 68
- Reserving Memory for Critical Notifications: Example, page 69

Setting a Low Free Memory Threshold: Examples

The following example specifies a threshold of 20000 KB of free processor memory before the router issues notifications:

Threshold for Free Processor Memory

```
Router(config)# memory free low-watermark processor 20000
```

The following example specifies a threshold of 20000 KB of free I/O memory before the router issues notifications:

Threshold for Free IO Memory

```
Router(config)# memory free low-watermark io 20000
```

If available free memory falls below the specified threshold, the router sends a notification message like this one:

```
000029: *Aug 12 22:31:19.559: %SYS-4-FREEMEMLOW: Free Memory has dropped below 20000k
Pool: Processor  Free: 66814056  freemem_lwm: 204800000
```

Once available free memory rises to above 5 percent of the threshold, another notification message like this is sent:

```
000032: *Aug 12 22:33:29.411: %SYS-5-FREEMEMRECOVER: Free Memory has recovered 20000k
Pool: Processor  Free: 66813960  freemem_lwm: 0
```

Reserving Memory for Critical Notifications: Example

The following example reserves 1000 KB of memory for critical notifications:

```
Router# memory reserved critical 1000
```

Note The amount of memory reserved for critical notifications cannot exceed 25 percent of total available memory.

Additional References

The following sections provide references related to the Memory Threshold Notifications feature:

Related Documents

Related Topic	Document Title
Logging system messages	“Troubleshooting, Logging, and Fault Management” chapter in the *Cisco IOS Configuration Fundamentals Configuration Guide*

Standards

Standards	Title
No new or modified standards are supported by this feature and support for existing standards has not been modified by this feature.	—

MIBs

MIBs	MIBs Link
No new or modified MIBs are supported by this feature and support for existing MIBs has not been modified by this feature.	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

RFCs	Title
No new or modified RFCs are supported by this feature and support for existing RFCs has not been modified by this feature.	—

Technical Assistance

Description	Link
Technical Assistance Center (TAC) home page, containing 30,000 pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/public/support/tac/home.shtml

Command Reference

The following new commands are pertinent to this feature. To see the command pages for these commands and other commands used with this feature, go to the *Cisco IOS Master Commands List*, Release 12.4, at http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124mindx/124index.htm.

- **memory free low-watermark**
- **memory reserve critical**

Event Tracer

Feature History

Release	Modification
12.0(18)S	This feature was introduced.
12.2(8)T	This feature was integrated into Cisco IOS Release 12.2(8)T.

This document describes the Event Tracer feature. It includes the following sections:

Feature Overview

The Event Tracer feature provides a binary trace facility for troubleshooting Cisco IOS software. This feature gives Cisco service representatives additional insight into the operation of the Cisco IOS software and can be useful in helping to diagnose problems in the unlikely event of an operating system malfunction or, in the case of redundant systems, route processor switchover.

Note This feature is intended for use as a software diagnostic tool and should be configured only under the direction of a Cisco Technical Assistance Center (TAC) representative.

Event tracing works by reading informational messages from specific Cisco IOS software subsystem components that have been preprogrammed to work with event tracing, and by logging messages from those components into system memory. Trace messages stored in memory can be displayed on the screen or saved to a file for later analysis.

By default, trace messages saved to a file are saved in binary format without applying additional processing or formatting. Saving messages in binary format allows event tracing to collect informational messages faster and for a longer time prior to a system malfunction or processor switchover. Optionally, event trace messages can be saved in ASCII format for additional file processing.

The Event Tracer feature can support multiple traces simultaneously. To do this, the feature assigns a unique ID number to each instance of a trace. This way, all messages associated with a single instance of a trace get the same ID number. Event tracing also applies a timestamp to each trace message, which aids in identifying the message sequence.

The number of trace messages stored in memory for each instance of a trace is configurable up to 65536 entries. As the number of trace messages stored in memory approaches the configured limit, the oldest entries are overwritten with new messages, which continues until the event trace is terminated.

Event tracing can be configured in "one-shot" mode. This is where the current contents of memory for a specified component are discarded and a new trace begins. New trace messages are collected until the message limit is reached, at which point the trace is automatically terminated.

Benefits

Event tracing has a number of benefits to aid in system diagnosis:

Binary Data Format

Event information is saved in binary format without applying any formatting or processing of the information. This results in capturing event information more quickly and for a longer period of time in the moments leading up to a system malfunction or processor switchover. The ability to gather information quickly is also helpful in tracing events that generate a lot of data quickly.

File Storage

Information gathered by the event tracing can be written to a file where it can be saved for further analysis.

Optional ASCII Data Format

Event tracing provides an optional command to save the information in ASCII format.

Multiple Trace Capability

Event tracing can be configured to trace one or more components of the Cisco IOS software simultaneously, depending on the software version running on the networking device.

Restrictions

Event tracing provides a mechanism to help TAC representatives assist Cisco customers in diagnosing certain Cisco IOS software functions. Configuration of this feature on a networking device is recommended only under the direction of a TAC representative. This feature does not produce customer readable data; therefore, it requires the assistance of a TAC representative for proper configuration and analysis.

Supported Platforms

- Cisco 12000 Internet router

Platform Support Through Feature Navigator

Cisco IOS software is packaged in feature sets that support specific platforms. To get updated information regarding platform support for this feature, access Feature Navigator. Feature Navigator dynamically updates the list of supported platforms as new platform support is added for the feature.

Feature Navigator is a web-based tool that enables you to quickly determine which Cisco IOS software images support a specific set of features and which features are supported in a specific Cisco IOS image.

To access Feature Navigator, you must have an account on Cisco.com. If you have forgotten or lost your account information, send a blank e-mail to cco-locksmith@cisco.com. An automatic check will verify that your e-mail address is registered with Cisco.com. If successful, account details with a new random password will be e-mailed to you. If you want to establish an account on Cisco.com, go to http://www.cisco.com/register and follow the directions to establish an account.

Feature Navigator is updated when major Cisco IOS software releases and technology releases occur. As of May 2001, Feature Navigator supports M, T, E, S, and ST releases. You can access Feature Navigator at the following URL:

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

Supported Standards, MIBs, and RFCs

Standards

None

MIBs

None

To obtain lists of supported MIBs by platform and Cisco IOS release, and to download MIB modules, go to the Cisco MIB website on Cisco.com at the following URL:

http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml

RFCs

None

Prerequisites

The list of software components that support event tracing can vary from one Cisco IOS software image to another. And in many cases, depending on the software component, the event tracing functionality is enabled or disabled by default. Knowing what software components support event tracing and knowing the existing state of the component configuration is important in deciding whether to configure event tracing.

To determine whether event tracing has been enabled or disabled by default for a specific component, follow these steps:

Step 1 Use the **monitor event-trace ?** command in global configuration mode to get a list of software components that support event tracing.

```
Router(config)# monitor event-trace ?
```

Step 2 Use the **show monitor event-trace** *component* **all** command to determine whether event tracing is enabled or disabled by default for the component.

```
Router# show monitor event-trace component all
```

Step 3 Use the **show monitor event-trace** *component* **parameters** command to find out the default size of the trace message file for the component.

```
Router# show monitor event-trace component parameters
```

This information can help you in determining your configuration options.

Configuration Tasks

See the following sections for configuration tasks for the Event Tracer feature. Each task in the list is identified as either required or optional.

- Configuring Event Tracing (Optional)
- Configuring the Event Trace Size (Optional)
- Configuring the Event Trace Message File (Optional)
- Verifying Event Trace Operation (Optional)

Follow the instructions in the “Prerequisites” section prior to configuring this feature. If the default configuration information meets your site requirements, no further configuration may be necessary, and you may proceed to the section “Verifying Event Trace Operation.”

Configuring Event Tracing

In most cases where Cisco IOS software components support event tracing, the feature is configured by default. For some software components, event tracing is enabled, while for other components event tracing might be disabled. In some cases, a TAC representative may want to change the default settings.

To enable or disable event tracing, use the following commands in global configuration mode:

Command	Purpose

`Router(config)# monitor event-trace component enable`
or
`Router(config)# monitor event-trace component disable`
	Enables or disables event tracing for the specified Cisco IOS software component on the networking device.
	Note Component names are set in the system software and are not configurable. To obtain a list of software components supporting event tracing for this release, use the **monitor event-trace ?** command.

Configuring the Event Trace Size

In most cases where Cisco IOS software components support event tracing, the feature is configured by default. In some cases, such as directed by a TAC representative, you might need to change the size parameter to allow for writing more or fewer trace messages to memory.

To configure the message size parameter, use the following command in global configuration mode:

Command	Purpose
`Router(config)# monitor event-trace component size number`	Configures the size of the trace for the specified component. The number of messages that can be stored in memory for each instance of a trace is configurable up to 65536 entries.

Configuring the Event Trace Message File

To configure the file location where you want to save trace messages, use the following command in global configuration mode:

Command	Purpose
`Router(config)# monitor event-trace component dump-file filename`	Configures the file where the trace messages will be saved. The maximum length of the filename (path:filename) is 100 characters. The path can point to flash memory on the networking device or to a TFTP or FTP server.

Verifying Event Trace Operation

Note Depending on the software component, event tracing is enabled or disabled by default. In either case, the default condition will not be reflected in the output of the **show running-config** command; however, changing any of the settings for a command that has been enable or disabled by default will cause those changes to show up in the output of the **show running-config** command.

Step 1 If you made changes to the event tracing configuration, enter the **show running-config** command in privileged EXEC mode to verify the changes.

```
Router# show running-config
```

Step 2 Enter the **show monitor event-trace** *component* command to verify that event tracing has been enabled or disabled for a component.

In the following example, event tracing has been enabled for the IPC component. Notice that each trace message is numbered sequentially (for example, 3667) and is followed by a the timestamp (derived from the device uptime). Following the timestamp is the component specific message data.

```
Router# show monitor event-trace ipc

3667:  6840.016:Message type:3 Data=0123456789
3668:  6840.016:Message type:4 Data=0123456789
3669:  6841.016:Message type:5 Data=0123456789
3670:  6841.016:Message type:6 Data=0123456
```

To view trace information for all components enabled for event tracing, enter the **show monitor event-trace all-traces** command. In this example, separate output is provided for each event and message numbers are interleaved between the events.

```
Router# show monitor event-trace all-traces

Test1 event trace:
3667: 6840.016:Message type:3 Data=0123456789
3669: 6841.016:Message type:4 Data=0123456789
3671: 6842.016:Message type:5 Data=0123456789
3673: 6843.016:Message type:6 Data=0123456789

Test2 event trace:
3668: 6840.016:Message type:3 Data=0123456789
3670: 6841.016:Message type:4 Data=0123456789
3672: 6842.016:Message type:5 Data=0123456789
3674: 6843.016:Message type:6 Data=0123456789
```

Step 3 Verify that you have properly configured the filename for writing trace messages.

```
Router# monitor event-trace ipc dump
```

Troubleshooting Tips

Event Tracing Does Not Appear to Be Configured in the Running Configuration

Depending on the software component, event tracing is enabled or disabled by default. In either case, the default condition will not be reflected in output of the **show running-config** command; however, changing any of the settings for a command that has been enabled or disabled by default will cause those changes to show up in the output of the **show running-config** command. Changing the condition of the component back to its default state (enabled or disabled), will cause the entry not to appear in the configuration file.

Show Command Output Is Reporting "One or More Entries Lost "

The trace function is not locked while information is being displayed to the console, which means that new trace messages can accumulate in memory. If entries accumulate faster than they can be displayed, some messages can be lost; however, messages will continue to display on the console. If the number of lost messages is excessive, the **show** command will stop displaying messages.

Show Command Output Terminates Unexpectedly

The trace function is not locked while information is being displayed to the console, which means that new trace messages can accumulate in memory. If entries accumulate faster than they can be displayed, some messages can be lost. If the number of lost messages is excessive, the **show** command will stop displaying messages.

Show Command Output Is Reporting That "Tracing Currently Disabled, from EXEC Command"

The Cisco IOS software allows for the subsystem components to define whether support for event tracing is enabled or disabled at boot time. Event tracing allows users to enable or disable event tracing in two ways: using the **monitor event-trace** (EXEC) command in privileged EXEC mode or using the **monitor event-trace** (global) command in global configuration mode. To enable event tracing again in this case, you would enter the **enable** form of either of these commands.

Show Command Output Is Reporting That "Tracing Currently Disabled, from Config Mode"

The Cisco IOS software allows for the subsystem components to define whether support for event tracing is enabled or disabled at boot time. Event tracing allows users to disable event tracing in two ways: using the **monitor event-trace disable** (EXEC) command in privileged EXEC mode or using the **monitor event-trace disable** (global) command in global configuration mode. To enable event tracing again in this case, you would enter the **enable** form of either of these commands.

Event Trace Messages Are Not Being Saved in ASCII Format

By default, the **monitor event-trace** *component* **dump** and **monitor event-trace dump-traces** commands save trace messages in binary format. If you want to save trace messages in ASCII format, use either the **monitor event-trace** *component* **dump pretty** command to write the trace messages for a single event, or the **monitor event-trace dump-traces pretty** command to write trace messages for all event traces currently enabled on the networking device.

Configuration Examples

This section provides the following configuration examples:

- Configuring Event Tracing for One Component Example
- Configuring Event Tracing for Multiple Components Example
- Configuring the Event Trace Size Example
- Configuring the Event Trace Message File Example

Configuring Event Tracing for One Component Example

In the following example, the networking device has been configured to trace IPC component events:

```
monitor event-trace ipc enable
```

Configuring Event Tracing for Multiple Components Example

In the following example, the networking device has been configured to trace IPC and MBUS component events:

```
monitor event-trace ipc enable
monitor event-trace mbus enable
```

Configuring the Event Trace Size Example

In the following example, the size of the IPC trace is set to 4096 entries while the size of the MBUS trace is set to 8192 entries:

```
monitor event-trace ipc size 4096
monitor event-trace mbus size 8192
```

Configuring the Event Trace Message File Example

The following example identifies the files in which to write trace messages. In this example, event tracing has been enabled for both the IPC and MBUS components, the IPC trace messages are written to the ipcdump file in flash memory, while the MBUS trace message files are written to the mbusdump file on the TFTP server.

```
monitor event-trace ipc dump-file slot0:ipcdump
monitor event-trace mbus dump-file TFTP:mbusdump
```

Command Reference

The following new commands are pertinent to this feature. To see the command pages for these commands and other commands used with this feature, go to the *Cisco IOS Master Commands List*, Release 12.4, at http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124mindx/124index.htm.

New Commands

- **monitor event-trace (EXEC)**
- **monitor event-trace (global)**
- **monitor event-trace dump-traces**
- **show monitor event-trace**

Embedded Resource Manager

The Embedded Resource Manager (ERM) feature allows you to impose and monitor an upper limit of usage for resources such as buffer, memory, and CPU. This feature monitors system resource usage to better understand scalability needs by allowing you to configure threshold values for the CPU, buffer, and memory resource owners. This check helps prevent catastrophic system failures due to high levels of resource depletion.

History for the Embedded Resource Manager Feature

Release	Modification
12.3(14)T	This feature was introduced.

Finding Support Information for Platforms and Cisco IOS Software Images

Use Cisco Feature Navigator to find information about platform support and Cisco IOS software image support. Access Cisco Feature Navigator at http://www.cisco.com/go/fn. You must have an account on Cisco.com. If you do not have an account or have forgotten your username or password, click **Cancel** at the login dialog box and follow the instructions that appear.

Contents

Information About Embedded Resource Manager

To configure and set up threshold values for resource manager entities, you should understand the following concepts:

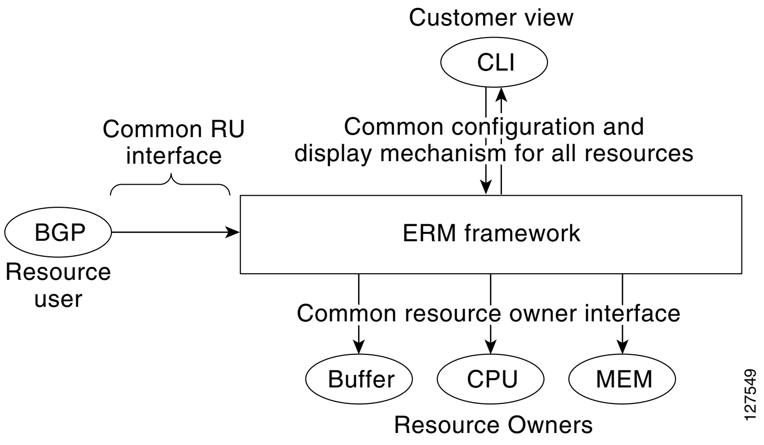
- Embedded Resource Manager Infrastructure, page 80
- Resource Owner, page 81
- Resource User, page 83
- Resource Usage Monitor, page 83
- Resource User Type, page 83
- Embedded Resource Manager Infrastructure Manager, page 83
- Benefits of Embedded Resource Manager, page 85
- Resource Owner Policy Templates, page 88

Embedded Resource Manager Infrastructure

The Embedded Resource Manager (ERM) infrastructure tracks resource depletion and resource dependencies across processes and within a system to handle various error conditions. The error conditions are handled by providing an equitable sharing of resources between various applications. The ERM framework provides a communication mechanism for resource entities and allows communication between these resource entities from numerous locations. The ERM framework also helps in debugging the CPU and memory related issues. The Embedded Resource Manager feature monitors system resource usage to better understand scalability needs by allowing you to configure threshold values for resources such as CPU, buffer, and memory.

The ERM architecture is illustrated in Figure 1.

Figure 1 ERM Architecture



The infrastructure provided by ERM can be extended to any resource that needs to be monitored. The ERM infrastructure also supports multi-processor platforms through a distributed ERM architecture (dERM) that shares the same commands and functionality as non-distributed ERM.

The ERM framework provides a mechanism to send notifications whenever the specified threshold values are violated by any resource user (RU). This notification helps in reducing the CPU, buffer, and memory utilization issues.

ERM has the following entities.

- Resource Owner, page 81
- Resource User, page 83
- Resource Usage Monitor, page 83
- Resource User Type, page 83

Resource Owner

Resource Owner (RO) is an entity (for example, buffer, CPU, or memory) that allocates its resources to the RUs. The ROs maintain a list of RUs and perform the following:

- Accounting and Thresholding, page 81
- Notifications Sent and Actions Taken, page 83
- View Statistics, page 83

Accounting and Thresholding

Accounting and thresholding involves accounting of resources allocated to each RU and using threshold limits for notifying the RUs and resource usage monitors (RM). Accounting is done by individual ROs. The Embedded Resource Manager feature allows you to set thresholding values for buffer, CPU, and memory utilization. When the utilization for each of the RUs crosses the threshold value you have set, the ROs send notifications to the RUs.

You can set rising and falling values for critical, major, and minor levels of thresholds. When the resource utilization crosses the rising threshold level, an Up notification is sent to the relevant RUs and ROs. When the resource utilization falls below the falling threshold level, a Down notification is sent to the relevant RUs and ROs.

The ROs allow three types of thresholding:

- System Global Thresholding, page 81
- User Local Thresholding, page 82
- Per User Global Thresholding, page 82

System Global Thresholding

System global thresholding is used when the entire resource reaches a specified value. That is, the RUs are notified when the total resource utilization goes above or below a specified threshold value. For critical thresholding, if the resource usage goes above the critical values, the system could cease to function effectively. The notification order is determined by the priority of the RU. The RUs with a lower priority are notified first, so that these low-priority RUs are expected to reduce the resource utilization. This order prevents the high-priority RUs from getting affected with unwanted notifications.

You can set rising and falling threshold values for minor, major, and critical levels of resource utilization for buffer, CPU, and memory ROs. For example, if you have set a CPU utilization threshold value of 60% as minor rising value, 70% as major rising value, and 90% as critical rising value, then when the total CPU utilization crosses the 60% mark, a minor Up notification is sent to all the RUs. When the total CPU utilization crosses the 70% mark, a major Up notification is sent to all the RUs, and when it crosses the 90% mark, a critical Up notification is sent to all the RUs. Similarly, if you have set a total CPU utilization threshold value of 5% as minor falling value, 15% as major falling value, and 20% as critical falling value, then when the total CPU utilization falls below 5%, a minor Down notification is sent to all the RUs. When the total CPU utilization falls below 15%, a major Down notification is sent to the RUs, and when the value falls below 20%, a critical Down notification is sent to all the RUs.

For the buffer RO, if you have set a total buffer usage count threshold value of 60% as minor rising value, 70% as major rising value, and 90% as the critical rising value, then when the total buffer usage count crosses the 60% mark, a minor Up notification is sent to all the RUs. When the total buffer usage count crosses the 70% mark, a major Up notification is sent to all the RUs, and when it crosses the 90% mark, a critical Up notification is sent to all the RUs. Similarly, if you have set a total buffer usage count threshold value of 5% as minor falling value, 15% as major falling value, and 20% as critical falling value, then when the total buffer usage count falls below 5%, a minor Down notification is sent to all the RUs. When the total buffer usage falls below 15%, a major Down notification is sent to the RUs, and when the value falls below 20%, a critical Down notification is sent to all the RUs.

For the memory RO, if you have set a total memory usage threshold value of 60% as minor rising value, 70% as major rising value, and 90% as the critical rising value, then when the total memory usage count crosses the 60% mark, a minor Up notification is sent to all the RUs. When the total memory usage crosses the 70% mark, a major Up notification is sent to all the RUs, and when it crosses the 90% mark, a critical Up notification is sent to all the RUs. Similarly, if you have set a total memory usage threshold value of 5% as minor falling value, 15% as major falling value, and 20% as critical falling value, then when the total memory usage falls below 5%, a minor Down notification is sent to all the RUs. When the total memory usage falls below 15%, a major Down notification is sent to all the RUs, and when the value falls below 20%, a critical Down notification is sent to all the RUs.

User Local Thresholding

User local thresholding is used when a specified RU's utilization exceeds the configured limits. The user local thresholding method prevents a single RU from monopolizing the resources. That is, the specified RU is notified when the resource utilization of the specified RU goes above or below a configured threshold value. For example, if you have set a CPU utilization threshold value of 60% as minor rising value, 70% as major rising value, and 90% as critical rising value, then when the CPU utilization of the specified RU crosses the 60% mark, a minor Up notification is sent to the specified RU only. When the CPU utilization of the specified RU crosses the 70% mark, a major Up notification is sent and when it crosses the 90% mark, a critical Up notification is sent to the specified RU only. Similarly, if you have set a CPU utilization threshold value of 5% as the minor falling value, then when the CPU utilization of the specified RU falls below the 5% mark, a minor Down notification is sent to the specified RU only. The same example applies to buffer and memory ROs also.

Per User Global Thresholding

Per user global thresholding is used when the entire resource reaches a configured value. This value is unique for every RU and notification is sent only to the specified RU. Per user global thresholding is similar to system global thresholding, except that the notification is sent only to the specified RU. That is, only the specified RU is notified when the total resource utilization goes above or below a configured threshold value. For example, if you have set a CPU utilization threshold value of 60% as the minor rising value, 70% as major rising value, and 90% as critical rising value, then when the total CPU utilization crosses the 60% mark, a minor Up notification is sent to the specified RU only. When the total CPU utilization crosses the 70% mark, a major Up notification is sent and when it crosses the 90% mark, a critical Up notification is sent to the specified RU only. Similarly, if you have set a CPU utilization threshold value of 5% as the minor falling value, then when the total CPU utilization falls below the 5% mark, a minor Down notification is sent to the specified RU only. The same example applies to buffer and memory ROs also.

Notifications Sent and Actions Taken

When an RU or RUs exceed local or global thresholding values, a notification is sent to the RUs. The RUs are expected to take actions on the notification by freeing or limiting the resource consumption.

The ROs may take action to avoid resource exhaustion. ROs restrain the RUs from allocating resources if the RU does not take action on limiting or freeing the resource usage.

View Statistics

The ROs provide a mechanism for logging and displaying the statistics through related **show** commands.

Resource User

A Resource User (RU) is an entity or application that consumes one or more resources. The RU registers with ROs for notification of threshold violations. When a RU receives an *Up* notification, it is expected to reduce its utilization of that resource.

Each RU has a priority associated with it. The RO uses this priority to determine the order of notification when a threshold violation occurs. The low-priority RUs are notified to take action before notifying high-priority RUs. After each RU is notified, the RO verifies whether the threshold violation is corrected or not. If the violation is corrected by the RUs, the RO stops sending further notification.

The RU can also register for remote resource providers (for example, Forwarding Memory on line cards) if the resource is allocated on behalf of another RU.

Resource Usage Monitor

The Resource usage Monitor (RM) is an entity or application that monitors resource violations and takes action based on RU and RO attributes. The RM registers with the ROs to monitor local thresholding and global thresholding and notifies the RO to change thresholds for a RU.

Resource User Type

The Resource User Type (RUT) defines a set of ROs. For example, a RUT named “process” has a set of ROs: CPU and memory. Any RU of type “process” can use only the CPU and memory resources owners.

Embedded Resource Manager Infrastructure Manager

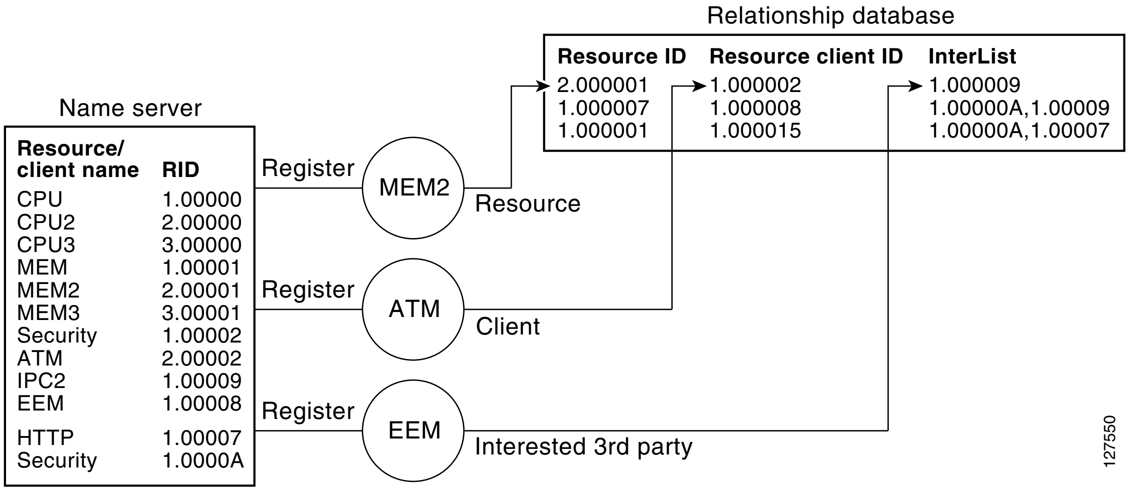
The Embedded Resource Manager Infrastructure Manager (ERMIM) maintains entity registrations and handles queries from the command line interface (CLI) to establish relationships between different entities.

ERMIM contains two databases:

- Name Server Database
- Relationship Database

The ERMIM server-database relationship is illustrated in Figure 2 below.

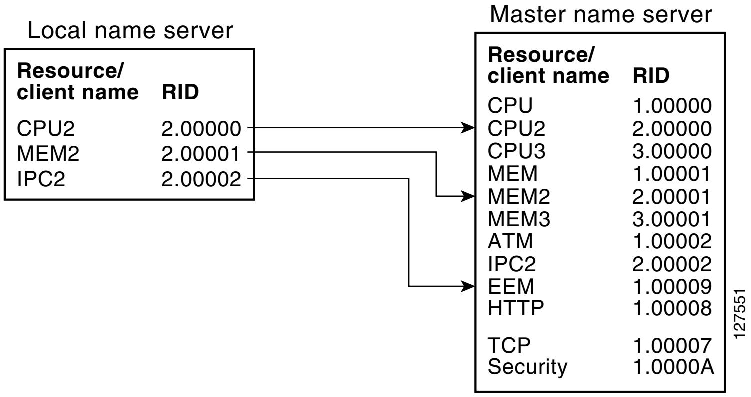
Figure 2 ERMIM Server-Database Relationship



Each Resource Entity (resource owner, resource user type, resource user, resource group, resource usage monitor) has a unique resource manager ID assigned to it. When an RU registers with an RO for resource thresholding and notification, it queries the master name server database for the resource manager ID of the RO. The ROs can be local or remote. An entry is added to the local and master resource relationship database in the ERMIM.

The ERMIM local-master name server relationship is illustrated in Figure 3.

Figure 3 ERMIM (Local-Master) Name Server Relationship



The relationship database contains the relationship information between the RUs and the ROs. Once an entry is added to the master relationship database, the RO gets a notification and the RO adds new users to its database. The ERMIM keeps the thresholds that were configured through the CLI and automatically applies the configured thresholds to the RUs after it has successfully registered with the RO.

Benefits of Embedded Resource Manager

This feature addresses the following infrastructure issues to improve the scalability of Cisco IOS devices:

- Crashes
- Memory allocation failure
- High CPU utilization

To address the above issues, the following resources are monitored:

- CPU Resource Owner, page 85
- Memory Resource Owner, page 86
- Buffer Resource Owner, page 86

CPU Resource Owner

Prior to this feature, the only CPU-related statistics available were from the **show processes cpu** command output. Though this information gives a general idea about CPU utilization of the processes, it does not provide sufficient specific information for ERMI to address the CPU issues. For example, it does not provide information on the latencies being faced by the processes or estimate the behavior of a process. Additionally, when a system faces a CPUHOG, the trace back emitted is usually unrelated to the routine causing the CPUHOG. Even for cases where it contains the offending routine, the information conveyed on CPUHOG cause is insufficient and multiple iterations are required to find the root cause of CPUHOG.

This feature uses the existing loadometer process, which calculates the load information displayed by the **show processes cpu** command and it also calculates the extended load statistics. This method generates a report of the extended load statistics and adds it to a circular buffer every 5 seconds. You can get a history of the past 1 minute through the CLI. This feature also provides a more intelligent CPUHOG profiling mechanism that helps to reduce the time required to diagnose the problems.

The following functions help in load monitoring:

Loadometer Process

The loadometer process generates an extended load monitor report every 5 seconds. The loadometer function, which calculates process CPU usage percentages, is enhanced to generate the loadometer process reports.

Scheduler

The scheduler collects data when a process gets executed, which enables the loadometer to generate reports. The collection of data is done by the scheduler when the process is launched or when the process transfers the control back to the scheduler.

Snapshot Management Using Event Trace

Snapshot management manages the buffer in which snapshots of reports are stored. The snapshot management infrastructure stores, displays, and releases the snapshots.

Automatic CPUHOG Profiling

Automatic CPUHOG profiling is achieved through timer Interrupt Service Routine (ISR). The timer ISR starts profiling a process when it notices that the process has taken more than the configured value or a default of 2x (maximum scheduling quantum). After starting the profiling process, the timer ISR saves the interrupted program counter (pc) and return address (ra) in a pre-allocated buffer. This process helps in CPUHOG analysis and analysis of long running computations on a process.

In CPUHOG analysis, the profiling continues until the CPUHOG is reported or the buffer is full. For the analysis of long running computations in a process you must specify a process ID (PID) and a threshold to start the profiling. When the specified process takes up more than the specified time (in milliseconds), the profiling starts. The data for the longest run is always stored if the longest run is shorter than a CPUHOG. Otherwise, it is treated as a CPUHOG.

The default size of the buffer is 1250 entries and can store up to 5 seconds of profiling data.

Memory Resource Owner

The Embedded Resource Manager feature enhances the memory manager in Cisco IOS devices. The enhancements include:

- Memory Usage History
- Memory Accounting

Memory Usage History

Prior to the implementation of the Embedded Resource Manager feature, when a memory fragmentation or depletion of free memory occurs, Cisco IOS software requests the users to collect the global memory usage data at periodic intervals. This data was used to investigate the patterns of memory usage. The Embedded Resource Manager feature helps in maintaining memory fragmentation information and reduces the burden on the user to maintain scripts for collecting this information.

A memory RO has the intelligence to allocate memory to a RU. That is, when a memory RO receives an allocation request, the memory is allocated to the current RU. When a free request is received, the memory RO reduces the memory allocation from the RU to which the corresponding allocation was done.

Memory Accounting

Prior to this feature, memory was accounted only on a per process basis. The Embedded Resource Manager feature enables accounting of memory on a per application basis. The accounting information for memory is maintained on a per RU basis. When a process is created, a corresponding RU is also created against which the accounting of memory is done. The process of creating RUs helps in migrating from a process-based accounting to a resource user-based accounting scheme for memory.

The memory RO maintains a global threshold and a per RU memory usage threshold. The thresholds can be configured through the ERMI infrastructure. The memory RO tracks the global free memory. When it exceeds the global free memory, a notification is sent to the registered RMs. Similarly when a particular RU exceeds its threshold of memory usage, a notification is sent to that RU. These notifications are sent using the ERMI infrastructure.

Buffer Resource Owner

The Embedded Resource Manager feature addresses the most frequently faced problems to the Buffer Manager. They are:

- Buffer Manager Tuning

- Buffer Leak Detection
- Buffer Accounting
- Buffer Usage Thresholding

Buffer Manager Tuning

Prior to this feature, tuning of buffers was a manual process. You had to manually tune low water mark, high water mark, and other tunable buffer parameters. This process was iterative and error prone. The Embedded Resource Manager feature allows you to automatically tune the buffers using the **buffer tune automatic** command. The buffer RO tunes permanent memory in particle pools based on the usage of the buffer pool.

The buffer RO tracks the number of failures and memory situations in the buffer pool. When the number of failures increases above 1% of the buffer hits or when the memory situation is zero (no memory) in the buffer pool, the buffer RO performs an automatic tuning.

Before enabling automatic tuning of buffers, check whether there is enough free I/O memory or main memory using the first lines of the **show memory** command.

Here are some general values that help to verify whether you have enough memory:

permanent: take the number of total buffers in a pool and add 20%.

min-free: set min-free to 20 to 30% of the permanent number of allocated buffers in the pool.

max-free: set max-free to a value greater than the sum of permanent and minimum values.

However, when there is a traffic burst, the Cisco IOS device may not have enough time to create the new buffers and the number of failures may continue to increase.

The Embedded Resource Manager feature monitors the buffer pool every minute for tuning (that is, for number of hits, number of failures, and the number of counters created). When buffer tuning is enabled, the buffer RO automatically tunes the buffers when required.

Buffer Leak Detection

Prior to this feature, there was no suitable mechanism to detect potential buffer leak situations. The Embedded Resource Manager feature allows Cisco IOS devices to detect and diagnose buffer leaks.

All the buffers in a pool are linked so that they can be traced easily. The number of buffers allocated for incoming and outgoing packets in each buffer pool is tracked and can be viewed from the output of the **show buffers leak** command.

Buffer Accounting

Prior to this feature, there was no accounting information available for buffer usage. When a Cisco IOS device was detected to be using a high number of buffers, it was not known which application or protocol or the type of packet that was responsible for the increased usage of buffers. The Embedded Resource Manager feature introduces mechanisms to account for the usage of buffers.

All buffers are owned by the pool manager process (buffer RU). When a RU requests for a buffer, the allocated buffer is accounted to that RU and when the RU returns the buffer, it is deducted from the RU's account. The packet type from the output of the **show buffers usage** command indicates the RU to which the packet belongs.

Buffer Usage Thresholding

Prior to this feature, there was no facility to detect high buffer usage situation and print an error message or send an SNMP notification. The Embedded Resource Manager feature provides a facility to manage high buffer utilization.

The buffer manager RO registers as a RU with the memory RO. The buffer manager RU is set before a memory allocation is made for creating new buffers. The buffer manager also registers as an RO. When a buffer is allocated, the current RU (if any) is charged with the memory allocation. The buffer manager RO registers for the notifications from the memory manager for the processor and I/O memory pool. In case the I/O memory pool is falling short of memory, the buffer manager tries to free the lists of all the buffer pools. If your Cisco IOS device does not support I/O memory, then it registers for notifications from the processor memory.

Cisco IOS software maintains a threshold per buffer pool. When a particular pool crosses the specified threshold, it sends a notification to all the RUs in that pool, so that the RUs can take corrective actions. Thresholds are configured for public buffer pools only.

Global notification is set for every pool in the system. That is, one notification for all pools in the public pool and one notification for each pool in the private pool. Threshold notifications are sent to only those RUs that have registered with the ROs for getting notifications. A list of RUs that have registered with the RO is maintained by the RO. When the threshold of a particular RU is violated, then that RU is notified and marked notified. When the buffers are recovered, the notified RUs are moved back to the original list.

For example, an Ethernet driver RU is allocated buffers from some particular private pool. Another RU, Inter Processor Communication (IPC) is added to the list. In this case, when the pool runs low on buffers, the IPC RU gets a notification and it can take corrective measures.

You can configure threshold values as percentages of the total buffers available in the public pool. Total buffer is the sum of maximum allowed buffers and the permanent pools in the public buffer pool. If these values change due to buffer tuning, then the threshold values also change. For example, if you had configured to send a notification when the IPC RU is holding more than 40% of Ethernet buffers and the sum of permanent and maximum allowed for Ethernet buffers is 150%, then when the holding of IPC RU reaches 60%, the Ethernet pool is notified.

Resource Owner Policy Templates

Resource owner policy is a template used by the ROs to associate a RU with a set of thresholds that are configured through the CLI. This template can be used to specify system global, user local, and per user global thresholds. A particular resource group or RU can have only one policy associated with it. The policy template for ROs is maintained by the ERMI framework.

When a policy template is associated with a user type and its instance (RUs), the thresholds configured in that policy are applied based on the RU to RO relationship. This method ignores any RO configuration that may not be applicable to the RU.

How to Configure and Apply a Policy for ERM

This section contains the following procedures.

- Configuring a Resource Policy, page 89 (required)
- Configuring Thresholds for the Buffer Resource Owner, page 90 (required)
- Configuring Thresholds for the CPU Resource Owner, page 92 (required)
- Configuring Thresholds for the Memory Resource Owner, page 97 (required)
- Configuring Automatic Tuning of Buffers, page 100 (required)
- Configuring Memory Usage History, page 101 (required)

- Configuring a CPU Process to Be Included in the Extended Load Monitor Report, page 102 (required)
- Configuring Extended CPU Load Monitoring, page 102 (required)
- Configuring Automatic CPUHOG Profiling, page 103 (required)
- Applying a Policy to Resource Users, page 104 (optional)
- Verifying ERM Operations, page 106 (optional)
- Troubleshooting Tips, page 121 (optional)

Configuring a Resource Policy

Perform this task to configure a resource policy or resource policy template for ERMI.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **resource policy**
4. **policy** *policy-name* [**global** | **type** *resource-user-type*]

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	`resource policy`
	Example:
	`Router(config)# resource policy`
		Enters ERM configuration mode.

Step 4	**policy** *policy-name* [**global** | **type** *resource-user-type*] **Example:** `Router(config-erm)# policy policy1 type iosprocess`	Configures a resource policy and enters ERM policy configuration mode. • The *policy-name* argument identifies the name of the resource policy. • The **global** keyword is used when you are configuring a system global policy. • The **type** keyword indicates that you are configuring either a user local or per user global policy. The *resource-user-type* argument identifies the name of the resource user type you want to attach the policy to.

Configuring Thresholds for the Buffer Resource Owner

Perform this task to configure threshold values for buffer RO.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **resource policy**
4. **policy** *policy-name* [**global** | **type** *resource-user-type*]
5. **system**
   or
   slot *slot-number*
6. **buffer public**
7. **critical rising** *rising-threshold-value* [**interval** *interval-value*] [**falling** *falling-threshold-value* [**interval** *interval-value*]] [**global**]
   or
   major rising *rising-threshold-value* [**interval** *interval-value*] [**falling** *falling-threshold-value* [**interval** *interval-value*]] [**global**]
   or
   minor rising *rising-threshold-value* [**interval** *interval-value*] [**falling** *falling-threshold-value* [**interval** *interval-value*]] [**global**]
8. **exit**

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	`resource policy`
	Example:
	`Router(config)# resource policy`
		Enters ERM configuration mode.

	Command or Action	Purpose

Step 4	**`policy`** *`policy-name`* `[`**`global`** `|` **`type`** *`resource-user-type`*`]`
	Example:
	`Router(config-erm)# policy policy1 type iosprocess`
		Configures a resource policy and enters ERM policy configuration mode.
		• The *policy-name* argument identifies the name of the resource policy.
		• The **global** keyword is used when you are configuring a system global policy.
		• The **type** keyword indicates that you are configuring either a user local or per user global policy. The *resource-user-type* argument identifies the name of the resource user type you want to attach the policy to.

Step 5	**`system`**
	or
	`slot` *`slot-number`*
	Example:
	`Router(config-erm-policy)# system`
	or
	Example:
	`Router(config-erm-policy)# slot 1`
		Enters policy node configuration mode with the **system** command.
		Enters ERM slot configuration mode with the **slot** *slot-number* command. This command is available only in distributed platforms like Route/Switch Processor (RSP).

Step 6	**`buffer public`**
	Example:
	`Router(config-policy-node)# buffer public`
		Enters buffer owner configuration mode.
		Allows you to set the rising and falling values for the critical, major, and minor thresholds.

	Command or Action	Purpose

Step 7	**`critical rising`** *`rising-threshold-value`* `[`**`interval`** *`interval-value`*`] [`**`falling`** *`falling-threshold-value`* `[`**`interval`** *`interval-value`*`]] [`**`global`**`]`
	or
	`major rising` *`rising-threshold-value`* `[`**`interval`** *`interval-value`*`] [`**`falling`** *`falling-threshold-value`* `[`**`interval`** *`interval-value`*`]] [`**`global`**`]`
	or
	`minor rising` *`rising-threshold-value`* `[`**`interval`** *`interval-value`*`] [`**`falling`** *`falling-threshold-value`* `[`**`interval`** *`interval-value`*`]] [`**`global`**`]`
	Example:
	`Router(config-owner-buffer) critical rising 40 falling 20 interval 10 global`
	or
	Example:
	`Router(config-owner-buffer) major rising 30 falling 15 interval 10 global`
	or
	Example:
	`Router(config-owner-buffer) minor rising 20 falling 10 interval 10 global`
		Allows you to set the rising and falling threshold values for critical, major, and minor levels of buffer usage count for the public buffer pools.
		Note If you had configured a global policy in Step 4, you do not need to give the **global** keyword while setting the threshold values in Step 7. However, if you have configured a user local or per user global policy (by not specifying the **global** keyword) in Step 4, enter the **global** keyword in Step 7 if you want to configure a per user global threshold.

Step 8	**`exit`**
	Example:
	`Router> enable`
		Exits buffer owner configuration mode.

Configuring Thresholds for the CPU Resource Owner

Perform this task to configure threshold values for the CPU RO.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **resource policy**
4. **policy** *policy-name* [**global** | **type** *resource-user-type*]
5. **system**
   or
   slot *slot-number*
6. **cpu interrupt**

7. **critical rising** *rising-threshold-value* [**interval** *interval-value*] [**falling** *falling-threshold-value* [**interval** *interval-value*]] **global**
   or
   major rising *rising-threshold-value* [**interval** *interval-value*] [**falling** *falling-threshold-value* [**interval** *interval-value*]] **global**
   or
   minor rising *rising-threshold-value* [**interval** *interval-value*] [**falling** *falling-threshold-value* [**interval** *interval-value*]] **global**
8. **exit**
9. **cpu process**
10. **critical rising** *rising-threshold-value* [**interval** *interval-value*] [**falling** *falling-threshold-value* [**interval** *interval-value*]] [**global**]
    or
    major rising *rising-threshold-value* [**interval** *interval-value*] [**falling** *falling-threshold-value* [**interval** *interval-value*]] [**global**]
    or
    minor rising *rising-threshold-value* [**interval** *interval-value*] [**falling** *falling-threshold-value* [**interval** *interval-value*]] [**global**]
11. **exit**
12. **cpu total**
13. **critical rising** *rising-threshold-value* [**interval** *interval-value*] [**falling** *falling-threshold-value* [**interval** *interval-value*]] **global**
    or
    major rising *rising-threshold-value* [**interval** *interval-value*] [**falling** *falling-threshold-value* [**interval** *interval-value*]] **global**
    or
    minor rising *rising-threshold-value* [**interval** *interval-value*] [**falling** *falling-threshold-value* [**interval** *interval-value*]] **global**
14. **exit**

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	**`resource policy`**
	Example:
	`Router(config)# resource policy`
		Enters ERM configuration mode.

	Command or Action	Purpose
Step 4	**policy** *policy-name* [**global** | **type** *resource-user-type*] **Example:** `Router(config-erm)# policy policy1 type iosprocess`	Configures a resource policy and enters ERM policy configuration mode. • The *policy-name* argument identifies the name of the resource policy. • The **global** keyword is used when you are configuring a system global policy. • The **type** keyword indicates that you are configuring either a user local or per user global policy. The *resource-user-type* argument identifies the name of the resource user type you want to attach the policy to.

Step 5	**system**
	or
	slot *slot-number*
	Example:
	`Router(config-erm-policy)# system`
	or
	Example:
	`Router(config-erm-policy)# slot 1`
		Enters policy node configuration mode with the **system** command.
		Enters ERM slot configuration mode with the **slot** *slot-number* command. This command is available only in distributed platforms like Route/Switch Processor (RSP).

Step 6	**cpu interrupt** **Example:** `Router(config-policy-node)# cpu interrupt`	(Optional) Enters CPU owner configuration mode. Allows you to set the rising and falling values for the critical, major, and minor thresholds.

	Command or Action	Purpose

Step 7	**critical rising** *rising-threshold-value* [**interval** *interval-value*] [**falling** *falling-threshold-value* [**interval** *interval-value*]] **global**
	or
	major rising *rising-threshold-value* [**interval** *interval-value*] [**falling** *falling-threshold-value* [**interval** *interval-value*]] **global**
	or
	minor rising *rising-threshold-value* [**interval** *interval-value*] [**falling** *falling-threshold-value* [**interval** *interval-value*]] **global**
	Example:
	`Router(config-owner-cpu) critical rising 40 falling 20 interval 10 global`
	or
	Example:
	`Router(config-owner-cpu) major rising 30 falling 15 interval 10 global`
	or
	Example:
	`Router(config-owner-cpu) minor rising 20 falling 10 interval 10 global`
		Allows you to set the rising and falling threshold values for critical, major, and minor levels of percentages of CPU interrupt utilization.
		Note If you had configured a global policy in Step 4, you do not need to give the **global** keyword while setting the threshold values in Step 7. However, if you have configured a user local or per user global policy (by not specifying the **global** keyword) in Step 4, enter the **global** keyword in Step 7 if you want to configure a per user global threshold.
		For interrupt CPU utilization, you can configure either global thresholds or per user global thresholds. Hence, you must enter the **global** keyword either in Step 4 or in Step 7.

Step 8	**exit** **Example:** `Router(config-owner-cpu)# exit`	Exits the CPU owner configuration.
Step 9	**cpu process** **Example:** `Router(config-policy-node)# cpu process`	(Optional) Enters CPU owner configuration mode. Allows you to set the rising and falling values for the critical, major, and minor thresholds.

	Command or Action	Purpose

Step 10	**`critical rising`** *`rising-threshold-value`* `[`**`interval`** *`interval-value`*`] [`**`falling`** *`falling-threshold-value`* `[`**`interval`** *`interval-value`*`]] [`**`global`**`]`
	or
	`major rising` *`rising-threshold-value`* `[`**`interval`** *`interval-value`*`] [`**`falling`** *`falling-threshold-value`* `[`**`interval`** *`interval-value`*`]] [`**`global`**`]`
	or
	`minor rising` *`rising-threshold-value`* `[`**`interval`** *`interval-value`*`] [`**`falling`** *`falling-threshold-value`* `[`**`interval`** *`interval-value`*`]] [`**`global`**`]`
	Example:
	`Router(config-owner-cpu) critical rising 40 falling 20 interval 10 global`
	or
	Example:
	`Router(config-owner-cpu) major rising 30 falling 15 interval 10 global`
	or
	Example:
	`Router(config-owner-cpu) minor rising 20 falling 10 interval 10 global`
		Allows you to set the rising and falling threshold values for critical, major, and minor levels of percentages of process CPU utilization.
		Note If you had configured a global policy in Step 4, you do not need to give the **global** keyword while setting the threshold values in Step 10. However, if you have configured a user local or per user global policy (by not specifying the **global** keyword) in Step 4, enter the **global** keyword in Step 10 if you want to configure a per user global threshold.
		For process CPU utilization, you can configure global thresholds, per user global thresholds or user local thresholds.

Step 11	**`exit`**
	Example:
	`Router(config-owner-cpu)# exit`
		Exits the CPU owner configuration.

Step 12	**`cpu total`**
	Example:
	`Router(config-policy-node)# cpu total`
		(Optional) Enters CPU owner configuration mode.
		Allows you to set the rising and falling values for the critical, major, and minor thresholds.

	Command or Action	Purpose

Step 13	**critical rising** *rising-threshold-value* [**interval** *interval-value*] [**falling** *falling-threshold-value* [**interval** *interval-value*]] **global**
	or
	major rising *rising-threshold-value* [**interval** *interval-value*] [**falling** *falling-threshold-value* [**interval** *interval-value*]] **global**
	or
	minor rising *rising-threshold-value* [**interval** *interval-value*] [**falling** *falling-threshold-value* [**interval** *interval-value*]] **global**
	Example:
	`Router(config-owner-cpu) critical rising 40 falling 20 interval 10 global`
	or
	Example:
	`Router(config-owner-cpu) major rising 30 falling 15 interval 10 global`
	or
	Example:
	`Router(config-owner-cpu) minor rising 20 falling 10 interval 10 global`
		Allows you to set the rising and falling threshold values for critical, major, and minor levels of percentages of total CPU utilization.
		Note If you had configured a global policy in Step 4, you do not need to give the **global** keyword while setting the threshold values in Step 13. However, if you have configured a user local or per user global policy (by not specifying the **global** keyword) in Step 4, enter the **global** keyword in Step 13 if you want to configure a per user global threshold.
		For total CPU utilization, you can configure either global thresholds or per user global thresholds. Hence, you must enter the **global** keyword either in Step 4 or in Step 13.

Step 14	**exit** **Example:** `Router(config-owner-cpu)# exit`	Exits the CPU owner configuration mode.

Configuring Thresholds for the Memory Resource Owner

Perform this task to configure threshold values for the memory RO.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **resource policy**
4. **policy** *policy-name* [**global** | **type** *resource-user-type*]
5. **system**
   or
   slot *slot-number*
6. **memory io**

7. **critical rising** *rising-threshold-value* [**interval** *interval-value*] [**falling** *falling-threshold-value* [**interval** *interval-value*]] [**global**]
   or
   major rising *rising-threshold-value* [**interval** *interval-value*] [**falling** *falling-threshold-value* [**interval** *interval-value*]] [**global**]
   or
   minor rising *rising-threshold-value* [**interval** *interval-value*] [**falling** *falling-threshold-value* [**interval** *interval-value*]] [**global**]
8. **exit**
9. **memory processor**
10. **critical rising** *rising-threshold-value* [**interval** *interval-value*] [**falling** *falling-threshold-value* [**interval** *interval-value*]] [**global**]
    or
    major rising *rising-threshold-value* [**interval** *interval-value*] [**falling** *falling-threshold-value* [**interval** *interval-value*]] [**global**]
    or
    minor rising *rising-threshold-value* [**interval** *interval-value*] [**falling** *falling-threshold-value* [**interval** *interval-value*]] [**global**]
11. **exit**

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	**`resource policy`**
	Example:
	`Router(config)# resource policy`
		Enters ERM configuration mode.

Step 4	**`policy`** *`policy-name`* `[`**`global`** `|` **`type`** *`resource-user-type`*`]`
	Example:
	`Router(config-erm)# policy policy1 type iosprocess`
		Configures a resource policy and enters ERM policy configuration mode.
		• The *policy-name* argument identifies the name of the resource policy.
		• The **global** keyword is used when you are configuring a system global policy.
		• The **type** keyword indicates that you are configuring either a user local or per user global policy. The *resource-user-type* argument identifies the name of the resource user type you want to attach the policy to.

	Command or Action	Purpose

Step 5	**system**
	or
	slot *slot-number*
	Example:
	`Router(config-erm-policy)# system`
	or
	Example:
	`Router(config-erm-policy)# slot 1`
		Enters policy node configuration mode with the **system** command.
		Enters ERM slot configuration mode with the **slot** *slot-number* command. This command is available only in distributed platforms like Route/Switch Processor (RSP).

Step 6	**memory io** **Example:** `Router(config-policy-node)# memory io`	(Optional) Enters memory owner configuration mode. Allows you to set the rising and falling values for the critical, major, and minor thresholds.

Step 7	**critical rising** *rising-threshold-value* [**interval** *interval-value*] [**falling** *falling-threshold-value* [**interval** *interval-value*]] [**global**]
	or
	major rising *rising-threshold-value* [**interval** *interval-value*] [**falling** *falling-threshold-value* [**interval** *interval-value*]] [**global**]
	or
	minor rising *rising-threshold-value* [**interval** *interval-value*] [**falling** *falling-threshold-value* [**interval** *interval-value*]] [**global**]
	Example:
	`Router(config-owner-memory) critical rising 40 falling 20 interval 10 global`
	or
	Example:
	`Router(config-owner-memory) major rising 30 falling 15 interval 10 global`
	or
	Example:
	`Router(config-owner-memory) minor rising 20 falling 10 interval 10 global`
		Allows you to set the rising and falling threshold values for critical, major, and minor levels of percentages of I/O memory usage.
		Note If you had configured a global policy in Step 4, you do not need to give the **global** keyword while setting the threshold values in Step 7. However, if you have configured a user local or per user global policy (by not specifying the **global** keyword) in Step 4, enter the **global** keyword in Step 7 if you want to configure a per user global threshold.

Step 8	**exit** **Example:** `Router(config-owner-memory)# exit`	Exits memory owner configuration mode.

	Command or Action	Purpose
Step 9	**memory processor** **Example:** `Router(config-policy-node)# memory processor`	(Optional) Enters memory owner configuration mode. Allows you to set the rising and falling values for the critical, major, and minor thresholds.

Step 10	**critical rising** *rising-threshold-value* [**interval** *interval-value*] [**falling** *falling-threshold-value* [**interval** *interval-value*]] [**global**]
	or
	major rising *rising-threshold-value* [**interval** *interval-value*] [**falling** *falling-threshold-value* [**interval** *interval-value*]] [**global**]
	or
	minor rising *rising-threshold-value* [**interval** *interval-value*] [**falling** *falling-threshold-value* [**interval** *interval-value*]] [**global**]
	Example:
	`Router(config-owner-memory) critical rising 40 falling 20 interval 10 global`
	or
	Example:
	`Router(config-owner-memory) major rising 30 falling 15 interval 10 global`
	or
	Example:
	`Router(config-owner-memory) minor rising 20 falling 10 interval 10 global`
		Allows you to set the rising and falling threshold values for critical, major, and minor levels of percentages of processor memory usage.
		Note If you had configured a global policy in Step 4, you do not need to give the **global** keyword while setting the threshold values in Step 10. However, if you have configured a user local or per user global policy (by not specifying the **global** keyword) in Step 4, enter the global keyword in Step 10 if you want to configure a per user global threshold.

Step 11	**exit** **Example:** `Router(config-owner-memory)#exit`	Exits memory owner configuration mode and enters resource policy node configuration mode.

Configuring Automatic Tuning of Buffers

Perform this task to enable automatic tuning of buffers.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **buffer tune automatic**

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	**buffer tune automatic** **Example:** `Router(config)# buffer tune automatic`	Enables automatic tuning of buffers.

Configuring Memory Usage History

Perform this task to change the number of hours for which the memory log is maintained.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **memory statistics history table** *number-of-hours*

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	**memory statistics history table** *number-of-hours* **Example:** `Router(config)# memory statistics history table 48`	Changes the time (number of hours) for which the memory log is maintained.

Configuring a CPU Process to Be Included in the Extended Load Monitor Report

Perform this task to configure a process (or processes) to be included in the extended load monitor report.

SUMMARY STEPS

1. **enable**
2. **monitor processes cpu extended** *process-id-list*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**monitor processes cpu extended** *process-id-list* **Example:** `Router# monitor processes cpu extended 1`	Enables the specified process or processes to be monitored for the extended CPU load. You can specify a maximum of eight processes to be monitored.

Configuring Extended CPU Load Monitoring

Perform this task to change the history size in the collection report for extended CPU load.

Restrictions

You cannot disable this feature completely. If the command is not configured, the default behavior is to collect a one-minute history. The one-minute history is equivalent to collecting history for a history size 12.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **process cpu extended history** *history-size*

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	**process cpu extended history** *history-size* **Example:** `Router(config)# process cpu extended history 24`	Enables you to change the history size of the extended collection report. If the command is not configured, the default behavior is to collect a one-minute history, which is equivalent to collecting history for history size 12.

Configuring Automatic CPUHOG Profiling

Perform this task to enable automatic profiling of CPUHOGs by predicting when a process could hog CPU and starting profiling of that process at the same time. This function is enabled by default.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **processes cpu autoprofile hog**

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	**processes cpu autoprofile hog** **Example:** `Router(config)# processes cpu autoprofile hog`	Enables automatic profiling of CPUHOG processes. This function is enabled by default.

Applying a Policy to Resource Users

Perform this task to apply a policy or policy template to RUs or resource groups.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **resource policy**
4. **policy** *policy-name* [**global** | **type** *resource-user-type*]
5. **exit**
6. **user** {*resource-instance-name resource-user-type resource-policy-name* | **global** *global-policy-name* | **group** *resource-group-name* **type** *resource-user-type*}
7. **instance** *instance-name*
8. **policy** *policy-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	**`resource policy`**
	Example:
	`Router(config)# resource policy`
		Enters ERM configuration mode.

Step 4	**`policy`** *`policy-name`* `[`**`global`** `|` **`type`** *`resource-user-type`*`]`
	Example:
	`Router(config-erm)# policy policy1 type iosprocess`
		Configures a resource policy and enters ERM policy configuration mode.
		• The *policy-name* argument identifies the name of the resource policy.
		• The **global** keyword is used when you are configuring a system global policy.
		• The **type** keyword indicates that you are configuring either a user local or per user global policy. The *resource-user-type* argument identifies the name of the resource user type you want to attach the policy to.

Step 5	**`exit`**	Exits ERM policy configuration mode.

	Command or Action	Purpose

Step 6	**user** {*resource-instance-name resource-user-type resource-policy-name* | **global** *global-policy-name* | **group** *resource-group-name* **type** *resource-user-type*}
	Example:
	`Router(config-erm)# user group lowPrioUsers type iosprocess`
		Applies a policy system wide (global thresholding), a group of users (group thresholding), or a particular user.
		Note When you apply a group policy to a group of RUs by giving the **group** keyword in this command, the Cisco IOS router enters the resource group configuration mode. Go to Step 7 if you want to add RUs to the resource group. Got to Step 8 if you want to apply a policy to the resource group.
		• The *resource-instance-name* argument identifies the name of the RU to which you are applying a policy.
		• The *resource-user-type-name* argument identifies the type of RU.
		• The *resource-policy-name* argument identifies the name resource policy you are applying to the individual RU.
		• The *global-policy-name* argument identifies the name of the global policy you are trying to apply.
		• The *resource-group-name* argument identifies the name of the resource group.

Step 7	**instance** *instance-name* **Example:** `Router(config-res-group)# instance http`	Adds an RU to a resource group. The *instance-name* argument specifies the RU or instance name. **Note** All the RUs added by this command will be grouped together under the resource group and the same thresholding policy will be applied to all the RUs. For example, if you have created a resource group **lowPrioUsers** in Step 6, then all the RUs you add in Step 7 will be part of the resource group **lowPrioUsers** and the same policy is applied to all the RUs.
Step 8	**policy** *policy-name* **Example:** `Router(config-res-group)# policy group-policy1`	Specifies the policy you want to apply to the resource group you created in Step 6. The *policy-name* argument specifies the name of the group policy. This command helps you to set the same threshold policy to a group of RUs grouped under a resource group. For example, if you have some low-priority tasks or RUs like **http** and **snmp** and you want to set a threshold not on these individual RUs, but as a group; then add these RUs to the **lowPrioUsers** group using Step 7 and then apply a threshold policy using Step 8. In this case, if you have set a minor rising threshold of 10% (this 10% threshold is applied to both **http** and **snmp** in the **lowPrioUsers** group), then a notification is sent to **lowPrioUsers** resource group when the accumulated usage crosses the 10% mark. That is, if http uses 4% and snmp uses 7%, a notification will be sent to all the RUs in the **lowPrioUsers** resource group.

Verifying ERM Operations

To verify the various ERM operations, perform the following steps.

SUMMARY STEPS

1. **show buffers leak** [**resource user**]
2. **show buffers tune**
3. **show buffers usage** [**pool** *pool-name*]
4. **show memory** [**processor** | **io**] **fragment** [**detail**]
5. **show memory statistics history table**
6. **show monitor event-trace cpu-report** {**brief** {**all** [**detail**] | **back** *time* | **clock** *time* | **from-boot** [*seconds* | **detail**] | **latest** [**detail**]} | **handle** *handle-number*}
7. **show processes cpu autoprofile hog**
8. **show processes cpu extended** [**history**]
9. **show resource all** [**brief** | **detailed**]
10. **show resource database**
11. **show resource owner** {*resource-owner-name* | **all**} **user** {*resource-user-type-name* | **all**} [**brief** | **detailed** | **triggers**]
12. **show resource relationship user** *resource-user-type*
13. **show resource user** {**all** | *resource-user-type*} [**brief** | **detailed**]

DETAILED STEPS

Step 1 **show buffers leak** [**resource user**]

Use this command without the optional keywords to display the details of all the buffers that are older than one minute in the system, for example:

```
Router# show buffers leak

Header   DataArea  Pool  Size  Link  Enc    Flags      Input     Output  User

6488F464  E000084 Small    74    0     0       10       None       None EEM ED Sy
6488FB5C  E000304 Small    74    0     0       10       None       None EEM ED Sy
648905D0  E0006C4 Small    61    0     0        0       None       None EEM ED Sy
648913C0  E000BC4 Small    74    0     0       10       None       None EEM ED Sy
6489173C  E000D04 Small    74    0     0       10       None       None EEM ED Sy
648921B0  E0010C4 Small    60    0     0        0       None       None Init
6489252C  E001204 Small   103    0     0       10       None       None EEM ED Sy
64892C24  E001484 Small    74    0     0       10       None       None EEM ED Sy
64892FA0  E0015C4 Small    74    0     0       10       None       None EEM ED Sy
64893A14  E001984 Small    74    0     0       10       None       None EEM ED Sy
64893D90  E001AC4 Small    61    0     0        0       None       None EEM ED Sy
64894804  E001E84 Small    61    0     0        0       None       None EEM ED Sy
6517CB64  E32F944 Small    74    0     0       10       None       None EEM ED Sy
6517D25C  E176D44 Small    74    0     0       10       None       None EEM ED Sy
6517D5D8  E176E84 Small    74    0     0       10       None       None EEM ED Sy
6517D954  E209A84 Small    74    0     0       10       None       None EEM ED Sy
6517E744  E209D04 Small    61    0     0        0       None       None EEM ED Sy
6517EE3C  E29CBC4 Small    61    0     0        0       None       None EEM ED Sy
65180324  E177844 Small    74    0     0       10       None       None EEM ED Sy
```

```
65180D98  E177C04 Small    61    0    0        0       None       None EEM ED Sy
65E1F3A0  E4431A4 Small   102    0    0        0       None       None EEM ED Sy
64895278  E002644 Middl   191    0    0       10       None       None EEM ED Sy
64895CEC  E003004 Middl   173    0    0       10       None       None EEM ED Sy
64896068  E003344 Middl   176    0    0       10       None       None EEM ED Sy
648963E4  E003684 Middl   191    0    0       10       None       None EEM ED Sy
64896E58  E004044 Middl   109    0    0       10       None       None EEM ED Sy
64897C48  E004D44 Middl   194    0    0       10       None       None EEM ED Sy
65181F04  E330844 Middl   173    0    0       10       None       None EEM ED Sy
65183070  E3C3644 Middl   105    0    0       10       None       None EEM ED Sy
65DF9558  E4746E4 Middl   107    0    0        0       None       None EEM ED Sy
65DFA6C4  E475724 Middl   116    0    0        0       None       None EEM ED Sy
65DFADBC  E475DA4 Middl   115    0    0        0       None       None EEM ED Sy
65DFC620  E477464 Middl   110    0    0        0       None       None EEM ED Sy
64C64AE0        0 FS He     0    0    3        0       None       None Init
64C64E5C        0 FS He     0    0    3        0       None       None Init
64C651D8        0 FS He     0    0    3        0       None       None Init
64C65554        0 FS He     0    0    0        0       None       None Init
64C658D0        0 FS He     0    0    0        0       None       None Init
64C65C4C        0 FS He     0    0    0        0       None       None Init
64C65FC8        0 FS He     0    0    0        0       None       None Init
64C66344        0 FS He     0    0    0        0       None       None Init
64D6164C        0 FS He     0    0    0        0       None       None Init
64EB9D10        0 FS He     0    0    0        0       None       None Init
6523EE14        0 FS He     0    0    0        0       None       None Init
65413648        0 FS He     0    0    0        0       None       None Init
```

Use this command with the optional keywords to display the details of the buffers of a specified RU that are older than one minute in the system, for example:

```
Router# show buffers leak resource user

Resource User:  EEM ED Syslog count:       32
Resource User:           Init count:        2
Resource User:         *Dead* count:        2
Resource User: IPC Seat Manag count:       11
Resource User:      XDR mcast count:        2
```

Step 2 **show buffers tune**

Use this command to display the details of automatic tuning of buffers, for example:

```
Router# show buffers tune

Tuning happened for the pool Small
Tuning happened at 20:47:25
Oldvalues
permanent:50  minfree:20  maxfree:150
Newvalues
permanet:61  minfree:15  maxfree:76

Tuning happened for the pool Middle
Tuning happened at 20:47:25
Oldvalues
permanent:25  minfree:10  maxfree:150
Newvalues
permanet:36  minfree:9  maxfree:45
```

Step 3 **show buffers usage** [**pool** *pool-name*]

Use this command without the optional keyword and argument to display the details of the buffer usage pattern in a specified buffer pool, for example:

```
Router# show buffers usage
```

```
Statistics for the Small pool
Caller pc    : 0x626BA9E0 count:       20
Resource User: EEM ED Sys count:       20
Caller pc    : 0x60C71F8C count:        1
Resource User:       Init count:        1
Number of Buffers used by packets generated by system:   62
Number of Buffers used by incoming packets:               0

Statistics for the Middle pool
Caller pc    : 0x626BA9E0 count:       12
Resource User: EEM ED Sys count:       12
Number of Buffers used by packets generated by system:   41
Number of Buffers used by incoming packets:               0

Statistics for the Big pool
Number of Buffers used by packets generated by system:   50
Number of Buffers used by incoming packets:               0

Statistics for the VeryBig pool
Number of Buffers used by packets generated by system:   10
Number of Buffers used by incoming packets:               0

Statistics for the Large pool
Number of Buffers used by packets generated by system:    0
Number of Buffers used by incoming packets:               0

Statistics for the Huge pool
Number of Buffers used by packets generated by system:    0
Number of Buffers used by incoming packets:               0

Statistics for the IPC pool
Number of Buffers used by packets generated by system:    2
Number of Buffers used by incoming packets:               0

Statistics for the Header pool
Number of Buffers used by packets generated by system:  511
Number of Buffers used by incoming packets:               0

Statistics for the FS Header pool
Caller pc    : 0x608F68FC count:        9
Resource User:       Init count:       12
Caller pc    : 0x61A21D3C count:        1
Caller pc    : 0x60643FF8 count:        1
Caller pc    : 0x61C526C4 count:        1
Number of Buffers used by packets generated by system:   28
Number of Buffers used by incoming packets:               0
```

Use this command with the optional keyword and argument to display the details of the buffer usage pattern in a small buffer pool, for example:

```
Router# show buffers usage pool small

Statistics for the Small pool
Caller pc    : 0x626BA9E0 count:       20
Resource User: EEM ED Sys count:       20
Caller pc    : 0x60C71F8C count:        1
Resource User:       Init count:        1
Number of Buffers used by packets generated by system:   62
Number of Buffers used by incoming packets:               0
```

Step 4 **show memory** [**processor** | **io**] **fragment** [**detail**]

Use this command without the optional keywords to display the block details of every allocated block for both I/O memory and processor memory, for example:

```
Router# show memory fragment

Processor memory

Free memory size : 211014448 Number of free blocks:      139
Allocator PC Summary for allocated blocks in pool: Processor

    PC          Total     Count  Name
0x6189A438     318520       1  RTPSPI
0x6205711C     237024       2  CCH323_CT
0x6080BE38      98416       2  Exec
0x606AD988      80256       1  Init
0x618F68A8      73784       1  CCSIP_UDP_SOCKET
0x6195AD04      67640       1  QOS_MODULE_MAIN
0x606488C8      65592       1  CEF: Adjacency chunk
0x60635620      65592       1  CEF: 16 path chunk pool
0x615ECE58      65592       1  XTagATM VC chunk
0x6165ACF8      65592       1  eddri_self_event
0x608DE168      65592       1  MallocLite
0x60857920      51020      11  Normal
0x6203BF88      42480       4  IPv6 CEF fib tables
0x60DC7F14      32824       1  PPP Context Chunks
.
.
.
I/O memory

Free memory size : 14700024 Number of free blocks:       52
Allocator PC Summary for allocated blocks in pool: I/O

    PC          Total   Count   Name
0x60857934    3936000      60  FastEthernet0/
0x60857898     524800       8  FastEthernet0/0
0x601263CC      29120       7  Init
0x6082DB28       9408      23  *Packet Data*
0x60126344       8448       4  Init

Allocator PC Summary for free blocks in pool: I/O

    PC          Total    Count   Name
0x608C5730   29391444       1  (coalesced)
0x608FC1F4       5376      28  (fragment)
0x6082DB28       4288      14  (fragment)
```

Use this command with the **detail** optional keyword to display the block details of every allocated block for both I/O memory and processor memory, for example:

```
Router# show memory fragment detail
Processor memory

Free memory size : 211038812 Number of free blocks:      139
 Address      Bytes     Prev     Next Ref     PrevF    NextF Alloc PC  what
644AAB70 0000001032 644AAB20 644AAFAC 001  -------- -------- 620450F8  Index Table Block
644AAFAC 0000000028 644AAB70 644AAFFC 000  0        6448CB5C 607B2ADC  NameDB String
644AAFFC 0000000076 644AAFAC 644AB07C 001  -------- -------- 60818DE0  Init
6448CB0C 0000000028 6448CABC 6448CB5C 001  -------- -------- 607F8380  Cond Debug
definition
6448CB5C 0000000028 6448CB0C 6448CBAC 000  644AAFAC 6489F158 607B2ADC  NameDB String
6448CBAC 0000000028 6448CB5C 6448CBFC 001  -------- -------- 607F8380  Cond Debug
definition
6489EF8C 0000000408 6489DBCC 6489F158 001  -------- -------- 60857920  Normal
6489F158 0000000064 6489EF8C 6489F1CC 000  6448CB5C 6448CABC 607B2ADC  NameDB String
6489F1CC 0000005004 6489F158 648A058C 001  -------- -------- 60857920  Normal
6448CA6C 0000000028 6448C9AC 6448CABC 001  -------- -------- 607D72FC  Parser Linkage
```

```
6448CABC 0000000028 6448CA6C 6448CB0C 000  6489F158 644949C8 607B2ADC  NameDB String
6448CB0C 0000000028 6448CABC 6448CB5C 001  -------- -------- 607F8380  Cond Debug 
definition
64494978 0000000028 64494928 644949C8 001  -------- -------- 607D72FC  Parser Linkage
644949C8 0000000028 64494978 64494A18 000  6448CABC 654F2868 607B2ADC  NameDB String
64494A18 0000000028 644949C8 64494A68 001  -------- -------- 607D72FC  Parser Linkage
654F27E8 0000000076 654F2768 654F2868 001  -------- -------- 60818DE0  Init
654F2868 0000000076 654F27E8 654F28E8 000  644949C8 654F1BE8 60818DE0  Init
.
.
.
I/O memory

Free memory size : 14700024 Number of free blocks:       52
 Address      Bytes     Prev     Next Ref     PrevF    NextF Alloc PC  what
0E000000 0000000056 00000000 0E00006C 000  0        E176F4C  00000000  (fragment)
0E00006C 0000000268 0E000000 0E0001AC 001  -------- -------- 6082DB28  *Packet Data*
0E176E0C 0000000268 0E176CCC 0E176F4C 001  -------- -------- 6082DB28  *Packet Data*
0E176F4C 0000000076 0E176E0C 0E176FCC 000  E000000  E209F4C  6082DB28  (fragment)
0E176FCC 0000002060 0E176F4C 0E17780C 001  -------- -------- 60126344  Init
0E209E0C 0000000268 0E209CCC 0E209F4C 001  -------- -------- 6082DB28  *Packet Data*
0E209F4C 0000000076 0E209E0C 0E209FCC 000  E176F4C  E29CF4C  6082DB28  (fragment)
0E209FCC 0000002060 0E209F4C 0E20A80C 001  -------- -------- 60126344  Init
0E29CE0C 0000000268 0E29CCCC 0E29CF4C 001  -------- -------- 6082DB28  *Packet Data*
0E29CF4C 0000000076 0E29CE0C 0E29CFCC 000  E209F4C  E32FF4C  6082DB28  (fragment)
0E29CFCC 0000002060 0E29CF4C 0E29D80C 001  -------- -------- 60126344  Init
0E32FE0C 0000000268 0E32FCCC 0E32FF4C 001  -------- -------- 6082DB28  *Packet Data*
0E32FF4C 0000000076 0E32FE0C 0E32FFCC 000  E29CF4C  0        6082DB28  (fragment)
0E32FFCC 0000002060 0E32FF4C 0E33080C 001  -------- -------- 60126344  Init
0E177FCC 0000004108 0E177E4C 0E17900C 001  -------- -------- 601263CC  Init
0E17900C 0000000140 0E177FCC 0E1790CC 000  0        E18910C  601263CC  (fragment)
```

Use this command with **detail** optional keyword to display the block details of every allocated block for processor memory, for example:

```
Router# show memory processor fragment detail

Processor memory

Free memory size : 65566148 Number of free blocks:      230
 Address      Bytes     Prev     Next Ref     PrevF    NextF Alloc PC  what
645A8148 0000000028 645A80F0 645A8194 001  -------- -------- 60695B20  Init
645A8194 0000000040 645A8148 645A81EC 000  0        200B4300 606B9614  NameDB String
645A81EC 0000000260 645A8194 645A8320 001  -------- -------- 607C2D20  Init
200B42B4 0000000028 200B4268 200B4300 001  -------- -------- 62366C80  Init
200B4300 0000000028 200B42B4 200B434C 000  645A8194 6490F7E8 60976574  AAA Event Data
200B434C 0000002004 200B4300 200B4B50 001  -------- -------- 6267D294  Coproc Request 
Structures
6490F79C 0000000028 6490F748 6490F7E8 001  -------- -------- 606DDA04  Parser Linkage
6490F7E8 0000000028 6490F79C 6490F834 000  200B4300 6491120C 606DD8D8  Init
6490F834 0000006004 6490F7E8 64910FD8 001  -------- -------- 607DF5BC  Process Stack
649111A0 0000000060 64911154 6491120C 001  -------- -------- 606DE82C  Parser Mode
6491120C 0000000028 649111A0 64911258 000  6490F7E8 500770F0 606DD8D8  Init
64911258 0000000200 6491120C 64911350 001  -------- -------- 603F0E38  Init
.
.
.
20000000 0000000828 5C3AEB24 2000036C 001  -------- -------- 60734010  *Packet Header*
6500BF94 0000000828 6500BC28 6500C300 001  -------- -------- 60734010  *Packet Header*
6500C300 0004760912 6500BF94 50000000 000  5C3AEB24 2C42E310 6071253C  (coalesced)
50000000 0000000828 6500C300 5000036C 001  -------- -------- 60734010  *Packet Header*
2C42E0B4 0000000556 2C429430 2C42E310 001  -------- -------- 60D4A0B4  Virtual Exec
2C42E310 0062725312 2C42E0B4 00000000 000  6500C300 0        6071253C  (coalesced)
```

Use this command with **detail** optional keyword to display the block details of every allocated block for I/O memory, for example:

```
Router# show memory io fragment detail

0E3F8BAC 0000000204 0E3F8AAC 0E3F8CAC 001  -------- -------- 608C5730  test memory
0E3F8CAC 0000000204 0E3F8BAC 0E3F8DAC 000  0        E3F8AAC  608C5730  test memory
0E3F8DAC 0000000204 0E3F8CAC 0E3F8EAC 001  -------- -------- 608C5730  test memory
0E3F89AC 0000000204 0E3F88AC 0E3F8AAC 001  -------- -------- 608C5730  test memory
0E3F8AAC 0000000204 0E3F89AC 0E3F8BAC 000  E3F8CAC  E3F88AC  608C5730  test memory
0E3F8BAC 0000000204 0E3F8AAC 0E3F8CAC 001  -------- -------- 608C5730  test memory
0E3F87AC 0000000204 0E3F86AC 0E3F88AC 001  -------- -------- 608C5730  test memory
0E3F88AC 0000000204 0E3F87AC 0E3F89AC 000  E3F8AAC  E3F86AC  608C5730  test memory
0E3F89AC 0000000204 0E3F88AC 0E3F8AAC 001  -------- -------- 608C5730  test memory
0E3F85AC 0000000204 0E3F826C 0E3F86AC 001  -------- -------- 608C5730  test memory
0E3F86AC 0000000204 0E3F85AC 0E3F87AC 000  E3F88AC  0        608C5730  test memory
0E3F87AC 0000000204 0E3F86AC 0E3F88AC 001  -------- -------- 608C5730  test memory
0E3F4E6C 0000000268 0E3F4D2C 0E3F4FAC 000  0        E3F5BEC  608C5730  test memory
0E3F5BEC 0000000268 0E3F5AAC 0E3F5D2C 000  E3F4E6C  E3EE56C  608C5730  test memory
0E3EE46C 0000000204 0E3EE12C 0E3EE56C 001  -------- -------- 608C5730  test memory
0E3EEFAC 0000000204 0E3EEE6C 0E3EF0AC 001  -------- -------- 608C5730  test memory
0E3F06EC 0000000204 0E3F03AC 0E3F07EC 001  -------- -------- 608C5730  test memory
0E3F8DAC 0000000204 0E3F8CAC 0E3F8EAC 001  -------- -------- 608C5730  test memory
```

Step 5 **show memory statistics history table**

Use this command to display the history of memory consumption, for example:

```
Router# show memory statistics history table

History for Processor memory

Time: 15:48:56.806
Used(b): 422748036 Largest(b): 381064952 Free blocks :291
Maximum memory users for this period
Process Name           Holding   Num Alloc
Virtual Exec             26992          37
TCP Protocols            14460           6
IP Input                  1212           1

Time: 14:42:54.506
Used(b): 422705876 Largest(b): 381064952 Free blocks :296
Maximum memory users for this period
Process Name           Holding   Num Alloc
Exec                 400012740          24
Dead                   1753456          90
Pool Manager            212796         257

Time: 13:37:26.918
Used(b): 20700520 Largest(b): 381064952 Free blocks :196
Maximum memory users for this period
Process Name           Holding   Num Alloc
Exec                      8372           5

Time: 12:39:44.422
Used(b): 20701436 Largest(b): 381064952 Free blocks :193

Time: 11:46:25.135
Used(b): 20701436 Largest(b): 381064952 Free blocks :193
Maximum memory users for this period
Process Name           Holding   Num Alloc
CDP Protocol              3752          25
.
.
```

```
.
History for I/O memory

Time: 15:48:56.809
Used(b):  7455520 Largest(b): 59370080 Free blocks :164

Time: 14:42:54.508
Used(b):  7458064 Largest(b): 59370080 Free blocks :165
Maximum memory users for this period
Process Name           Holding   Num Alloc
Pool Manager            141584         257

Time: 13:37:26.920
Used(b):  7297744 Largest(b): 59797664 Free blocks :25

Time: 12:39:44.424
Used(b):  7297744 Largest(b): 59797664 Free blocks :25
.
.
.
Time: 09:38:53.040
Used(b):  7297744 Largest(b): 59797664 Free blocks :25

Time: 01:02:05.533
Used(b):  7308336 Largest(b): 59797664 Free blocks :23

Time: 00:00:17.937
Used(b):  7308336 Largest(b): 59797664 Free blocks :23
Maximum memory users for this period
Process Name           Holding   Num Alloc
Init                   7296000         214
Pool Manager               816           3
```

Step 6 **show monitor event-trace cpu-report** {**brief** {**all** [**detail**] | **back** *time* | **clock** *time* | **from-boot** [*seconds* | **detail**] | **latest** [**detail**]} | **handle** *handle-number*}

Use this command to view a brief CPU report details for event tracing on a networking device, for example:

```
Router# show monitor event-trace cpu-report brief all

Timestamp   : Handle Name               Description
00:01:07.320:  1     CPU                None
```

Use this command to view a brief CPU report details for event tracing on a networking device, for example:

```
Router# show monitor event-trace cpu-report handle 1

00:01:07.320:  1     CPU                None
################################################################################
Global Statistics
-----------------
5 sec CPU util 0%/0% Timestamp 21:03:56
Queue Statistics
----------------
             Exec Count    Total CPU  Response Time       Queue Length
                                       (avg/max)            (avg/max)
Critical           1          0          0/0                  1/1
High               5          0          0/0                  1/1
Normal           178          0          0/0                  2/9
Low               15          0          0/0                  2/3
Common Process Information
-------------------------------
```

```
 PID   Name         Prio Style
-------------------------------
  10 AAA high-capacit M  New
 133 RADIUS TEST CMD  M  New
  47 VNM DSPRM MAIN   H  New
  58 TurboACL         M  New
  97 IP Background    M  New
  99 CEF: IPv4 proces L  New
 112 X.25 Background  M  New
 117 LFDp Input Proc  M  New
   3 Init             M  Old
CPU Intensive processes
-------------------------------------------------------------------------------
 PID Total       Exec    Quant         Burst  Burst size  Schedcall  Schedcall
     CPUms      Count   avg/max        Count avg/max(ms)      Count Per avg/max
-------------------------------------------------------------------------------
   3   820          6   136/236         1     24/24             18  887/15172
Priority Suspends
------------------------------------
 PID Exec Count Prio-Susps
------------------------------------
   3          6          1

Latencies
-------------------------
 PID     Exec Count Latency
                     avg/max
-------------------------
  10          1 15192/15192
 133          1 15192/15192
  58          1 15192/15192
 112          1 15192/15192
 117          1 15192/15192
  99          1 15172/15172
  47          1 15172/15172
  97          1 15172/15172
################################################################################
################################################################################
Global Statistics
-----------------
5 sec CPU util 0%/0% Timestamp 00:00:00
Queue Statistics
----------------
         Exec Count  Total CPU    Response Time           Queue Length
                                    (avg/max)                (avg/max)
Critical      0          0              0/0                    0/0
High          0          0              0/0                    0/0
Normal        0          0              0/0                    0/0
Low           0          0              0/0                    0/0

Common Process Information
-------------------------------
 PID Name            Prio Style
-------------------------------

CPU Intensive processes
-------------------------------------------------------------------------------
 PID Total       Exec    Quant         Burst  Burst size  Schedcall  Schedcall
     CPUms      Count   avg/max        Count avg/max(ms)      Count Per avg/max
-------------------------------------------------------------------------------
Priority Suspends
------------------------------------
 PID Exec Count Prio-Susps
------------------------------------
```

```
Latencies
-------------------------
 PID Exec Count   Latency
                  avg/max
-------------------------
################################################################################
```

Step 7 **show processes cpu autoprofile hog**

Use this command to view the CPUHOG autoprofile data, for example:

```
Router# show processes cpu autoprofile hog

0x6075DD40 0x60755638
0x6075DD24 0x60755638
0x6075563C 0x60755638
0x60755638 0x60755638
0x60755638 0x60755638
0x6075DD10 0x60755638
0x6075DD40 0x60755638
0x6075DD40 0x60755638
0x6075563C 0x60755638
0x6075DCE0 0x60755638
0x6075DD44 0x60755638
0x6075DCCC 0x60755638
0x6075DD10 0x60755638
.
.
.
0x6075DD3C 0x60755638
0x6075DD38 0x60755638
0x6075DD10 0x60755638
0x6075DCCC 0x60755638
0x6075DCDC 0x60755638
0x6075563C 0x60755638
0x6075DD3C 0x60755638
0x6075DD20 0x60755638
0x6075DD58 0x60755638
0x6075DD1C 0x60755638
0x6075DD10 0x60755638
0x6075DCDC 0x60755638
0x6075DCF8 0x60755638
```

Step 8 **show processes cpu extended** [**history**]

Use this command to view an extended CPU load report, for example:

```
Router# show processes cpu extended

################################################################################
Global Statistics
-----------------
5 sec CPU util 0%/0% Timestamp 21:03:56
Queue Statistics
----------------
             Exec Count  Total CPU    Response Time         Queue Length
                                       (avg/max)             (avg/max)
Critical           1          0          0/0                   1/1
High               5          0          0/0                   1/1
Normal           178          0          0/0                   2/9
Low               15          0          0/0                   2/3
Common Process Information
-------------------------------
 PID Name            Prio Style
-------------------------------
```

```
CPU Intensive processes
-------------------------------------------------------------------------------
 PID Total       Exec    Quant         Burst  Burst size  Schedcall  Schedcall
     CPUms      Count   avg/max        Count avg/max(ms)      Count Per avg/max
-------------------------------------------------------------------------------
Priority Suspends
------------------------------------
 PID Exec Count Prio-Susps
------------------------------------
Latencies
-------------------------
 PID Exec Count   Latency
                  avg/max
-------------------------
################################################################################
```

Step 9 **show resource all** [**brief** | **detailed**]

Use this command without the optional keywords to display the resource details, for example:

```
Router# show resource all

Resource Owner: cpu
Resource User Type: iosprocess
Resource User: Init(ID: 0x1000001)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777217           0         0          0  0.00%  0.00%  0.00% Init
  Resource User: Scheduler(ID: 0x1000002)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777218           0         0          0  0.00%  0.00%  0.00% Scheduler
  Resource User: Dead(ID: 0x1000003)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777219           0         0          0  0.00%  0.00%  0.00% Dead
  Resource User: Interrupt(ID: 0x1000004)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777220           0         0          0  0.00%  0.00%  0.00% Interrupt
  Resource User: Memory RO RU(ID: 0x1000005)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777221           0         0          0  0.00%  0.00%  0.00% Memory RO RU
  Resource User: Chunk Manager(ID: 0x1000006)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777222           0        13          0  0.00%  0.00%  0.00% Chunk Manager
  Resource User: Load Meter(ID: 0x1000007)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777223        2872     36029         79  0.00%  0.00%  0.00% Load Meter
  Resource User: Check heaps(ID: 0x1000009)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777225      352744     33446      10546  0.00%  0.20%  0.17% Check heaps
  Resource User: Pool Manager(ID: 0x100000A)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777226           0         1          0  0.00%  0.00%  0.00% Pool Manager
  Resource User: Buffer RO RU(ID: 0x100000B)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777227           0         0          0  0.00%  0.00%  0.00% Buffer RO RU
  Resource User: Timers(ID: 0x100000C)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777228           0         2          0  0.00%  0.00%  0.00% Timers
  Resource User: Serial Background(ID: 0x100000D)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777229           0         2          0  0.00%  0.00%  0.00% Serial Backgroun
  Resource User: AAA_SERVER_DEADTIME(ID: 0x100000E)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777230           0         1          0  0.00%  0.00%  0.00% AAA_SERVER_DEADT
  Resource User: AAA high-capacity counters(ID: 0x100000F)
```

```
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777231           0         2          0  0.00%  0.00%  0.00% AAA high-capacit
  Resource User: Policy Manager(ID: 0x1000010)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777232           0         1          0  0.00%  0.00%  0.00% Policy Manager
  Resource User: Crash writer(ID: 0x1000011)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777233           0         1          0  0.00%  0.00%  0.00% Crash writer
  Resource User: RO Notify Timers(ID: 0x1000012)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777234           0         1          0  0.00%  0.00%  0.00% RO Notify Timers
  Resource User: RMI RM Notify Watched Policy(ID: 0x1000013)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777235           0         1          0  0.00%  0.00%  0.00% RMI RM Notify Wa
  Resource User: EnvMon(ID: 0x1000014)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777236       11164     92859        120  0.00%  0.00%  0.00% EnvMon
  Resource User: IPC Dynamic Cache(ID: 0x1000015)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777237           0      3004          0  0.00%  0.00%  0.00% IPC Dynamic Cach
  Resource User: IPC Periodic Timer(ID: 0x1000017)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777239           0    180082          0  0.00%  0.00%  0.00% IPC Periodic Tim
  Resource User: IPC Managed Timer(ID: 0x1000018)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777240         572     79749          7  0.00%  0.00%  0.00% IPC Managed Time
  Resource User: IPC Deferred Port Closure(ID: 0x1000019)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777241           4    180088          0  0.00%  0.00%  0.00% IPC Deferred Por
  Resource User: IPC Seat Manager(ID: 0x100001A)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777242       97560   1408799         69  0.23%  0.02%  0.00% IPC Seat Manager
  Resource User: IPC Session Service(ID: 0x100001B)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777243           0         1          0  0.00%  0.00%  0.00% IPC Session Serv
  Resource User: ARP Input(ID: 0x100001C)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777244          20      3082          6  0.00%  0.00%  0.00% ARP Input
  Resource User: EEM ED Syslog(ID: 0x100001D)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777245           0        49          0  0.00%  0.00%  0.00% EEM ED Syslog
  Resource User: DDR Timers(ID: 0x100001E)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777246           0         2          0  0.00%  0.00%  0.00% DDR Timers
  Resource User: Dialer event(ID: 0x100001F)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777247           0         2          0  0.00%  0.00%  0.00% Dialer event
  Resource User: Entity MIB API(ID: 0x1000020)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777248          28        16       1750  0.00%  0.00%  0.00% Entity MIB API
.
.
.
Resource User: draco-oir-process:slot 2(ID: 0x100011E)
Getbufs  Retbufs  Holding  RU Name
0        0        0        draco-oir-proces

  Resource User: SCP async: Draco-LC4(ID: 0x1000125)
Getbufs  Retbufs  Holding  RU Name
35849    243101   4294760044 SCP async: Draco

  Resource User: IFCOM Msg Hdlr(ID: 0x1000127)
Getbufs  Retbufs  Holding  RU Name
2        2        0        IFCOM Msg Hdlr
```

```
  Resource User: IFCOM Msg Hdlr(ID: 0x1000128)
Getbufs  Retbufs  Holding  RU Name
28       28       0        IFCOM Msg Hdlr

  Resource User: Exec(ID: 0x100012C)
Getbufs  Retbufs  Holding  RU Name
912      912      0        Exec

Resource Owner: test_mem
 Resource User Type: test_process
 Resource User Type: mem_rut
Resource Owner: test_cpu
 Resource User Type: test_process
 Resource User Type: cpu_rut
```

Step 10 **show resource database**

Use this command to display the resource database details, for example:

```
Router# show resource database

List of all Resource Owners :
Owner: cpu                       Id:0x1
Owner's list of monitors is empty.
Owner: memory                    Id:0x2
Owner's list of monitors is empty.
Owner: Buffer                    Id:0x3
Owner's list of monitors is empty.
Owner: test_mem                  Id:0x4
Owner's list of monitors is empty.
Owner: test_cpu                  Id:0x5
Owner's list of monitors is empty.
Owner: test_RO0                  Id:0x7
Owner's list of monitors is empty.
Owner: test_RO1                  Id:0x8
Owner's list of monitors is empty.
Owner: test_RO2                  Id:0x9
Owner's list of monitors is empty.
Owner: test_RO3                  Id:0xA
Owner's list of monitors is empty.
.
.
.
Resource Monitor: test_ROM0, ID: 0x1B
 Not Watching any Relations.
 Not Watching any Policies.
Resource Monitor: test_ROM1, ID: 0x1C
 Not Watching any Relations.
 Not Watching any Policies.
Resource Monitor: test_ROM2, ID: 0x1D
 Not Watching any Relations.
 Not Watching any Policies.
```

Step 11 **show resource owner** {*resource-owner-name* | **all**} **user** {*resource-user-type-name* | **all**} [**brief** | **detailed** | **triggers**]

Use this command to display the resource owner details, for example:

```
Router# show resource owner all user all

Resource Owner: cpu
 Resource User Type: iosprocess
  Resource User: Init(ID: 0x1000001)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
```

```
16777217           0         0          0  0.00%  0.00%  0.00% Init
  Resource User: Scheduler(ID: 0x1000002)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777218           0         0          0  0.00%  0.00%  0.00% Scheduler
  Resource User: Dead(ID: 0x1000003)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777219           0         0          0  0.00%  0.00%  0.00% Dead
  Resource User: Interrupt(ID: 0x1000004)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777220           0         0          0  0.00%  0.00%  0.00% Interrupt
  Resource User: Memory RO RU(ID: 0x1000005)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777221           0         0          0  0.00%  0.00%  0.00% Memory RO RU
  Resource User: Chunk Manager(ID: 0x1000006)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777222           4         3       1333  0.00%  0.00%  0.00% Chunk Manager
  Resource User: Load Meter(ID: 0x1000007)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777223           4       292         13  0.00%  0.00%  0.00% Load Meter
  Resource User: Check heaps(ID: 0x1000009)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777225         376       192       1958  0.00%  0.02%  0.00% Check heaps
  Resource User: Pool Manager(ID: 0x100000A)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777226           0         1          0  0.00%  0.00%  0.00% Pool Manager
  Resource User: Buffer RO RU(ID: 0x100000B)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777227           0         0          0  0.00%  0.00%  0.00% Buffer RO RU
  Resource User: Timers(ID: 0x100000C)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777228           0         2          0  0.00%  0.00%  0.00% Timers
  Resource User: Serial Background(ID: 0x100000D)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777229           0         2          0  0.00%  0.00%  0.00% Serial Backgroun
  Resource User: ALARM_TRIGGER_SCAN(ID: 0x100000E)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777230           0       268          0  0.00%  0.00%  0.00% ALARM_TRIGGER_SC
  Resource User: AAA_SERVER_DEADTIME(ID: 0x100000F)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777231           0         1          0  0.00%  0.00%  0.00% AAA_SERVER_DEADT
  Resource User: AAA high-capacity counters(ID: 0x1000010)
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
.
.
.
Resource User Type: test_RUT143
Resource User Type: test_RUT144
Resource User Type: test_RUT145
Resource User Type: test_RUT146
Resource User Type: test_RUT147
```

Step 12 **show resource relationship user** *resource-user-type*

Use this command to display the relationship details between different resource owners, for example:

```
Router# show resource relationship

Resource User Type: iosprocess (ID: 0x1)
 -> Resource Owner: cpu (ID: 0x1)
 -> Resource Owner: memory (ID: 0x2)
 -> Resource Owner: Buffer (ID: 0x3)
 -> Resource User: Init (ID: 0x1000001)
 -> Resource User: Scheduler (ID: 0x1000002)
 -> Resource User: Dead (ID: 0x1000003)
 -> Resource User: Interrupt (ID: 0x1000004)
 -> Resource User: Memory RO RU (ID: 0x1000005)
 -> Resource User: Chunk Manager (ID: 0x1000006)
 -> Resource User: Load Meter (ID: 0x1000007)
 -> Resource User: Check heaps (ID: 0x1000009)
 -> Resource User: Pool Manager (ID: 0x100000A)
 -> Resource User: Buffer RO RU (ID: 0x100000B)
 -> Resource User: Timers (ID: 0x100000C)
 -> Resource User: Serial Background (ID: 0x100000D)
 -> Resource User: ALARM_TRIGGER_SCAN (ID: 0x100000E)
 -> Resource User: AAA_SERVER_DEADTIME (ID: 0x100000F)
 -> Resource User: AAA high-capacity counters (ID: 0x1000010)
 -> Resource User: Policy Manager (ID: 0x1000011)
 -> Resource User: Crash writer (ID: 0x1000012)
 -> Resource User: RO Notify Timers (ID: 0x1000013)
 -> Resource User: RMI RM Notify Watched Policy (ID: 0x1000014)
 -> Resource User: EnvMon (ID: 0x1000015)
 -> Resource User: OIR Handler (ID: 0x1000016)
 -> Resource User: IPC Dynamic Cache (ID: 0x1000017)
 -> Resource User: IPC Zone Manager (ID: 0x1000018)
 -> Resource User: IPC Periodic Timer (ID: 0x1000019)
 -> Resource User: IPC Managed Timer (ID: 0x100001A)
 -> Resource User: IPC Deferred Port Closure (ID: 0x100001B)
 -> Resource User: IPC Seat Manager (ID: 0x100001C)
 -> Resource User: IPC Session Service (ID: 0x100001D)
 -> Resource User: Compute SRP rates (ID: 0x100001E)
 -> Resource User: ARP Input (ID: 0x100001F)
 -> Resource User: DDR Timers (ID: 0x1000020)
 -> Resource User: Dialer event (ID: 0x1000021)
 -> Resource User: Entity MIB API (ID: 0x1000022)
 -> Resource User: SERIAL A'detect (ID: 0x1000023)
 -> Resource User: GraphIt (ID: 0x1000024)
 -> Resource User: HC Counter Timers (ID: 0x1000025)
 -> Resource User: Critical Bkgnd (ID: 0x1000026)
 -> Resource User: Net Background (ID: 0x1000027)
 -> Resource User: Logger (ID: 0x1000028)
.
.
.
Resource User Type: test_RUT141 (ID: 0x92)
 -> Resource Owner: test_RO0 (ID: 0x7)
 Resource User Type: test_RUT142 (ID: 0x93)
 -> Resource Owner: test_RO0 (ID: 0x7)
 Resource User Type: test_RUT143 (ID: 0x94)
 -> Resource Owner: test_RO0 (ID: 0x7)
 Resource User Type: test_RUT144 (ID: 0x95)
 -> Resource Owner: test_RO0 (ID: 0x7)
 Resource User Type: test_RUT145 (ID: 0x96)
 -> Resource Owner: test_RO0 (ID: 0x7)
 Resource User Type: test_RUT146 (ID: 0x97)
 -> Resource Owner: test_RO0 (ID: 0x7)
 Resource User Type: test_RUT147 (ID: 0x98)
 -> Resource Owner: test_RO0 (ID: 0x7)
 Resource User Type: test_RUT148 (ID: 0x99)
 -> Resource Owner: test_RO0 (ID: 0x7)
 Resource User Type: test_RUT149 (ID: 0x9A)
 -> Resource Owner: test_RO0 (ID: 0x7)
```

Step 13 **show resource user** {**all** | *resource-user-type*} [**brief** | **detailed**]

Use this command to display the relationship details between different ROs, for example:

```
Router# show resource user all
```

```
Resource User Type: iosprocess
Resource Grp: Init
Resource Owner: memory
Processor memory
Allocated   Freed  Holding   Blocks
27197780  8950144 18247636     6552

I/O memory
Allocated   Freed  Holding   Blocks
 7296000     9504  7286496      196

Resource Owner: cpu
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777224       14408       116      124206 100.40%  8.20%  1.70% Init
Resource Owner: Buffer
Getbufs  Retbufs  Holding  RU Name
332      60       272      Init

Resource User: Init
Resource User: Scheduler
Resource Owner: memory
Processor memory
Allocated   Freed  Holding   Blocks
   77544        0    77544        2

Resource Owner: cpu
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777218           0         0          0  0.00%  0.00%  0.00% Scheduler
Resource Owner: Buffer
Getbufs  Retbufs  Holding  RU Name
0        0        0        Scheduler

Resource User: Dead
Resource Owner: memory
Processor memory
Allocated   Freed  Holding   Blocks
 1780540      260  1780280      125
.
.
.

 Resource User: BGP Scanner
  Resource Owner: memory
Processor memory
Allocated   Freed  Holding   Blocks
    9828     9828        0        0

  Resource Owner: cpu
    RUID Runtime(ms)   Invoked      uSecs   5Sec   1Min   5Min Res Usr
16777406         660       659       1001  0.00%  0.00%  0.00% BGP Scanner
  Resource Owner: Buffer
Getbufs  Retbufs  Holding  RU Name
0        0        0        BGP Scanner

Resource User Type: test_process
Resource User Type: mem_rut
Resource User Type: cpu_rut
```

Troubleshooting Tips

To trace and troubleshoot the notification and registration activities for resources using the Embedded Resource Manager feature, use the following suggested techniques.

- Enable debugging of resource registration using the **debug resource policy registration** command in privileged EXEC mode.
- Enable debugging of resource manager notification using the **debug resource policy notification** command in privileged EXEC mode.

SUMMARY STEPS

1. **enable**
2. **debug resource policy registration**
3. **debug resource policy notification** [**owner** *resource-owner-name*]

DETAILED STEPS

	Command or Action	Purpose

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

Step 2	`debug resource policy registration`
	Example:
	`Router# debug resource policy registration`
		Enables debugging on resource policy registration.

Step 3	**`debug resource policy notification`** [**`owner`** *`resource-owner-name`*] **Example:** `Router# debug resource policy notification owner cpu`	Enables notification debugging on ROs.

Examples

Use the **debug resource policy registration** command to trace the resource manager registration information, for example:

```
Router# debug resource policy registration

Registrations debugging is on

When a Resource User is created
*Mar  3 09:35:58.304: resource_user_register: RU: ruID: 0x10000B8, rutID: 0x1, rg_ID: 0x0
name: usrr1

When a Resource User is deleted
*Mar  3 09:41:09.500: resource_user_unregister: RU: ruID: 0x10000B8, rutID: 0x1, rg_ID:
0x0 name: usrr1
```

Use the **debug resource policy notification** [**owner** *resource-owner-name*] command to trace the resource policy notification information, for example:

```
Router# debug resource policy notification

Enabled notif. debugs on all owners
```

When a threshold is violated, you would see these messages:

```
*Mar  3 09:50:44.081: Owner: 'memory' initiated a notification:
*Mar  3 09:50:44.081: %SYS-4-RESMEMEXCEED: Resource user usrr1 has exceeded the Major 
memory threshold
Pool: Processor Used: 42932864 Threshold :42932860
*Mar  3 09:50:46.081: Notification from Owner: 'memory' is dispatched for User: 'usrr1' 
(ID: 0x10000B9)
*Mar  3 09:50:46.081: %SYS-4-RESMEMEXCEED: Resource user usrr1 has exceeded the Major 
memory threshold
Pool: Processor Used: 42932864 Threshold :42932860

Router# no debug resource policy notification

Disabled notif. debugs on all owners

Router# debug resource policy notification owner cpu

Enabled notif. debugs on owner 'cpu'

Router# no debug resource policy notification owner cpu

Disabled notif. debugs on owner 'cpu'

Router# debug resource policy notification owner memory

Enabled notif. debugs on owner 'memory'

Router# no debug resource policy notification owner memory

Disabled notif. debugs on owner 'memory'

Router# debug resource policy notification owner Buffer

Enabled notif. debugs on owner 'Buffer'

Router# no debug resource policy notification owner Buffer

Disabled notif. debugs on owner 'Buffer'
```

Configuration Examples for Embedded Resource Manager

This section provides the following configuration examples:

- Configuring a Resource Policy: Example, page 123
- Configuring Thresholds for Resource Owners: Example, page 123
- Applying a Policy: Example, page 128

Configuring a Resource Policy: Example

The following example shows how to configure a global resource policy with the policy name system-global-pc1:

```
configure terminal
resource policy
policy system-global-pc1 global
```

The following example shows how to configure a per user global resource policy with the policy name per-user-global-pc1 and the resource type as iosprocess:

```
configure terminal
resource policy
policy per-user-global-pc1 type iosprocess
```

The following example shows how to configure a user local resource policy with the policy name user-local-pc1 and the resource type as iosprocess:

```
configure terminal
resource policy
policy user-local-pc1 type iosprocess
```

Configuring Thresholds for Resource Owners: Example

The following example shows how to configure various thresholds for buffer, CPU, and memory ROs.

Configuring System Global Thresholding Policy for Buffer RO

The following example shows how to configure a global policy with the policy name as system-global-pc1 for public buffer with critical threshold values of 90% as rising at an interval of 12 seconds, 20% as falling at an interval of 10 seconds, major threshold values of 70% as rising at an interval of 12 seconds, 15% as falling at an interval of 10 seconds, and minor threshold values of 60% as rising at an interval of 12 seconds, 10% as falling at an interval of 10 seconds:

```
configure terminal
resource policy
policy system-global-pc1 global
system
buffer public
critical rising 90 interval 12 falling 20 interval 10
major rising 70 interval 12 falling 15 interval 10
minor rising 60 interval 12 falling 10 interval 10
```

Configuring Per User Global Thresholding Policy for Buffer RO

The following example shows how to configure a per user global policy with the policy name as per-user-global-pc1 for public buffer with critical threshold values of 90% as rising at an interval of 12 seconds, 20% as falling at an interval of 10 seconds, major threshold values of 70% as rising at an interval of 12 seconds, 15% as falling at an interval of 10 seconds, and minor threshold values of 60% as rising at an interval of 12 seconds, 10% as falling at an interval of 10 seconds:

```
configure terminal
resource policy
policy per-user-global-pc1 type iosprocess
system
buffer public
critical rising 90 interval 12 falling 20 interval 10 global
```

```
major rising 70 interval 12 falling 15 interval 10 global
minor rising 60 interval 12 falling 10 interval 10 global
```

Configuring User Local Thresholding Policy for Buffer RO

The following example shows how to configure a user local policy with the policy name as user-local-pc1 for public buffer with critical threshold values of 90% as rising at an interval of 12 seconds, 20% as falling at an interval of 10 seconds, major threshold values of 70% as rising at an interval of 12 seconds, 15% as falling at an interval of 10 seconds, and minor threshold values of 60% as rising at an interval of 12 seconds, 10% as falling at an interval of 10 seconds:

```
configure terminal
resource policy
policy user-local-pc1 type iosprocess
system
buffer public
critical rising 70 interval 12 falling 20 interval 10
major rising 70 interval 12 falling 15 interval 10
minor rising 60 interval 12 falling 10 interval 10
```

Configuring System Global Thresholding Policy for I/O Memory RO

The following example shows how to configure a global policy with the policy name as system-global-pc1 for I/O memory with critical threshold values of 90% as rising at an interval of 12 seconds, 20% as falling at an interval of 10 seconds, major threshold values of 70% as rising at an interval of 12 seconds, 15% as falling at an interval of 10 seconds, and minor threshold values of 60% as rising at an interval of 12 seconds, 10% as falling at an interval of 10 seconds:

```
configure terminal
resource policy
policy system-global-pc1 global
system
memory io
critical rising 90 interval 12 falling 20 interval 10
major rising 70 interval 12 falling 15 interval 10
minor rising 60 interval 12 falling 10 interval 10
```

Configuring Per User Global Thresholding Policy for I/O Memory RO

The following example shows how to configure a per user global policy with the policy name as per-user-global-pc1 for I/O memory with critical threshold values of 90% as rising at an interval of 12 seconds, 20% as falling at an interval of 10 seconds, major threshold values of 70% as rising at an interval of 12 seconds, 15% as falling at an interval of 10 seconds, and minor threshold values of 60% as rising at an interval of 12 seconds, 10% as falling at an interval of 10 seconds:

```
configure terminal
resource policy
policy per-user-global-pc1 type iosprocess
system
memory io
critical rising 90 interval 12 falling 20 interval 10 global
major rising 70 interval 12 falling 15 interval 10 global
minor rising 60 interval 12 falling 10 interval 10 global
```

Configuring User Local Thresholding Policy for I/O Memory RO

The following example shows how to configure a user local policy with the policy name as user-local-pc1 for I/O memory with critical threshold values of 90% as rising at an interval of 12 seconds, 20% as falling at an interval of 10 seconds, major threshold values of 70% as rising at an interval of 12 seconds, 15% as falling at an interval of 10 seconds, and minor threshold values of 60% as rising at an interval of 12 seconds, 10% as falling at an interval of 10 seconds:

```
configure terminal
resource policy
policy user-local-pc1 type iosprocess
system
memory io
critical rising 90 interval 12 falling 20 interval 10
major rising 70 interval 12 falling 15 interval 10
minor rising 60 interval 12 falling 10 interval 10
```

Configuring System Global Thresholding Policy for Processor Memory RO

The following example shows how to configure a user system global policy with the policy name as system-global-pc1 for processor memory with critical threshold values of 90% as rising at an interval of 12 seconds, 20% as falling at an interval of 10 seconds, major threshold values of 70% as rising at an interval of 12 seconds, 15% as falling at an interval of 10 seconds, and minor threshold values of 60% as rising at an interval of 12 seconds, 10% as falling at an interval of 10 seconds:

```
configure terminal
resource policy
policy system-global-pc1 global
system
memory processor
critical rising 90 interval 12 falling 20 interval 10
major rising 70 interval 12 falling 15 interval 10
minor rising 60 interval 12 falling 10 interval 10
```

Configuring Per User Global Thresholding Policy for Processor Memory RO

The following example shows how to configure a per user global policy with the policy name as user-global-pc1 and the resource type as iosprocess for processor memory with critical threshold values of 90% as rising at an interval of 12 seconds, 20% as falling at an interval of 10 seconds, major threshold values of 70% as rising at an interval of 12 seconds, 15% as falling at an interval of 10 seconds, and minor threshold values of 60% as rising at an interval of 12 seconds, 10% as falling at an interval of 10 seconds:

```
configure terminal
resource policy
policy user-global-pc1 type iosprocess
system
memory processor
critical rising 90 interval 12 falling 20 interval 10
major rising 70 interval 12 falling 15 interval 10
minor rising 60 interval 12 falling 10 interval 10
```

Configuring User Local Thresholding Policy for Processor Memory RO

The following example shows how to configure a user local policy with the policy name as user-local-pc1 and the resource type as iosprocess for processor memory with critical threshold values of 90% as rising at an interval of 12 seconds, 20% as falling at an interval of 10 seconds, major threshold values of 70% as rising at an interval of 12 seconds, 15% as falling at an interval of 10 seconds, and minor threshold values of 60% as rising at an interval of 12 seconds, 10% as falling at an interval of 10 seconds:

```
configure terminal
resource policy
policy user-local-pc1 type iosprocess
system
memory processor
critical rising 90 interval 12 falling 20 interval 10
major rising 70 interval 12 falling 15 interval 10
minor rising 60 interval 12 falling 10 interval 10
```

Configuring System Global Thresholding Policy for Interrupt CPU RO

The following example shows how to configure a global policy with the policy name as system-global-pc1 for interrupt CPU with critical threshold values of 90% as rising at an interval of 12 seconds, 20% as falling at an interval of 10 seconds, major threshold values of 70% as rising at an interval of 12 seconds, 15% as falling at an interval of 10 seconds, and minor threshold values of 60% as rising at an interval of 12 seconds, 10% as falling at an interval of 10 seconds:

```
configure terminal
resource policy
policy system-global-pc1 global
system
cpu interrupt
critical rising 90 interval 12 falling 20 interval 10
major rising 70 interval 12 falling 15 interval 10
minor rising 60 interval 12 falling 10 interval 10
```

Configuring Per User Global Thresholding Policy for Interrupt CPU RO

The following example shows how to configure a per user global policy with the policy name as per-user-global-pc1 and the resource type as iosprocess for interrupt CPU with critical threshold values of 90% as rising at an interval of 12 seconds, 20% as falling at an interval of 10 seconds, major threshold values of 70% as rising at an interval of 12 seconds, 15% as falling at an interval of 10 seconds, and minor threshold values of 60% as rising at an interval of 12 seconds, 10% as falling at an interval of 10 seconds:

```
configure terminal
resource policy
policy per-user-global-pc1 type iosprocess
system
cpu interrupt
critical rising 90 interval 12 falling 20 interval 10 global
major rising 70 interval 12 falling 15 interval 10 global
minor rising 60 interval 12 falling 10 interval 10 global
```

Configuring User Local Thresholding Policy for Interrupt CPU RO

The following example shows how to configure a user local policy with the policy name as user-local-pc1 and the resource type as iosprocess for interrupt CPU with critical threshold values of 90% as rising at an interval of 12 seconds, 20% as falling at an interval of 10 seconds, major threshold values of 70% as rising at an interval of 12 seconds, 15% as falling at an interval of 10 seconds, and minor threshold values of 60% as rising at an interval of 12 seconds, 10% as falling at an interval of 10 seconds:

```
configure terminal
resource policy
```

```
policy user-local-pc1 global type iosprocess
system
cpu interrupt
critical rising 90 interval 12 falling 20 interval 10
major rising 70 interval 12 falling 15 interval 10
minor rising 60 interval 12 falling 10 interval 10
```

Configuring System Global Thresholding Policy for Process CPU RO

The following example shows how to configure a global policy with the policy name as system-global-pc1 for process CPU with critical threshold values of 90% as rising at an interval of 12 seconds, 20% as falling at an interval of 10 seconds, major threshold values of 70% as rising at an interval of 12 seconds, 15% as falling at an interval of 10 seconds, and minor threshold values of 60% as rising at an interval of 12 seconds, 10% as falling at an interval of 10 seconds:

```
configure terminal
resource policy
policy system-global-pc1 global
system
cpu process
critical rising 90 interval 12 falling 20 interval 10
major rising 70 interval 12 falling 15 interval 10
minor rising 60 interval 12 falling 10 interval 10
```

Configuring Per User Global Thresholding Policy for Process CPU RO

The following example shows how to configure a per user global policy with the policy name as per-user-global-pc1 and the resource type as iosprocess for process CPU with critical threshold values of 90% as rising at an interval of 12 seconds, 20% as falling at an interval of 10 seconds, major threshold values of 70% as rising at an interval of 12 seconds, 15% as falling at an interval of 10 seconds, and minor threshold values of 60% as rising at an interval of 12 seconds, 10% as falling at an interval of 10 seconds:

```
configure terminal
resource policy
resource policy per-user-global-pc1 type iosprocess
system
cpu process
critical rising 90 interval 12 falling 20 interval 10 global
major rising 70 interval 12 falling 15 interval 10 global
minor rising 60 interval 12 falling 10 interval 10 global
```

Configuring User Local Thresholding Policy for Process CPU RO

The following example shows how to configure a user local policy with the policy name as user-local-pc1 and the resource type as iosprocess for process CPU with critical threshold values of 90% as rising at an interval of 12 seconds, 20% as falling at an interval of 10 seconds, major threshold values of 70% as rising at an interval of 12 seconds, 15% as falling at an interval of 10 seconds, and minor threshold values of 60% as rising at an interval of 12 seconds, 10% as falling at an interval of 10 seconds:

```
configure terminal
resource policy
policy user-local-pc1 global type iosprocess
system
cpu process
critical rising 90 interval 12 falling 20 interval 10
major rising 70 interval 12 falling 15 interval 10
minor rising 60 interval 12 falling 10 interval 10
```

Configuring System Global Thresholding Policy for Total CPU RO

The following example shows how to configure a global policy with the policy name as system-global-pc1 for total CPU with critical threshold values of 90% as rising at an interval of 12 seconds, 20% as falling at an interval of 10 seconds, major threshold values of 70% as rising at an interval of 12 seconds, 20% as falling at an interval of 10 seconds, and minor threshold values of 60% as rising at an interval of 12 seconds, 10% as falling at an interval of 10 seconds:

```
configure terminal
resource policy
policy system-global-pc1 global
system
cpu total
critical rising 90 interval 12 falling 20 interval 10
major rising 70 interval 12 falling 15 interval 10
minor rising 60 interval 12 falling 10 interval 10
```

Configuring Per User Global Thresholding Policy for Total CPU RO

The following example shows how to configure a per user global policy with the policy name as per-user-global-pc1 and the resource type as iosprocess for total CPU with critical threshold values of 90% as rising at an interval of 12 seconds, 20% as falling at an interval of 10 seconds, major threshold values of 70% as rising at an interval of 12 seconds, 15% as falling at an interval of 10 seconds, and minor threshold values of 60% as rising at an interval of 12 seconds, 10% as falling at an interval of 10 seconds:

```
configure terminal
resource policy
policy per-user-global-pc1 type iosprocess
system
cpu total
critical rising 90 interval 12 falling 20 interval 10 global
major rising 70 interval 12 falling 15 interval 10 global
minor rising 60 interval 12 falling 10 interval 10 global
```

Configuring User Local Thresholding Policy for Total CPU RO

The following example shows how to configure a user local policy with the policy name as user-local-pc1 and the resource type as iosprocess for total CPU with critical threshold values of 90% as rising at an interval of 12 seconds, 20% as falling at an interval of 10 seconds, major threshold values of 70% as rising at an interval of 12 seconds, 15% as falling at an interval of 10 seconds, and minor threshold values of 60% as rising at an interval of 12 seconds, 10% as falling at an interval of 10 seconds:

```
configure terminal
resource policy
policy user-local-pc1 type iosprocess
system
cpu total
critical rising 90 interval 12 falling 20 interval 10
major rising 70 interval 12 falling 15 interval 10
minor rising 60 interval 12 falling 10 interval 10
```

Applying a Policy: Example

The following example shows how to apply a per user thresholding policy for the resource instance EXEC, resource user type iosprocess, and policy name policy-test1:

```
configure terminal
resource policy
```

```
policy policy-test1 type iosprocess
exit
user EXEC iosprocess policy-test1
```

The following example shows how to apply a global thresholding policy with the policy name global-global-test1:

```
configure terminal
resource policy
policy global-global-test1 global
exit
user global global-global-test1
```

The following example shows how to apply a group thresholding policy with the group name gr1 and resource type as iosprocess:

```
configure terminal
resource policy
policy group-test1
exit
user group gr1 type iosprocess
instance http
policy group-test1
```

Additional References

The following sections provide references related to Embedded Resource Manager.

Related Documents

Related Topic	Document Title
Cisco IOS Configuration Fundamentals and Network Management Command Reference	*Cisco IOS Configuration Fundamentals and Network Management Command Reference*, Release 12.3T

Standards

Standards	Title
No new or modified standards are supported by this feature.	—

MIBs

MIBs	MIBs Link
No new or modified MIBs are supported by this feature.	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

RFCs	Title
No new or modified RFCs are supported by this feature.	—

Technical Assistance

Description	Link
Technical Assistance Center (TAC) home page, containing 30,000 pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/public/support/tac/home.shtml

Command Reference

The following new commands are pertinent to this feature. To see the command pages for these commands and other commands used with this feature, go to the *Cisco IOS Master Commands List*, Release 12.4, at http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124mindx/124index.htm.

- **buffer public**
- **buffer tune automatic**
- **cpu interrupt**
- **cpu process**
- **cpu total**
- **critical rising**
- **debug resource policy notification**
- **debug resource policy registration**
- **instance(resource group)**
- **major rising**
- **memory io**
- **memory processor**
- **memory statistics history table**
- **minor rising**
- **monitor event-trace cpu-report (EXEC)**
- **monitor event-trace cpu-report (global)**
- **monitor processes cpu extended**
- **policy(ERM)**

- **policy(resource group)**
- **processes cpu autoprofile hog**
- **processes cpu extended**
- **resource policy**
- **show buffers leak**
- **show buffers tune**
- **show buffers usage**
- **show memory fragment**
- **show memory statistics history table**
- **show monitor event-trace cpu-report**
- **show processes cpu autoprofile hog**
- **show processes cpu extended**
- **show resource all**
- **show resource database**
- **show resource owner**
- **show resource relationship**
- **show resource user**
- **slot (ERM policy)**
- **system (ERM policy)**
- **user (ERM)**

Glossary

CPUHOG—Each process is allocated a quantum of time, which is equivalent to 200 ms. If a process is running for more than 2 seconds, the process is hogging the CPU. This condition is called CPUHOG.

RM—Resource usage Monitors. Applications that wants to monitor resource utilization of resources by the resource users.

RO—Resource Owners. Provides resources to the resource users. For example, CPU, buffer, memory and so on.

RU—Resource Users. Applications or clients (like HTTP, SNMP, telnet, and so on) that use the resources and receive notifications to throttle when thresholds exceed the current values.

Note Refer to *Internetworking Terms and Acronyms* for terms not included in this glossary.

Embedded Event Manager 2.1

Embedded Event Manager (EEM) is a distributed, scalable, and customized approach to event detection and recovery offered directly in a Cisco IOS device. EEM offers the ability to monitor events and take informational or corrective action when the monitored events occur or when a threshold is reached. An EEM policy is an entity that defines an event and the actions to be taken when that event occurs.

EEM 2.1 introduces some new event detectors and actions, some new functionality to allow EEM policies to be run manually, and the ability to run multiple concurrent policies. Support for Simple Network Management Protocol (SNMP) event detector rate-based events is provided as is the ability to create policies using Tool Command Language (Tcl).

History for the Embedded Event Manager Feature

Release	Modification
12.0(26)S	This feature was introduced.
12.3(4)T	Additional functionality was added, and this feature was integrated into Cisco IOS Release 12.3(4)T.
12.3(2)XE	This feature was integrated into Cisco IOS Release 12.3(2)XE.
12.2(25)S	Additional functionality was added, and this feature was integrated into Cisco IOS Release 12.2(25)S.
12.3(14)T	Additional functionality was added.

Finding Support Information for Platforms and Cisco IOS Software Images

Use Cisco Feature Navigator to find information about platform support and Cisco IOS software image support. Access Cisco Feature Navigator at http://www.cisco.com/go/fn. You must have an account on Cisco.com. If you do not have an account or have forgotten your username or password, click **Cancel** at the login dialog box and follow the instructions that appear.

Contents

Prerequisites for Embedded Event Manager 2.1

- If the **action cns-event** command is used, access to a CNS Event gateway must be configured.
- If the **action force-switchover** command is used, a secondary processor must be configured on the device.
- If the **action snmp-trap** command is used, the **snmp-server enable traps event-manager** command must be enabled to permit SNMP traps to be sent from the Cisco IOS device to the SNMP server. Other relevant **snmp-server** commands must also be configured; for details see the **action snmp-trap** command page.

Information About Embedded Event Manager 2.1

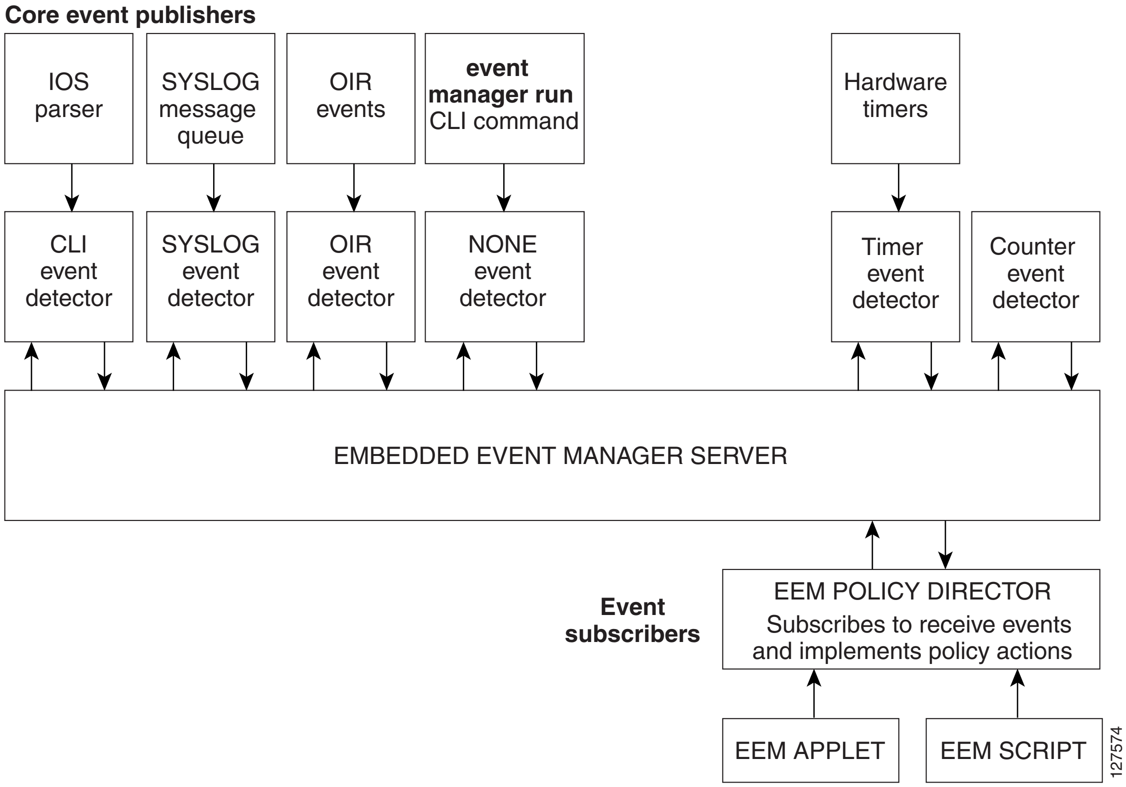
To configure Embedded Event Manager, you should understand the following concepts:

Embedded Event Manager

Event tracking and management has traditionally been performed by devices external to the networking device. Embedded Event Manager (EEM) has been designed to offer event management capability directly in Cisco IOS based devices. The on-device, proactive event management capabilities of EEM are useful because not all event management can be done off router because some problems compromise communication between the router and the external network management device. Capturing the state of the router during such situations can be invaluable in taking immediate recovery actions and gathering information to perform root-cause analysis. Network availability is also improved if automatic recovery actions are performed without the need to fully reboot the routing device.

EEM 2.1 is a flexible, policy-driven framework that supports in-box monitoring of different components of the system with the help of software agents known as event detectors. Figure 4 shows the relationship between the EEM server, core event publishers (event detectors), and the event subscribers (policies). Basically, event publishers screen events and publish them when there is a match on an event specification that is provided by the event subscriber. Event detectors notify the EEM when an event of interest occurs. The EEM policies that are configured using the Cisco IOS command-line interface (CLI) then implement recovery on the basis of the current state of the system and the actions specified in the policy for the given event.

Figure 4 Embedded Event Manager Core Event Detectors



EEM offers the ability to monitor events and take informational or corrective action when the monitored events occur or when a threshold is reached. An EEM policy is an entity that defines an event and the actions to be taken when that event occurs. There are two types of EEM policies: an applet or a script. An applet is a simple form of policy that is defined within the CLI configuration. A script is a form of policy that is written in Tcl.

Embedded Event Manager 2.1

EEM 2.1 is supported on Cisco IOS Release 12.3(14)T and introduced some new features. EEM 2.1 introduces the following new event detectors:

- CLI—The CLI event detector screens command-line interface (CLI) commands for a regular expression match.
- None—The none event detector publishes an event when the Cisco IOS **event manager run** CLI command executes an EEM policy.
- OIR—The online insertion and removal (OIR) event detector publishes an event when a particular hardware insertion or removal event occurs.

EEM 2.1 introduces the following actions:

- Executing a Cisco IOS command-line interface (CLI) command.
- Requesting system information when an event occurs.

- Sending a short e-mail.
- Manually running an EEM policy.

EEM 2.1 also permits multiple concurrent policies to be run using the new **event manager scheduler script** command. Support for Simple Network Management Protocol (SNMP) event detector rate-based events is provided as is the ability to create policies using Tool Command Language (Tcl).

Event Detectors

Embedded Event Manager (EEM) uses software programs known as *event detectors* to determine when an EEM event occurs. Event detectors are separate systems that provide an interface between the agent being monitored, for example Simple Network Management Protocol (SNMP), and the EEM policies where an action can be implemented. EEM 2.1 contains the following event detectors.

Application-Specific Event Detector

The application-specific event detector allows any Embedded Event Manager policy to publish an event.

CLI Event Detector

The CLI event detector screens command-line interface (CLI) commands for a regular expression match. When a match is found, an event is published. The match logic is performed on the fully expanded CLI command before the end of line (EOL) routine is run. The CLI event detector supports three publish modes:

- Synchronous publishing of CLI events—The CLI command is not executed until the EEM policy exits, and the EEM policy can control whether the command is executed.
- Asynchronous publishing of CLI events—The CLI event is published, and then the CLI command is executed.
- Asynchronous publishing of CLI events with command skipping—The CLI event is published, but the CLI command is not executed.

Counter Event Detector

The counter event detector publishes an event when a named counter crosses a specified threshold. There are two or more participants that affect counter processing. The counter event detector can modify the counter, and one or more subscribers define the criteria that cause the event to be published. After a counter event has been published, the counter monitoring logic can be reset to start monitoring the counter immediately or it can be reset when a second threshold—called an exit value—is crossed.

Interface Counter Event Detector

The interface counter event detector publishes an event when a generic Cisco IOS interface counter for a specified interface crosses a defined threshold. A threshold can be specified as an absolute value or an incremental value. If the incremental value is set to 50, for example, an event would be published when the interface counter increases by 50.

After an interface counter event has been published, the interface counter monitoring logic is reset using two methods. The interface counter is reset either when a second threshold—called an exit value—is crossed or when an elapsed period of time occurs.

None Event Detector

The none event detector publishes an event when the Cisco IOS **event manager run** CLI command executes an EEM policy. EEM schedules and runs policies on the basis of an event specification that is contained within the policy itself. An EEM policy must be identified and registered to be permitted to be run manually before the **event manager run** command will execute

OIR Event Detector

The online insertion and removal (OIR) event detector publishes an event when one of the following hardware insertion or removal events occurs:

- A card is removed.
- A card is inserted.
- The software on an inserted card becomes fully operational.

Route processors (RPs), line cards, or feature cards can be monitored for OIR events.

SNMP Event Detector

The SNMP event detector allows a standard SNMP MIB object to be monitored and an event to be generated when the object matches specified values or crosses specified thresholds.

Syslog Event Detector

The syslog event detector allows for screening syslog messages for a regular expression pattern match. The selected messages can be further qualified, requiring that a specific number of occurrences be logged within a specified time. A match on a specified event criteria triggers a configured policy action.

Timer Event Detector

The timer event detector publishes events for the following four different types of timers:

- An absolute-time-of-day timer publishes an event when a specified absolute date and time occurs.
- A countdown timer publishes an event when a timer counts down to zero.
- A watchdog timer publishes an event when a timer counts down to zero and then the timer automatically resets itself to its initial value and starts to count down again.
- A CRON timer publishes an event using a UNIX standard CRON specification to indicate when the event is to be published. A CRON timer never publishes events more than once per minute.

Watchdog System Monitor Event Detector

The Cisco IOS watchdog system monitor event detector publishes an event when one of the following occurs:

- CPU utilization for a Cisco IOS process crosses a threshold.
- Memory utilization for a Cisco IOS process crosses a threshold.

Two events may be monitored at the same time, and the event publishing criteria can be specified to require one event or both events to cross their specified thresholds.

Embedded Event Manager Actions

The CLI-based corrective actions that are taken when event detectors report events enable a powerful on-device event management mechanism. EEM 2.1 supports the following actions:

- Executing a Cisco IOS command-line interface (CLI) command.
- Generating a CNS event for upstream processing by Cisco CNS devices.
- Setting or modifying a named counter.
- Switching to a secondary processor in a fully redundant hardware configuration.
- Requesting system information when an event occurs.
- Sending a short e-mail.
- Manually running an EEM policy.
- Publishing an application-specific event.
- Reloading the Cisco IOS software.
- Generating an SNMP trap.
- Generating prioritized syslog messages.

Embedded Event Manager Environment Variables

Tool Command Language (Tcl) permits global variables—called environment variables—to be defined for use within an EEM policy. There are three different types of environment variables associated with Embedded Event Manager:

- User-defined
- Cisco-defined for a specific sample policy
- Cisco system-defined

User-defined environment variables are defined by you if you create an environment variable in a policy that you have written. Cisco-defined environment variables are either created for a specific sample policy (see Table 5) or considered to be Cisco system-defined (see Table 6) and may apply to one specific event detector or to all event detectors. Environment variables that are user-defined or defined by Cisco in a sample policy are set using the **event manager environment** command. Variables that are used in the EEM policy must be defined before you register the policy. A policy contains a section called “Environment Must Define” that can be defined to check that any required environment variables are defined before the policy runs. Cisco system-defined environment variables are set by the system when the policy starts to execute.

Note Cisco-defined environment variables begin with an underscore character (_). We strongly recommend that customers avoid the same naming convention to prevent naming conflicts.

Table 5 describes the Cisco-defined variables used in the sample EEM policies.

Table 5 Cisco-Defined Environmental Variables and Examples

Environment Variable	Description	Example
_email_server	A Simple Mail Transfer Protocol (SMTP) mail server used to send e-mail.	mailserver.customer.com
_email_to	The address to which e-mail is sent.	engineering@customer.com
_email_from	The address from which e-mail is sent.	devtest@customer.com
_email_cc	The address to which the e-mail must be copied.	manager@customer.com

Table 6 describes the Cisco system-defined environment variables.

Table 6 Cisco System-Defined Environment Variables

Environment Variable	Description
All Events	
_event_pub_time	Time at which the event type was published.
_event_type_string	Event type that triggered the event.
Application-Specific Event Detector	
_application_component_id	Event application component identifier.
_application_data1	Character text, the value of an environment variable, or a combination of the two to be passed to an application-specific event when the event is published.
_application_data2	Character text, the value of an environment variable, or a combination of the two to be passed to an application-specific event when the event is published.
_application_data3	Character text, the value of an environment variable, or a combination of the two to be passed to an application-specific event when the event is published.
_application_data4	Character text, the value of an environment variable, or a combination of the two to be passed to an application-specific event when the event is published.
_application_sub_system	Event application subsystem number.
_application_type	Type of application.
CLI Event Detector	
_cli_msg	The fully expanded message that triggered the CLI event.
_cli_msg_count	The number of times that a message match occurred before the event was published.
Counter Event Detector	
_counter_name	Name of counter.
_counter_value	Value of counter.

Table 6 Cisco System-Defined Environment Variables (continued)

Environment Variable	Description
Interface Counter Event Detector	
_interface_is_increment	Value to indicate whether the current interface counter value is an absolute value (0) or an increment value (1).
_interface_name	Name of the interface to be monitored.
_interface_parameter	Name of the interface counter to be monitored.
_interface_value	Value with which the current interface counter value is compared.
OIR Event Detector	
_oir_event	Value of 1 indicates an insertion event; value of 2 indicates a removal event.
_oir_slot	The slot number for the OIR event.
SNMP Event Detector	
_snmp_exit_event	A value of 0 indicates that this is not an exit event; a value of 1 indicates an exit event.
_snmp_oid	The SNMP object ID that caused the event to be published.
_snmp_oid_value	The SNMP object ID value when the event was published.
Syslog Event Detector	
_syslog_msg	The syslog message that caused the event to be published.
Timer Event Detector	
_timer_remain	Time available before the timer expires. **Note** This environment variable is not available for the CRON timer.
_timer_time	Time at which the last event was triggered.
_timer_type	Type of timer.
Watchdog System Monitor (Cisco IOS) Event Detector	
_ioswd_node	Slot number for the route processor (RP) reporting node.
_ioswd_num_subs	Number of subevents present.
All Watchdog System Monitor (Cisco IOS) Subevents	
_ioswd_sub1_present _ioswd_sub2_present	Indicates if subevent 1 or subevent 2 is present. A value of 1 means that the subevent is present; a value of 0 means that the subevent is not present.
_ioswd_sub1_type _ioswd_sub2_type	Event type, either cpu_util or mem_used.
Watchdog System Monitor (Cisco IOS) cpu_util Events	
_ioswd_sub1_path _ioswd_sub2_path	Process name of subevents.
_ioswd_sub1_period _ioswd_sub2_period	Time period, in seconds and optional milliseconds, used for measurement in subevents.
_ioswd_sub1_pid _ioswd_sub2_pid	Process identifier of subevents.

Table 6 Cisco System-Defined Environment Variables (continued)

Environment Variable	Description
_ioswd_sub1_taskname _ioswd_sub2_taskname	Task name of subevents.
_ioswd_sub1_value _ioswd_sub2_value	CPU utilization of subevents measured as a percentage.
Watchdog System Monitor (Cisco IOS) mem_used Events	
_ioswd_sub1_diff _ioswd_sub2_diff	Percentage value of the difference that triggered the event. **Note** This variable is set only when the _ioswd_subx_is_percent variable contains a value of 1.
_ioswd_sub1_is_percent _ioswd_sub2_is_percent	Identifies whether the value is a percentage. A value of 0 means that the value is not a percentage; a value of 1 means that the value is a percentage.
_ioswd_sub1_path _ioswd_sub2_path	Process name of subevents.
_ioswd_sub1_pid _ioswd_sub2_pid	Process identifier of subevents.
_ioswd_sub1_taskname _ioswd_sub2_taskname	Task name of subevents.
_ioswd_sub1_value _ioswd_sub2_value	CPU utilization of subevents measured as a percentage.

Embedded Event Manager Policies

EEM offers the ability to monitor events and take informational or corrective action when the monitored events occur or reach a threshold. An EEM policy is an entity that defines an event and the actions to be taken when that event occurs. There are two types of EEM policies: an applet or a script. An applet is a simple form of policy that is defined within the CLI configuration. A script is a form of policy that is written in Tool Command Language (Tcl)

Scripts are defined off the networking device using an ASCII editor. The script is then copied to the networking device and registered with EEM. Tcl scripts are supported by EEM.

EEM allows you to write and implement your own policies using Tcl. Writing an EEM policy involves:

- Selecting the event for which the policy is run
- Defining the event detector options associated with logging and responding to the event
- Choosing the actions to be followed when the event occurs

Cisco provides enhancements to Tcl in the form of keyword extensions that facilitate the development of EEM policies. The main categories of keywords identify the detected event, the subsequent action, utility information, counter values, and system information. For more details about the EEM event detectors and about creating EEM policies, see the *Writing Embedded Event Manager Policies* document.

Cisco includes a set of sample policies. You can copy the sample policies to a user directory and then modify the policies, or you can write your own policies. Tcl is currently the only Cisco-supported scripting language for policy creation. Tcl policies can be modified using a text editor such as Emacs. Policies must execute within a defined number of seconds of elapsed time and the time variable can be configured within a policy. The default is currently 20 seconds.

Table 7 describes the sample EEM policies.

Table 7 Sample EEM Policy Descriptions

Name of Policy	Description
sl_intf_down.tcl	This policy runs when a configurable syslog message is logged. It will execute a configurable CLI command and e-mail the results.
tm_cli_cmd.tcl	This policy runs using a configurable CRON entry. It will execute a configurable CLI command and e-mail the results.

The sample policies feature the System Manager, Timer, and Syslog event detectors. The System Manager event detector screens the following System Manager events:

- Process start requests
- Normal process termination requests
- Abnormal process termination requests
- User-requested process restart requests
- User-requested process terminate requests

The Timer event detector generates the following time-based events:

- Watchdog
- Countdown
- Absolute time
- CRON

Watchdog timer events occur when a timer counts down to zero and automatically rearm when they reach zero. Countdown timer events occur when a timer counts down to zero without being rearmed. An absolute timer event occurs when an absolute time of day is passed. CRON timer events occur when the CRON string specification matches the current time.

The Syslog event detector screens syslog messages using Posix regular expressions. An event can be triggered after one or more occurrences of a message match. An additional modifier can be specified to require that the number of message match occurrences happen within a set period of time in order for an event to be triggered.

For more details about the sample policies, see the "EEM Event Detector Demo: Example" section on page 158.

How to Configure Embedded Event Manager 2.1

This section contains the following tasks:

- Registering and Defining an Embedded Event Manager Applet, page 143
- Registering and Defining an Embedded Event Manager Tcl Script, page 145
- Registering and Defining an Embedded Event Manager Policy to Run Manually, page 147
- Unregistering Embedded Event Manager Policies, page 148
- Suspending Embedded Event Manager Policy Execution, page 150
- Managing Embedded Event Manager Policies, page 151
- Displaying Embedded Event Manager History Data, page 152
- Displaying Embedded Event Manager Registered Policies, page 153

Registering and Defining an Embedded Event Manager Applet

Perform this task to register an applet with Embedded Event Manager and to define the EEM applet using event applet and action applet commands. Only one event applet command is allowed in an EEM applet. Multiple action applet commands are permitted. If no event and no action commands are specified, the applet is removed when you exit configuration mode.

EEM Policies

EEM offers the ability to monitor events and take informational or corrective action when the monitored events occur or when a threshold is reached. An EEM policy is an entity that defines an event and the actions to be taken when that event occurs. There are two types of EEM policies: an applet or a script. An applet is a simple form of policy that is defined within the CLI configuration. A script is a form of policy that is written in Tcl.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **event manager applet** *applet-name*
4. **event snmp oid** *oid-value* **get-type** {**exact** | **next**} **entry-op** *operator* **entry-val** *entry-value* [**exit-comb** {**or** | **and**}] [**exit-op** *operator*] [**exit-val** *exit-value*] [**exit-time** *exit-time-value*] **poll-interval** *poll-int-value*
5. **action** *label* **syslog** [**priority** *priority-level*] **msg** *msg-text*
6. Repeat Step 5.
7. **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	**event manager applet** *applet-name* **Example:** `Router(config)# event manager applet memory-fail`	Registers the applet with the Embedded Event Manager (EEM) and enters applet configuration mode.
Step 4	**event snmp oid** *oid-value* **get-type** {**exact** | **next**} **entry-op** *operator* **entry-val** *entry-value* [**exit-comb** {**or** | **and**}] [**exit-op** *operator*] [**exit-val** *exit-value*] [**exit-time** *exit-time-value*] **poll-interval** *poll-int-value* **Example:** `Router(config-applet)# event snmp oid 1.3.6.1.4.1.9.9.48.1.1.1.6.1 get-type exact entry-op lt entry-val 5120000 poll-interval 10`	Specifies the event criteria that cause the EEM applet to run. • In this example, an EEM event is triggered when one of the fields specified by an SNMP object ID crosses a defined threshold. • Exit criteria are optional, and if not specified, event monitoring is reenabled immediately.
Step 5	**action** *label* **syslog** [**priority** *priority-level*] **msg** *msg-text* **Example:** `Router(config-applet)# action 1.0 syslog priority critical msg "Memory exhausted; current available memory is $_snmp_oid_val bytes"`	Specifies the action to be taken when an EEM applet is triggered. • In this example, the action to be taken is to write a message to syslog. • The optional **priority** keyword specifies the priority level of the syslog messages. If selected, the *priority-level* argument must be defined. • The *msg-text* argument can be character text, an environment variable, or a combination of the two.
Step 6	Repeat Step 5. **Example:** `Router(config-applet)# action 2.0 force-switchover`	(Optional) Repeat Step 5 to add other action CLI commands to the applet.

Step 7	**end**
	Example:
	`Router(config-applet)# end`
		Exits applet configuration mode and returns to privileged EXEC mode.

Troubleshooting Tips

Use the **debug event manager** command in privileged EXEC mode to troubleshoot EEM command operations. Use any debugging command with caution as the volume of generated output can slow or stop the router operations. We recommend that this command be used only under the supervision of a Cisco engineer.

Registering and Defining an Embedded Event Manager Tcl Script

Perform this task to configure environment variables and register an EEM policy. EEM schedules and runs policies on the basis of an event specification that is contained within the policy itself. When an EEM policy is registered, the software examines the policy and registers it to be run when the specified event occurs.

EEM Policies

EEM offers the ability to monitor events and take informational or corrective action when the monitored events occur or when a threshold is reached. An EEM policy is an entity that defines an event and the actions to be taken when that event occurs. There are two types of EEM policies: an applet or a script. An applet is a simple form of policy that is defined within the CLI configuration. A script is a form of policy that is written in Tcl.

Prerequisites

You must have a policy available that is written in the Tcl scripting language. Two sample policies—sl_intf_down.tcl and tm_cli_cmd.tcl—are provided, and these sample policies can be stored in the system policy directory.

SUMMARY STEPS

1. **enable**
2. **show event manager environment** [**all** | *variable-name*]
3. **configure terminal**
4. **event manager environment** *variable-name string*
5. Repeat Step 4 for all the required environment variables.
6. **event manager policy** *policy-filename* [**type** {**system** | **user**}] [**trap**]
7. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**show event manager environment** [**all**| *variable-name*] **Example:** `Router# show event manager environment all`	(Optional) Displays the name and value of EEM environment variables. • The optional **all** keyword displays all the EEM environment variables. • The optional *variable-name* argument displays information about the specified environment variable.
Step 3	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 4	**event manager environment** *variable-name string* **Example:** `Router(config)# event manager environment _cron_entry 0-59/2 0-23/1 * * 0-6`	Configures the value of the specified EEM environment variable. • In this example, the software assigns a CRON timer environment variable to be set to every second minute, every hour of every day.
Step 5	Repeat Step 4 for all the required environment variables.	Repeat Step 4 to configure all the environment variables required by the policy to be registered in Step 6.
Step 6	**event manager policy** *policy-filename* [**type** {**system** | **user**}] [**trap**] **Example:** `Router(config)# event manager policy tm_cli_cmd.tcl type system`	Registers the EEM policy to be run when the specified event defined within the policy occurs. • Use the **system** keyword to register a Cisco-defined system policy. • Use the **user** keyword to register a user-defined system policy. • In this example, the sample EEM policy named tm_cli_cmd.tcl is registered as a system policy.
Step 7	**exit** **Example:** `Router(config)# exit`	Exits global configuration mode and returns to privileged EXEC mode.

Examples

In the following example, the **show event manager environment** privileged EXEC command is used to display the name and value of all EEM environment variables.

```
Router# show event manager environment all

No.  Name                         Value
1    _cron_entry                  0-59/2 0-23/1 * * 0-6
2    _show_cmd                    show ver
3    _syslog_pattern              .*UPDOWN.*Ethernet1/0.*
4    _config_cmd1                 interface Ethernet1/0
5    _config_cmd2                 no shut
```

Registering and Defining an Embedded Event Manager Policy to Run Manually

There are two ways to manually run an EEM policy. EEM usually schedules and runs policies on the basis of an event specification that is contained within the policy itself. The **event none** command allows EEM to identify an EEM policy that can either be run manually or be run when an EEM applet is triggered. To run the policy, use either the **action policy** command in applet configuration mode or the **event manager run** command in global configuration mode.

Perform this task to register an EEM policy to be run manually using the **event manager run** command. For an example of how to manually run a policy using the **action policy** command, see the "Embedded Event Manager Manual Policy Execution: Example" section on page 156.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **event manager applet** *applet-name*
4. **event none** *policy-filename*
5. **exit**
6. **event manager run** *policy-filename*
7. **exit**

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.

	Command or Action	Purpose
Step 3	**event manager applet** *applet-name* **Example:** `Router(config)# event manager applet manual-policy`	Registers the applet with the Embedded Event Manager and enters applet configuration mode.
Step 4	**event none** *policy-filename* **Example:** `Router(config-applet)# event none manual-policy`	Specifies that an EEM policy is to be registered with the EEM and can be run manually.
Step 5	**exit** **Example:** `Router(config-applet)# exit`	Exits applet configuration mode and returns to global configuration mode.
Step 6	**event manager run** *policy-filename* **Example:** `Router(config)# event manager run manual-policy`	Manually runs a registered EEM policy.
Step 7	**exit** **Example:** `Router(config)# exit`	Exits global configuration mode and returns to privileged EXEC mode.

Unregistering Embedded Event Manager Policies

Perform this task to remove an EEM policy from the running configuration file. Execution of the policy is canceled.

SUMMARY STEPS

1. **enable**
2. **show event manager policy registered** [**event-type** *event-name*] [**system** | **user**] [**time-ordered** | **name-ordered**]
3. **configure terminal**
4. **no event manager policy** *policy-filename* [**type** {**system** | **user**}] [**trap**]
5. **exit**
6. Repeat Step 2 to ensure that the policy is removed.

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. - Enter your password if prompted.
Step 2	**show event manager policy registered** [**event-type** *event-name*] [**system** | **user**] [**time-ordered** | **name-ordered**] **Example:** `Router# show event manager policy registered`	(Optional) Displays the EEM policies that are currently registered. - The optional **system** or **user** keyword displays the registered system or user policies. - If no keywords are specified, EEM registered policies for all event types are displayed in time order.
Step 3	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 4	**no event manager policy** *policy-filename* **Example:** `Router(config)# no event manager policy pr_cdp_abort.tcl`	Removes the EEM policy from the configuration, causing the policy to be unregistered. - In this example, the **no** form of the command is used to unregister a specified policy.
Step 5	**exit** **Example:** `Router(config)# exit`	Exits global configuration mode and returns to privileged EXEC mode.
Step 6	Repeat Step 2 to ensure that the policy is removed. **Example:** `Router# show event manager policy registered`	—

Examples

Sample Output for the show event manager policy registered Command

In the following example, the **show event manager policy registered** privileged EXEC command is used to display the three EEM policies that are currently registered:

```
Router# show event manager policy registered

No.  Type    Event Type          Trap  Time Registered           Name
1    system  timer cron          Off   Sat Oct11  01:43:18 2003  tm_cli_cmd.tcl
 name {crontimer2} cron entry {0-59/1 0-23/1 * * 0-7}
 nice 0 priority normal maxrun_sec 240 maxrun_nsec 0

2    system  syslog              Off   Sat Oct11  01:43:28 2003  sl_intf_down.tcl
 occurs 1 pattern {.*UPDOWN.*Ethernet1/0.*}
 nice 0 priority normal maxrun_sec 90 maxrun_nsec 0
```

```
3    system  proc abort          Off   Sat Oct11  01:43:38 2003  pr_cdp_abort.tcl
 instance 1 path {cdp2.iosproc}
 nice 0 priority normal maxrun_sec 20 maxrun_nsec 0
```

Suspending Embedded Event Manager Policy Execution

Perform this task to immediately suspend the execution of all EEM policies. Suspending instead of unregistering policies might be necessary for reasons of temporary performance or security.

SUMMARY STEPS

1. **enable**
2. **show event manager policy registered** [**event-type** *event-name*] [**system** | **user**] [**time-ordered** | **name-ordered**]
3. **configure terminal**
4. **event manager scheduler policy suspend**
5. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**show event manager policy registered** [**event-type** *event-name*] [**system** | **user**] [**time-ordered** | **name-ordered**] **Example:** `Router# show event manager policy registered`	(Optional) Displays the EEM policies that are currently registered. • The optional **system** or **user** keyword displays the registered system or user policies. • If no keywords are specified, EEM registered policies for all event types are displayed in time order.
Step 3	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 4	**event manager scheduler policy suspend** **Example:** `Router(config)# event manager scheduler policy suspend`	Immediately suspends the execution of all EEM policies.
Step 5	**exit** **Example:** `Router(config)# exit`	Exits global configuration mode and returns the router to privileged EXEC mode.

Examples

Sample Output for the show event manager policy registered Command

In the following example, the **show event manager policy registered** privileged EXEC command is used to display all the EEM registered policies:

```
Router# show event manager policy registered

No.  Type    Event Type          Trap  Time Registered           Name
1    system  timer cron          Off   Sat Oct11  01:43:18 2003  tm_cli_cmd.tcl
 name {crontimer2} cron entry {0-59/1 0-23/1 * * 0-7}
 nice 0 priority normal maxrun_sec 240 maxrun_nsec 0

2    system  syslog              Off   Sat Oct11  01:43:28 2003  sl_intf_down.tcl
 occurs 1 pattern {.*UPDOWN.*Ethernet1/0.*}
 nice 0 priority normal maxrun_sec 90 maxrun_nsec 0

3    system  proc abort          Off   Sat Oct11  01:43:38 2003  pr_cdp_abort.tcl
 instance 1 path {cdp2.iosproc}
 nice 0 priority normal maxrun_sec 20 maxrun_nsec 0
```

Managing Embedded Event Manager Policies

Perform this task to define a location in the local file system containing an installed modular Cisco IOS image to run on all the nodes in a system, or on just one specified node.

SUMMARY STEPS

1. **enable**
2. **show event manager directory user** [**library** | **policy**]
3. **configure terminal**
4. **event manager directory user** [**library** *path* | **policy** *path*]
5. **exit**

DETAILED STEPS

	Command or Action	Purpose

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

Step 2	`show event manager directory user [library | policy]`
	Example:
	`Router# show event manager directory user library`
		(Optional) Displays the directory to use for storing EEM user library or policy files.
		• The optional **library** keyword displays the directory to use for user library files.
		• The optional **policy** keyword displays the directory to use for user-defined EEM policies.

	Command or Action	Purpose
Step 3	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 4	**event manager directory user** [**library** | **policy**] *path* **Example:** `Router(config)# event manager directory user library disk0:/usr/lib/tcl`	Specifies a directory to use for storing user library files or user-defined EEM policies. • Use the *path* argument to specify the absolute pathname to the user directory.
Step 5	**exit** **Example:** `Router(config)# exit`	Exits global configuration mode and returns to privileged EXEC mode.

Examples

Sample Output for the show event manager directory user Command

In the following example, the **show event manager directory user** privileged EXEC command is used to display the directory, if it exists, to use for storing EEM user library files:

```
Router# show event manager directory user library

disk0:/usr/lib/tcl
```

Displaying Embedded Event Manager History Data

Perform this optional task to change the size of the history tables and to display EEM history data.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **event manager history size** {**events** | **traps**} [*size*]
4. **exit**
5. **show event manager history events** [**detailed**] [**maximum** *number*]
6. **show event manager history traps** {**server** | **policy**}

DETAILED STEPS

Step 1 **enable**

Enables privileged EXEC mode. Enter your password if prompted.

```
Router> enable
```

Step 2 **configure terminal**

Enters global configuration mode.

```
Router# configure terminal
```

Step 3 **event manager history size** {**events** | **traps**} [*size*]

Use this command to change the size of the EEM event history table or the size of the EEM SNMP trap history table. In the following example, the size of the EEM event history table is changed to 30 entries:

```
Router(config)# event manager history size events 30
```

Step 4 **exit**

Exits global configuration mode and returns to privileged EXEC mode.

```
Router(config)# exit
```

Step 5 **show event manager history events** [**detailed**] [**maximum** *number*]

Use this command to display detailed information about each EEM event, for example:

```
Router# show event manager history events

No.  Time of Event             Event Type          Name
1    Fri Aug13  21:42:57 2004  snmp                applet: SAAping1
2    Fri Aug13  22:20:29 2004  snmp                applet: SAAping1
3    Wed Aug18  21:54:48 2004  snmp                applet: SAAping1
4    Wed Aug18  22:06:38 2004  snmp                applet: SAAping1
5    Wed Aug18  22:30:58 2004  snmp                applet: SAAping1
6    Wed Aug18  22:34:58 2004  snmp                applet: SAAping1
7    Wed Aug18  22:51:18 2004  snmp                applet: SAAping1
8    Wed Aug18  22:51:18 2004  application         applet: CustApp1
```

Step 6 **show event manager history traps** {**server** | **policy**}

Use this command to display the EEM SNMP traps that have been sent either from the EEM server or from an EEM policy. In the following example, the EEM SNMP traps that were triggered from within an EEM policy are displayed.

```
Router# show event manager history traps policy

No.  Time                      Trap Type           Name
1    Wed Aug18  22:30:58 2004  policy              EEM Policy Director
2    Wed Aug18  22:34:58 2004  policy              EEM Policy Director
3    Wed Aug18  22:51:18 2004  policy              EEM Policy Director
```

Displaying Embedded Event Manager Registered Policies

Perform this optional task to display EEM registered policies.

SUMMARY STEPS

1. **enable**
2. **show event manager policy registered** [**event-type** *event-name*] [**time-ordered** | **name-ordered**]

DETAILED STEPS

Step 1 **enable**

Enables privileged EXEC mode. Enter your password if prompted.

```
Router> enable
```

Step 2 **show event manager policy registered** [**event-type** *event-name*] [**time-ordered** | **name-ordered**]

Use this command with the **time-ordered** keyword to display information about currently registered policies sorted by time, for example:

```
Router# show event manager policy registered time-ordered

No.  Type    Event Type          Time                    Registered Name
1    applet  snmp                Thu May30 05:57:16 2004 memory-fail
 oid {1.3.6.1.4.1.9.9.48.1.1.1.6.1} get-type exact entry-op lt entry-val
{5120000} poll-interval 10
action 1.0 syslog priority critical msg Memory exhausted; current available memory
is $_snmp_oid_val bytes
 action 2.0 force-switchover
2    applet  syslog              Wed Jul16 00:05:17 2004 intf-down
 pattern {.*UPDOWN.*Ethernet1/0.*}
 action 1.0 cns-event msg Interface state change: $_syslog_msg
```

Use this command with the **name-ordered** keyword to display information about currently registered policies sorted by name, for example:

```
Router# show event manager policy registered name-ordered

No.  Type    Event Type          Time Registered          Name
1    applet  syslog              Wed Jul16  00:05:17 2004 intf-down
 pattern {.*UPDOWN.*Ethernet1/0.*}
 action 1.0 cns-event msg Interface state change: $_syslog_msg
2    applet  snmp                Thu May30 05:57:16 2004   memory-fail
 oid {1.3.6.1.4.1.9.9.48.1.1.1.6.1} get-type exact entry-op lt entry-val
{5120000} poll-interval 10
 action 1.0 syslog priority critical msg Memory exhausted; current available memory
is $_snmp_oid_val bytes
 action 2.0 force-switchover
```

Use this command with the **event-type** keyword to display information about currently registered policies for the event type specified in the *event-name* argument, for example:

```
Router# show event manager policy registered event-type syslog

No.  Type    Event Type          Time Registered           Name
1    applet  syslog              Wed Jul16  00:05:17 2004 intf-down
 pattern {.*UPDOWN.*Ethernet1/0.*}
 action 1.0 cns-event msg Interface state change: $_syslog_msg
```

Configuration Examples for Embedded Event Manager 2.1

This section contains the following configuration examples:

- Embedded Event Manager Applet Configuration: Example, page 155
- Embedded Event Manager Manual Policy Execution: Example, page 156
- Embedded Event Manager Watchdog System Monitor Event Detector Configuration: Example, page 157
- EEM Event Detector Demo: Example, page 158

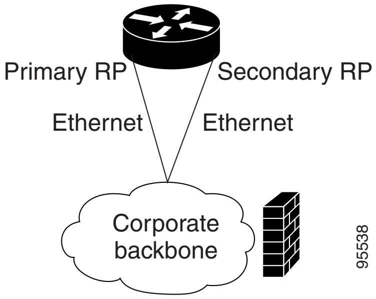
Embedded Event Manager Applet Configuration: Example

The following example shows how to configure an EEM applet that causes a switch to the secondary (redundant) Route Processor (RP) when the primary RP runs low on memory.

This example illustrates a method for taking preventative action against a software fault that causes a memory leak. The action taken here is designed to reduce downtime by switching over to a redundant RP when a possible memory leak is detected.

Figure 5 shows a dual RP router that is running an EEM image. An EEM applet has been registered through the CLI using the **event manager applet** command. The applet will run when the available memory on the primary RP falls below the specified threshold of 5,120,000 bytes. The applet actions are to write a message to syslog that indicates the number of bytes of memory available and to switch to the secondary RP.

Figure 5 Dual RP Topology



The commands used to register the policy are shown below.

```
event manager applet memory-demo
 event snmp oid 1.3.6.1.4.1.9.9.48.1.1.1.6.1 get-type exact entry-op lt entry-val
5120000 poll-interval 10
 action 1.0 syslog priority critical msg "Memory exhausted; current available memory
is $_snmp_oid_val bytes"
 action 2.0 force-switchover
```

The registered applet is displayed using the **show event manager policy registered** command:

```
Router# show event manager policy registered

No.  Type    Event Type          Time Registered           Name
1    applet  snmp                Thu Jan30  05:57:16 2003  memory-demo
 oid {1.3.6.1.4.1.9.9.48.1.1.1.6.1} get-type exact entry-op lt entry-val {5120000}
poll-interval 10
```

```
 action 1.0 syslog priority critical msg Memory exhausted; current available memory is
$_snmp_oid_val bytes
 action 2.0 force-switchover
```

For the purpose of this example, a memory depletion is forced on the router, and a series of **show memory** commands are executed to watch the memory deplete:

```
Router# show memory

                Head    Total(b)     Used(b)     Free(b)   Lowest(b)  Largest(b)
Processor   53585260   212348444   119523060    92825384    92825384    92365916
Fast        53565260      131080       70360       60720       60720       60668

Router# show memory

                Head    Total(b)     Used(b)     Free(b)   Lowest(b)  Largest(b)
Processor   53585260   212364664   164509492    47855172    47855172    47169340
Fast        53565260      131080       70360       60720       60720       60668

Router# show memory

                Head    Total(b)     Used(b)     Free(b)   Lowest(b)  Largest(b)
Processor   53585260   212369492   179488300    32881192    32881192    32127556
Fast        53565260      131080       70360       60720       60720       60668
```

When the threshold is reached, an EEM event is triggered. The applet named memory-demo runs, causing a syslog message to be written to the console and a switch to be made to the secondary RP. The following messages are logged:

```
00:08:31: %HA_EM-2-LOG: memory-demo: Memory exhausted; current available memory is
4484196 bytes
00:08:31: %HA_EM-6-FMS_SWITCH_HARDWARE: fh_io_msg: Policy has requested a hardware
switchover
```

Configuration for the Primary RP and Secondary RP

The following is partial output from the **show running-config** command on both the primary RP and the secondary (redundant) RP:

```
redundancy
 mode sso
.
.
.
!
event manager applet memory-demo
 event snmp oid 1.3.6.1.4.1.9.9.48.1.1.1.6.1 get-type exact entry-op lt entry-val
5120000 poll-interval 10
 action 1.0 syslog priority critical msg "Memory exhausted; current available memory
is $_snmp_oid_val bytes"
 action 2.0 force-switchover
```

Embedded Event Manager Manual Policy Execution: Example

The following examples show how to configure an EEM policy (applet or script) to be run manually.

Using the event manager run Command

This example shows how to run a policy manually using the **event manager run** command. The policy is registered using the **event none** command under applet configuration mode and then run from global configuration mode using the **event manager run** command.

```
event manager applet manual-policy
 event none
 action 1.0 syslog msg "Manual-policy triggered"
 exit
!
event manager run manual-policy
```

Using the action policy Command

This example shows how to run a policy manually using the **action policy** command. The policy is registered using the **event none** command under applet configuration mode and then the policy is executed using the **action policy** command in applet configuration mode.

```
event manager applet manual-policy
 event none
 action 1.0 syslog msg "Manual-policy triggered"
 exit
!
event manager applet manual-policy-two
 event none
 action 1.0 policy manual-policy
 exit
!
event manager run manual-policy-two
```

Embedded Event Manager Watchdog System Monitor Event Detector Configuration: Example

The following example shows how to configure three EEM applets to demonstrate how the watchdog system monitor event detector works.

Watchdog System Monitor Sample1 Policy

The first policy triggers an applet when the average CPU usage for the process named “IP Input” is greater than or equal to 1 percent for 10 seconds:

```
event manager applet IOSWD_Sample1
 event ioswdsysmon sub1 cpu-proc taskname “IP Input” op ge val 1 period 10
 action 1.0 syslog msg “IOSWD_Sample1 Policy Triggered”
```

Watchdog System Monitor Sample2 Policy

The second policy triggers an applet when the total amount of memory used by the process named “Net Input” is greater than 100 kb:

```
event manager applet IOSWD_Sample2
 event ioswdsysmon sub1 mem-proc taskname “Net Input” op gt val 100 is-percent false
 action 1.0 syslog msg “IOSWD_Sample2 Policy Triggered”
```

Watchdog System Monitor Sample3 Policy

The third policy triggers an applet when the total amount of memory used by the process named “IP RIB Update” has increased by more than 50 percent over the sample period of 60 seconds:

```
event manager applet IOSWD_Sample3
 event ioswdsysmon sub1 mem-proc taskname “IP RIB Update” op gt val 50 is-percent true
period 60
 action 1.0 syslog msg “IOSWD_Sample3 Policy Triggered”
```

The three policies are configured, and then repetitive large pings are made to the networking device from several workstations, causing the networking device to register some usage. This will trigger policies 1 and 2, and the console will display the following messages:

```
00:42:23: %HA_EM-6-LOG: IOSWD_Sample1: IOSWD_Sample1 Policy Triggered
00:42:47: %HA_EM-6-LOG: IOSWD_Sample2: IOSWD_Sample2 Policy Triggered
```

To view the policies that are registered, use the **show event manager policy registered** command:

```
Router# show event manager policy registered

No.  Class   Type    Event Type          Trap  Time Registered           Name
1    applet  system  ioswdsysmon         Off   Fri Jul 23 02:27:28 2004  IOSWD_Sample1
 sub1 cpu_util {taskname {IP Input} op ge val 1 period 10.000 }
 action 1.0 syslog msg IOSWD_Sample1 Policy Triggered

2    applet  system  ioswdsysmon         Off   Fri Jul 23 02:23:52 2004  IOSWD_Sample2
 sub1 mem_used {taskname {Net Input} op gt val 100 is_percent FALSE}
 action 1.0 syslog msg IOSWD_Sample2 Policy Triggered

3    applet  system  ioswdsysmon         Off   Fri Jul 23 03:07:38 2004  IOSWD_Sample3
 sub1 mem_used {taskname {IP RIB Update} op gt val 50 is_percent TRUE period 60.000 }
 action 1.0 syslog msg "IOSWD_Sample3 Policy Triggered"
```

EEM Event Detector Demo: Example

This example uses the sample policies to demonstrate how to use Embedded Event Manager policies. Proceed through the following sections to see how to use the sample policies:

- EEM Sample Policy Descriptions
- Event Manager Environment Variables for the Sample Policies
- Registration of Some EEM Policies
- Basic Configuration Details for All Sample Policies
- Using the Sample Policies

EEM Sample Policy Descriptions

This configuration example features the two sample EEM policies:

- sl_intf_down.tcl—Will be run when a configurable Syslog message is logged. It will execute up to two configurable CLI commands and will e-mail the results.
- tm_cli_cmd.tcl—Will be run using a configurable CRON entry. It will execute a configurable CLI command and will e-mail the results.

Event Manager Environment Variables for the Sample Policies

Event manager environment variables are Tcl global variables that are defined external to the EEM policy before the policy is registered and run. The sample policies require three of the e-mail environment variables to be set (see Table 5 on page 139 for a list of the e-mail variables); only _email_cc is optional. Other required variable settings are outlined in the following tables.

Table 8 describes the EEM environment variables that must be set before the tm_cli_cmd.tcl sample policy is run.

Table 8 Environment Variables Required for the tm_cli_cmd.tcl Policy

Environment Variable	Description	Example
_cron_entry	A CRON specification that determines when the policy will run. See the *Writing Embedded Event Manager Policies* document for more information about how to specify a cron entry.	0-59/1 0-23/1 * * 0-7
_show_cmd	The CLI command to be executed when the policy is run.	**show version**

Table 9 describes the EEM environment variables that must be set before the sl_intf_down.tcl sample policy is run.

Table 9 Environment Variables required for the sl_intf_down.tcl Policy

Environment Variable	Description	Example
_syslog_pattern	A regular expression pattern match string that is used to compare syslog messages to determine when the policy runs.	.*UPDOWN.*FastEthernet0/0.*
_config_cmd1	The first configuration command that is executed.	**interface Ethernet1/0**
_config_cmd2	The second configuration command that is executed. This variable is optional and need not be specified.	**no shutdown**

Registration of Some EEM Policies

Some EEM policies must be unregistered and then reregistered if an EEM environment variable is modified after the policy is registered. The event_register_*xxx* statement that appears at the start of the policy contains some of the EEM environment variables, and this statement is used to establish the conditions under which the policy is run. If the environment variables are modified after the policy has registered, the conditions may become invalid. To avoid any errors, the policy must be unregistered and then reregistered. The following variables are affected:

- _cron_entry in the tm_cli_cmd.tcl policy
- _syslog_pattern in the sl_intf_down.tcl policy

Basic Configuration Details for All Sample Policies

To allow e-mail to be sent from the Embedded Event Manager, the **hostname** and **ip domain-name** commands must be configured. The EEM environment variables must also be set. After a modular Cisco IOS image has been booted, use the following initial configuration, substituting appropriate values for your network:

```
hostname cpu
ip domain-name cisco.com
event manager _email_server ms.cisco-user.net
event manager _email_to username@cisco-user.net
event manager _email_from engineer@cisco-user.net
event manager _email_cc projectgroup@cisco-user.net
event manager _cron_entry 0-59/2 0-23/1 * * 0-7
event manager _show_cmd show event manager policy registered
event manager _syslog_pattern .*UPDOWN.*FastEthernet0/0
event manager _config_cmd1 interface Ethernet1/0
event manager _config_cmd2 no shut
end
```

Using the Sample Policies

This section contains the following configuration scenarios to demonstrate how to use the five sample Tcl policies:

- Running the sl_intf_down.tcl Sample Policy
- Running the tm_cli_cmd.tcl Sample Policy

Running the sl_intf_down.tcl Sample Policy

This sample policy demonstrates the ability to modify the configuration when a syslog message with a specific pattern is logged. The policy gathers detailed information about the event and uses the CLI library to execute the configuration commands specified in the EEM environment variables _config_cmd1 and, if specified, _config_cmd2. An e-mail message is sent with the results of the CLI command.

The following sample configuration demonstrates how to use this policy. Starting in user EXEC mode, enter the **enable** command at the router prompt. The router enters privileged EXEC mode, where you can enter the **show event manager policy registered** command to verify that no policies are currently registered. The next command is the **show event manager policy available** command to display which policies are available to be installed. After you enter the **configure terminal** command to reach global configuration mode, you can register the sl_intf_down.tcl policy with EEM using the **event manager policy** command. Exit from global configuration mode and enter the **show event manager policy registered** command again to verify that the policy has been registered.

The policy will run when an interface goes down. Enter the **show event manager environment** command to display the current environment variable values. Unplug the cable for the interface specified in the _syslog_pattern EEM environment variable. The interface goes down, prompting the syslog daemon to log a syslog message about the interface being down, and the syslog event detector is called. The syslog event detector reviews the outstanding event specifications and finds a match for the interface process crash. The EEM server is notified, and the server runs the policy that is registered to handle this event—sl_intf_down.tcl.

```
enable
show event manager policy registered
show event manager policy available
config terminal
 event manager policy sl_intf_down.tcl
 end
show event manager policy registered
show event manager environment
```

Running the tm_cli_cmd.tcl Sample Policy

This sample policy demonstrates the ability to periodically execute a CLI command and to e-mail the results. The CRON specification “0-59/2 0-23/1 * * 0-7” will cause this policy to be run every other minute. The policy gathers detailed information about the event and uses the CLI library to execute the configuration commands specified in the EEM environment variable _show_cmd. An e-mail message is sent with the results of the CLI command.

The following sample configuration demonstrates how to use this policy. Starting in user EXEC mode, enter the **enable** command at the router prompt. The router enters privileged EXEC mode where you can enter the **show event manager policy registered** command to verify that no policies are currently registered. The next command is the **show event manager policy available** command to display which policies are available to be installed. After entering the **configure terminal** command to reach global configuration mode, the tm_cli_cmd.tcl policy can be registered with EEM using the **event manager policy** command. Exit from global configuration mode and enter the **show event manager policy registered** command to verify that the policy has been registered.

The Timer event detector triggers an event for this case periodically according to the CRON string set in the EEM environment variable _cron_entry. The EEM server is notified and the server runs the policy that is registered to handle this event—tm_cli_cmd.tcl.

```
enable
show event manager policy registered
show event manager policy available
config terminal
 event manager policy tm_cli_cmd.tcl
 end
show event manager policy registered
```

Where to Go Next

For more details about other network management technologies, see the *Cisco IOS Configuration Fundamentals and Network Management Configuration Guide*, Release 12.3.

Additional References

The following sections provide references related to Embedded Event Manager 2.1.

Related Documents

Related Topic	Document Title
EEM commands: complete command syntax, defaults, command mode, command history, usage guidelines, and examples	*Cisco IOS Configuration Fundamentals and Network Management Command Reference*, Release 12.3T
Embedded Event Manager policy writing using Tcl	*Writing Embedded Event Manager Policies*
CNS event agent	*CNS Event Agent* feature document, Release 12.2(2)T
CNS Configuration Engine	*Cisco CNS Configuration Registrar: Installing and Configuring the IE2100*

Standards

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

MIBs

MIB	MIBs Link
CISCO-EMBEDDED-EVENT-MGR-MIB	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 by this feature, and support for existing RFCs has not been modified by this feature.	—

Technical Assistance

Description	Link
The Cisco Technical Support website contains thousands of pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/techsupport

Command Reference

The following new and modified commands are pertinent to this feature. To see the command pages for these commands and other commands used with this feature, go to the *Cisco IOS Master Commands List*, Release 12.4, at http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124mindx/124index.htm.

- **action cli**
- **action counter**
- **action info**
- **action mail**
- **action policy**
- **action publish-event**
- **action snmp-trap**
- **debug event manager**
- **event application**
- **event cli**
- **event counter**

- **event interface**
- **event ioswdsysmon**
- **event manager directory user**
- **event manager environment**
- **event manager history size**
- **event manager policy**
- **event manager run**
- **event manager scheduler policy suspend**
- **event manager scheduler script**
- **event manager session cli username**
- **event none**
- **event oir**
- **event snmp**
- **event syslog**
- **event timer**
- **set (EEM)**
- **show event manager directory user**
- **show event manager environment**
- **show event manager history events**
- **show event manager history traps**
- **show event manager policy available**
- **show event manager policy pending**
- **show event manager policy registered**
- **show event manager session cli username**

XML Interface to Syslog Messages

The XML Interface to Syslog Messages features provides command-line interface (CLI) commands for enabling syslog messages to be sent in an Extensible Markup Language (XML) format. Logs in a standardized XML format can be more readily used in external customized monitoring tools.

Specifications for the XML Interface to Syslog Messages Feature

Feature History	
Release	**Modification**
12.2(15)T	This feature was introduced.
Supported Platforms[1]	
All platforms that support standard system message logging. For details, see Cisco Feature Navigator.	

[1] For image and plaform support details and updates, see Cisco Feature Navigator. Access Cisco Feature Navigator at http://www.cisco.com/go/fn. You must have an account on Cisco.com. If you do not have an account or have forgotten your username or password, click Cancel at the login dialog box and follow the instructions that appear.

Contents

Information About the XML Interface to Syslog Messages Feature

To configure the XML Interface to Syslog Messages feature, you must understand the following concepts:

- Cisco IOS System Message Logging
- XML-Formatted System Message Logging
- System Logging Message Formatting

Cisco IOS System Message Logging

The Cisco IOS system message logging (syslog) process allows the system to report and save important error and notifications messages, either locally or to a remote logging server. These syslog messages include messages in a standardized format (often called system error messages) and output from **debug** commands. These messages are generated during network operation to assist users and Cisco TAC engineers with identifying the type and severity of a problem, or to aid users in monitoring router activity. Syslog messages can be sent to the console, a monitor (TTY and Telnet connections), the system buffer, or to remote hosts.

Note The system message logging process in Cisco IOS software is abbreviated as "syslog". The messages generated by this process are called "syslog messages". However, syslog messages are also referred to in Cisco IOS documenation as "system error messages" or "SEMs". Note that syslog messages are not restricted to error conditions, and can reflect purely informational messages.

XML-Formatted System Message Logging

XML, a derivative of SGML, provides a representation scheme to structuralize consistently formatted data such as that found in syslog messages.

The XML Interface to Syslog Messages features provides CLI commands for enabling syslog messages to be sent in an XML format. Logs in a standardized XML format can be more readily used in external customized monitoring tools. Within the Cisco IOS software, a closed set of meaningful XML tags are defined and, when enabled, applied to the syslog messages sent to the console, monitor, buffer, or to remote hosts.

Two system logging formats exist in Cisco IOS software: the standard logging format and the XML logging format. This means that you can specify that the standard syslog messages be sent to one remote host while the XML-formatted syslog messages are sent to another host. Similarly, if logging messages are sent to the system buffer, the XML logging buffer is separate from the standard logging buffer, and you can have the standard and XML logging buffers running at the same time.

The XML logging process is dependant on the standard logging process. In most cases, settings for the standard logging process carry over to the XML logging process. For example, the severity level for the **logging buffered xml** command is determined by the level set for the standard **logging buffered** command (or, if not set, by the default severity level for the standard buffer). Similarly, the default size of the XML logging buffer is the same as the standard logging buffer's default (the default buffer size varies by platform).

System Logging Message Formatting

System logging messages take the following format:

```
%<facility>-<severity>-<mnemonic>: <message-text>
```

For example:

```
%LINK-5-CHANGED: Interface Serial3/3, changed state to administratively down
```

Usually, these messages are proceeded by additional text, such as the timestamp and message sequence number:

```
<sequence-number>: <date or system-up-time> <time>:%<facility>-<severity>-<mnemonic>:
<message-text>
```

For example:

```
000013: Mar 18 14:52:10.039:%LINK-5-CHANGED: Interface Serial3/3, changed state to
administratively down
```

Note The timestamp format used in system logging messages is determined by the **service timestamps** global configuration mode command. The **service sequence-numbers** global configuration command enables or disables the leading sequence number. An asterix (*) before the time indicates that the time may be incorrect because the system clock has not synchronized to a reliable time source.

Table 10 shows the XML tags applied to syslog messages (the XML formatting):

Table 10 XML Tags used for Syslog Message Fields

Tag Applied	Delimited Item
<ios-log-msg></ios-log-message>	Entire syslog message.
<facility></facility>	Facility Name. FACILITY is a code consisting of two or more uppercase letters that indicate the facility to which the message refers. A facility can be a hardware device, a protocol, or a module of the system software.
<severity></severity>	Severity Value. SEVERITY is a single-digit code from 0 to 7 that reflects the severity of the condition. The lower the number, the more serious the situation.
<msg-id></msg-id>	Mnemonic. The MNEMONIC is a code (usually an abbreviated description) that uniquely identifies the type of error or event.
<seq></seq>	The error sequence number.
<time></time>	The timestamp, including date and time, or the system uptime (time since last reboot).

Table 10 XML Tags used for Syslog Message Fields

Tag Applied	Delimited Item
<args></args>	The variables within the message text. The full “human readable” text of the message is not retained in XML. Only the variables are extracted and formatted. The variables within a system error message are identified with brackets (`[chars]`, `[hex]`, `[int]`, and so on) in Cisco IOS documentation. For example: `%LINK-5-CHANGED: : Interface [chars], changed state to [chars]` For the complete text of syslog messages, see the *Cisco IOS System Error Messages* document, available on Cisco.com.
<arg id=“x”></arg>	A specific argument. “x” is a sequential variable I.D. number, starting with zero.

The following example shows a syslog message in standard format, followed by the same message with XML formatting applied:

Standard Syslog Message Format

```
000013: *Oct 11 14:52:10.039: %SYS-5-CONFIG_I: Configured from console by vty0
(172.19.208.14)
```

XML Syslog Message Format

```
<ios-log-msg><facility>SYS</facility><severity>5</severity><msg-id>CONFIG_I</msg-id><seq>0
00013</seq><time>*Oct 11 14:52:10.039</time><args><arg id=“0”>console</arg><arg
id=“1”>vty0 (172.19.208.14)</arg></args></ios-log-msg>
```

Note System logging messages include debugging messages when debugging is enabled on the router and logging is configured to record severity level 7 messages. However, debugging messages do not use the system logging message format. XML formatting will not, therefore, be applied to these messages.

How to Configure XML Formatting of Syslog Messages

Enabling logging in an XML format consists of simply using the appropriate logging command to indicate where syslog messages should be sent, followed by the **xml** keyword. Standard system message logging is enabled by default, but XML formatting of these messages is disabled by default.

As mentioned previously, the XML-formatted logging process is separate than (but dependant on) the standard logging process, so you can configure XML-formatted logging in addition to standard logging if the destination is a remote host or the system buffer.

COMMAND SUMMARY

To enable XML formatting for syslog messages, use one of the following commands in global configuration mode:

- **logging console xml**
- **logging monitor xml**
- **logging buffered xml**
- **logging host** {*ip-address* | *host-name*} **xml**

To view the status of logging and the contents of the XML logging buffer, use the **show logging xml** command in EXEC mode. To clear the contents of the XML logging buffer, use the **clear logging xml** command in EXEC mode.

COMMAND DETAILS

Command or Action	Purpose
logging console xml [*severity-level*] **Example:** `Router(config)#logging console xml informational`	Enables system message logging to the console connections in XML format. Messages at or numerically below the severity level will be logged. The default severity level varies by platform, but is generally level 7 (“debugging”), meaning that messages at all severity levels (0 through 7) are logged.
logging monitor xml [*severity-level*] **Example:** `Router(config)#logging monitor xml 6`	Enables system message logging to the monitor connections (all available TTY or Telnet connections) in XML format. Messages at or numerically below the severity level will be logged. The default severity level varies by platform, but is generally level 7 (“debugging”), meaning that messages at all severity levels (0 through 7) are logged. Note that the display of logging messages is often disabled by default, meaning that messages will not be displayed when you log into the terminal until you issue the **terminal monitor** EXEC mode command.

Command or Action	Purpose
logging buffered xml [*xml-buffer-size*] **Example:** Router(config)#logging buffered xml 14336	Enables system message logging to the system buffer in XML format. The severity level for logged messages is determined by the setting of the **logging buffered** command. If the **logging buffered** command has not been used, the default severity level for that command is used. The default severity level varies by platform, but is generally level 7("debugging") , meaning that messages at all severity levels (0 through 7) are logged. For more information on severity levels, see the documentation of the **logging buffered** command. The default XML logging buffer size varies by platform. (The size of the XML logging buffer is the same as the standard logging buffer's default.) The valid range for the XML buffer size is 4096 to 2147483647 bytes (4 Kilobytes to 2 Gigabytes).
logging host {*ip-address* | *host-name*} **xml** **Example:** Router(config)#logging host 209.165.202.132 xml Router(config)#logging host 209.165.201.20 xml	Enables system message logging in XML format to the specified host. By issuing this command more than once, you build a list of syslog servers that receive logging messages. **Note** To send standard logging output to one host and XML-formatted logging output to another host, you must specify a different IP address (or host name) in the **logging host** (standard) command. The default severity level varies by platform, but is generally level 5("notifications") , meaning that messages at severity levels 0 through 7 are logged. To specify the severity level for logging to all remote hosts, use the **logging trap** command.

Configuration Examples for XML Formatting of Syslog Messages

In the following example, logging is enabled and then logging to the standard buffer and to the XML buffer is enabled. The last two **show logging** commands compare the difference between the standard syslog buffer and the XML syslog buffer.

```
Router#show logging
Syslog logging: disabled (10 messages dropped, 5 messages rate-limited, 6 flush)
    Console logging: disabled
    Monitor logging: disabled
    Buffer logging: disabled, xml disabled
    Logging Exception size (8192 bytes)
    Count and timestamp logging messages: disabled
    Trap logging: level informational, 31 message lines logged
Router#config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#logging on
Router(config)#logging buffered
Router(config)#end
Router#show logging
Syslog logging: enabled (10 messages dropped, 5 messages rate-limited, 6 flushed)
    Console logging: disabled
    Monitor logging: disabled
    Buffer logging: level debugging, 1 messages logged, xml disabled
    Logging Exception size (8192 bytes)
    Count and timestamp logging messages: disabled
    Trap logging: level informational, 32 message lines logged

Log Buffer (8192 bytes):

1w0d: %SYS-5-CONFIG_I: Configured from console by console
Router#config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#logging buffered xml
Router(config)#end
Router#show logging
Syslog logging: enabled (10 messages dropped, 5 messages rate-limited, 6 flushes, 0
overruns, xml enabled)
    Console logging: disabled
    Monitor logging: disabled
    Buffer logging: level debugging, 2 messages logged, xml enabled (1 messages logged)
    Logging Exception size (8192 bytes)
    Count and timestamp logging messages: disabled
    Trap logging: level informational, 33 message lines logged

Log Buffer (8192 bytes):

1w0d: %SYS-5-CONFIG_I: Configured from console by console
1w0d: %SYS-5-CONFIG_I: Configured from console by console
Router#show logging xml
<syslog-logging status="enabled" msg-dropped="10" msg-rate-limited="5" flushes="6"
overruns="0"><xml>enabled</xml></syslog-logging>
    <console-logging>disabled</console-logging>
    <monitor-logging>disabled</monitor-logging>
    <buffer-logging level="debugging" messages-logged="2"><xml
messages-logged="1">enabled</xml></buffer-logging>
    <logging-exception size="8192 bytes"></logging-exception>
    <count-and-timestamp-logging status="disabled"></count-and-timestamp-logging>
    <trap-logging level="informational" messages-lines-logged="33"></trap-logging>

<log-xml-buffer size="8192 bytes"></log-xml-buffer>

<ios-log-msg><facility>SYS</facility><severity>5</severity><msg-id>CONFIG_I</msg-id><time>
1w0d</time><args><arg id="0">console</arg>
Router#
```

Additional References

For additional information related to XML Interface to Syslog Messages feature, refer to the following references:

Related Documents

Related Topic	Document Title
system message logging	"Cisco IOS Configuration Fundamentals Configuration Guide, Release 12.2"; *Troubleshooting and Fault Management* chapter
System Error Messages (SEMs)	"Cisco IOS System Error Messages, Release 12.2"
Debug-level System Messages	"Cisco IOS Debug Command Reference, Release 12.2"

Standards

XML is not currently an Internet Standard. The XML 1.0 Recommendation ("Extensible Markup Language (XML) 1.0 (Second Edition)") is defined at http://www.w3.org/TR/. See also RFC 3076.

MIBs

No relevant MIBs are associated with this feature.

RFCs

RFCs[1]	Title
RFC 3470	"Guidelines for the Use of Extensible Markup Language (XML) within IETF Protocols" (Status: BEST CURRENT PRACTICE)

[1] Not all supported RFCs are listed.

Technical Assistance

Description	Link
Technical Assistance Center (TAC) The Cisco TAC home page contains 30,000 pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/public/support/tac/home.shtml
System Error Message Decoder tool For help with researching and resolving your Cisco IOS error messages, try the Cisco IOS Error Message Decoder tool. This tool is made available by the Cisco Technical Assistance Center (TAC) for registered Cisco.com users.	http://www.cisco.com/cgi-bin/Support/Errordecoder/home.pl

Command Reference

The following new and modified commands are pertinent to this feature. To see the command pages for these commands and other commands used with this feature, go to the *Cisco IOS Master Commands List*, Release 12.4, at http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124mindx/124index.htm.

- **clear logging xml**
- **logging buffered xml**
- **logging console xml**
- **logging host**
- **logging monitor xml**
- **show logging xml**

Note The **logging host** command replaced the **logging** command in Release 12.2(15)T.

Glossary

Note Refer to the *Internetworking Terms and Acronyms* for terms not included in this glossary.

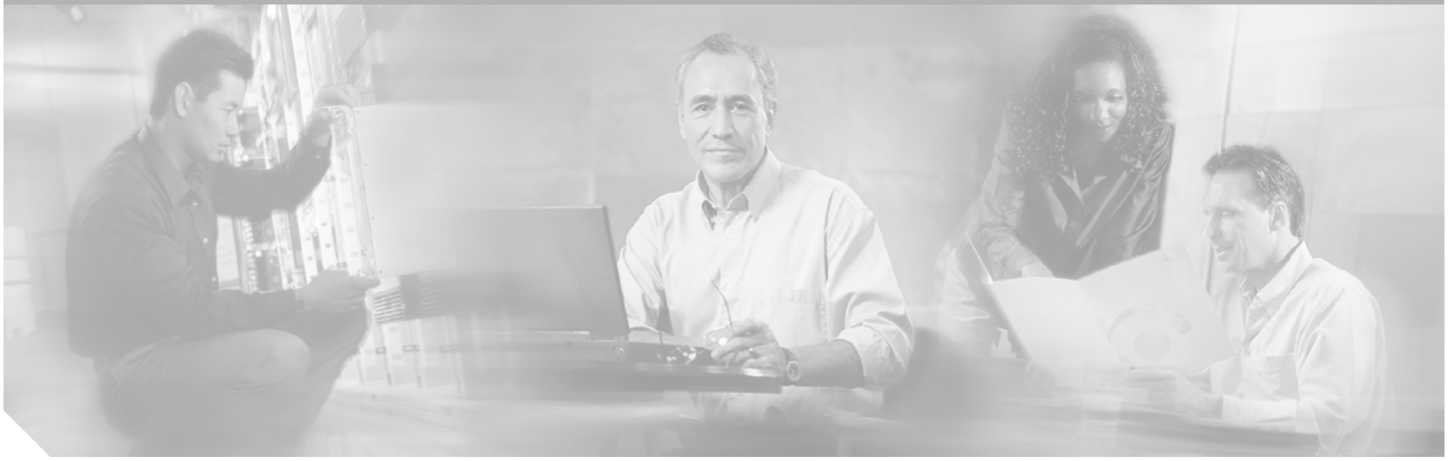
console — In the context of this feature, specifies the connection (CTY or console line) to the console port of the router. Typically, this is a terminal attached directly to the console port, or a PC with a terminal emulation program. Corresponds to the **show terminal** command.

monitor — In the context of this feature, specifies the TTY (TeleTYpe) line connection at a line port. In other words, the "monitor" keyword corresponds to a TTY line connection or a Telnet (terminal emulation) connection. TTY lines (also called ports) communicate with peripheral devices such as terminals, modems, and serial printers. An example of a TTY connection is a PC with a terminal emulation program connected to the device using a dial-up modem.

SEMs—Abbreviation for system error messages. "System error messages" is a term sometimes used for messages generated by the system logging (syslog) process. Syslog messages use a standardized format, and come in 8 severity levels, from "emergencies" (level 0) to "debugging" (level 7). The term "system error message" is actually misleading, as these messages can include notifications of router activity beyond "errors" (such as informational notices).

syslog—Abbreviation for the system message logging process in Cisco IOS software. Also used to identify the messages generated, as in "syslog messages." Technically, the term "syslog" refers only to the process of logging messages to a remote host or hosts, but is commonly used to refer to all Cisco IOS system logging processes.

trap — A trigger in the system software for sending error messages. In the context of this feature, "trap logging" means logging messages to a remote host. The remote host is actually a syslog host from the perspective of the device sending the trap messages, but because the receiving device typically provides collected syslog data to other devices, the receiving device is also referred to as a "syslog server."



Part 2: Configuring SNMP Support

Configuring SNMP Support

First Published: September 8, 2006

Simple Network Management Protocol (SNMP) is an application-layer protocol that provides a message format for communication between SNMP managers and agents. SNMP provides a standardized framework and a common language that is used for the monitoring and management of devices in a network.

This document discusses how to enable the SNMP agent on your Cisco device, and how to control the sending of SNMP notifications from the agent. For information on using SNMP management systems, see the appropriate documentation for your NMS application.

For a complete description of the router monitoring commands mentioned in this document, see the the *Cisco IOS Configuration Fundamentals Command Reference*. To locate documentation of other commands that appear in this document, use the *Cisco IOS Command Reference Master Index* or search online.

Finding Feature Information in This Module

Your Cisco IOS software release may not support all of the features documented in this module. To reach links to specific feature documentation in this module and to see a list of the releases in which each feature is supported, use the "Feature Information for Configuring SNMP Support" section on page 222.

Finding Support Information for Platforms and Cisco IOS and Catalyst OS Software Images

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

Restrictions for Configuring SNMP Support

Not all Cisco platforms are supported on the features described in this module. Use Cisco Feature Navigator to find information about platform support and Cisco IOS software image support.

Information About SNMP Support

To configure SNMP support on your network, you should understand the following concepts:

- Components of SNMP, page 178
- SNMP Notifications, page 179
- MIBs and RFCs, page 181
- SNMP Versions, page 182
- Detailed Interface Registration Information, page 183
- SNMP Support for VPNs, page 184
- MIB Persistence, page 185
- Circuit Interface Identification Persistence, page 186
- SNMP Notification Logging, page 186

Components of SNMP

SNMP is an application-layer protocol that provides a message format for communication between SNMP managers and agents. SNMP provides a standardized framework and a common language used for the monitoring and management of devices in a network.

The SNMP framework has three parts:

- An SNMP manager
- An SNMP agent
- A MIB

SNMP Manager

The SNMP manager is the system used to control and monitor the activities of network hosts using SNMP. The most common managing system is a Network Management System (NMS). The term NMS can be applied either to a dedicated device used for network management or to the applications used on such a device. A variety of network management applications are available for use with SNMP. These include a range from simple command-line applications toa graphical user interfaces (such as the CiscoWorks2000 line of products).

SNMP Agent

The SNMP agent is the software component within the managed device that maintains the data for the device and reports this data, as needed, to managing systems. The agent and MIB reside on the routing device (router, access server, or switch). To enable the SNMP agent on a Cisco routing device, you must define the relationship between the manager and the agent.

Note Although it is possible to configure a Cisco router to be an SNMP agent , this practice is notrecommended because the commands that the agent needs to control the SNMP process are available through the Cisco IOS CLI without additional configuration.

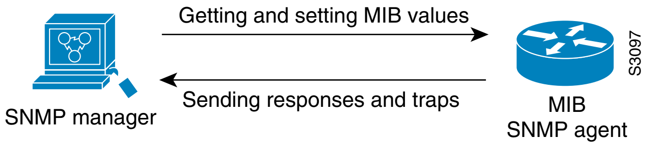
MIB

The MIB is a virtual information storage area for network management information, which consists of collections of managed objects. Within the MIB there are collections of related objects, defined in MIB modules. MIB modules are written in the SNMP MIB module language, as defined in STD 58, RFC 2578, RFC 2579, and RFC 2580 (see the "MIBs and RFCs" section for an explanation of RFC and STD documents). Individual MIB modules are also referred to as MIBs; for example, the Interfaces Group MIB (IF-MIB) is a MIB module within *the* MIB on your system.

The SNMP agent contains MIB variables whose values the SNMP manager can request or change through Get or Set operations. A manager can get a value from an agent or store a value into that agent. The agent gathers data from the MIB, the repository for information about device parameters and network data. The agent can also respond to manager requests to Get or Set data.

Figure 6 illustrates the communications between the SNMP manager and agent. A manager can send the agent requests to get and set MIB values. The agent can respond to these requests. Independent of this interaction, the agent can send unsolicited notifications (traps or informs) to the manager to notify the manager of network conditions.

Figure 6 Communication Between an SNMP Agent and Manager



SNMP Notifications

A key feature of SNMP is the ability to generate notifications from an SNMP agent. These notifications do not require that requests be sent from the SNMP manager.

Traps and Informs

Unsolicited (asynchronous) notifications can be generated as *traps* or *inform requests*. Traps are messages alerting the SNMP manager to a condition on the network. Inform requests (informs) are traps that include a request for confirmation of receipt from the SNMP manager. Notifications can indicate improper user authentication, restarts, the closing of a connection, loss of connection to a neighbor router, or other significant events.

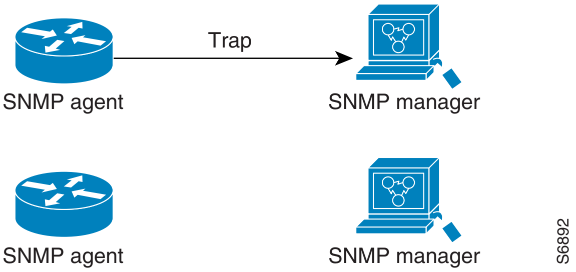
Traps are less reliable than informs because the receiver does not send any acknowledgment when it receives a trap. The sender cannot determine if the trap was received. An SNMP manager that receives an inform request acknowledges the message with an SNMP response protocol data unit (PDU). If the manager does not receive an inform request, it does not send a response. If the sender never receives a response, the inform request can be sent again. Thus, informs are more likely to reach their intended destination.

However, traps are often preferred because informs consume more resources in the router and in the network. Unlike a trap, which is discarded as soon as it is sent, an inform request must be held in memory until a response is received or the request times out. Also, traps are sent only once, while an inform may be retried several times. The retries increase traffic and contribute to a higher overhead on the network. Thus, traps and inform requests provide a trade-off between reliability and resources. If it is important that the SNMP manager receives every notification, use inform requests. However, if you are concerned about traffic on your network or memory in the router and you need not receive every notification, use traps.

Figure 7 through Figure 10 illustrate the differences between traps and inform requests.

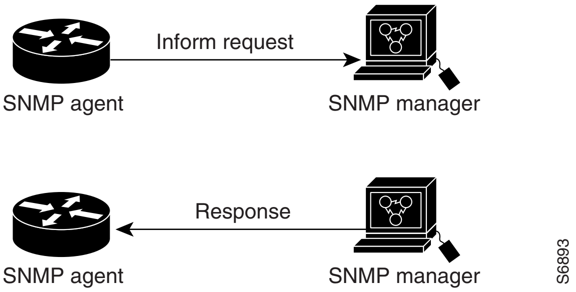
In Figure 7, the agent router successfully sends a trap to the SNMP manager. Although the manager receives the trap, it does not send any acknowledgment to the agent. The agent has no way of knowing that the trap reached its destination.

Figure 7 Trap Successfully Sent to SNMP Manager



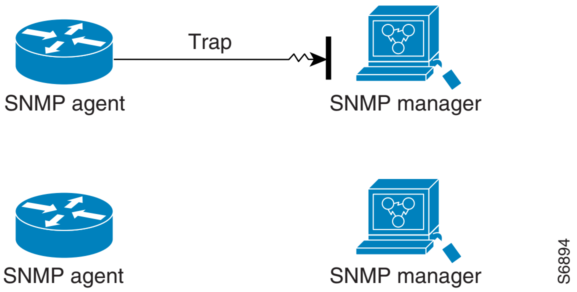
In Figure 8, the agent router successfully sends an inform request to the manager. When the manager receives the inform request, it sends a response to the agent. Thus, the agent knows that the inform request reached its destination. Notice that, in this example, twice as much traffic is generated as in Figure 7; however, the agent knows that the manager received the notification.

Figure 8 Inform Request Successfully Sent to SNMP Manager



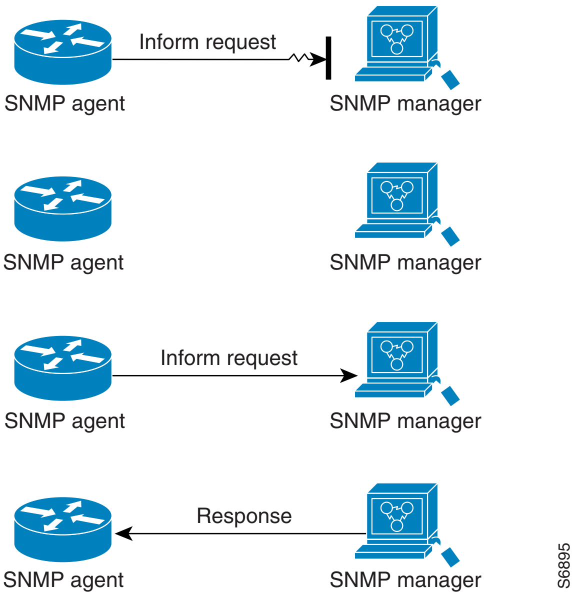
In Figure 9, the agent sends a trap to the manager, but the trap does not reach the manager. Because the agent has no way of knowing that the trap did not reach its destination, the trap is not sent again. The manager never receives the trap.

Figure 9 Trap Unsuccessfully Sent to SNMP Manager



In Figure 10, the agent sends an inform request to the manager, but the inform request does not reach the manager. Because the manager did not receive the inform request, it does not send a response. After a period of time, the agent will resend the inform request. The second time, the manager receives the inform request and replies with a response. In this example, there is more traffic than in Figure 9; however, the notification reaches the SNMP manager.

Figure 10 Inform Request Unsuccessfully Sent to SNMP Manager



MIBs and RFCs

MIB modules typically are defined in RFC documents submitted to the Internet Engineering Task Force (IETF), an international standards body. RFCs are written by individuals or groups for consideration by the Internet Society and the Internet community as a whole, usually with the intention of establishing a recommended Internet standard. Before being given RFC status, recommendations are published as Internet Draft (I-D) documents. RFCs that have become recommended standards are also labeled as standards (STD) documents. You can learn about the standards process and the activities of the IETF at the Internet Society website at http://www.isoc.org. You can read the full text of all RFCs, I-Ds, and STDs referenced in Cisco documentation at the IETF website at http://www.ietf.org.

The Cisco implementation of SNMP uses the definitions of MIB II variables described in RFC 1213 and definitions of SNMP traps described in RFC 1215.

Cisco provides its own private MIB extensions with every system. Cisco enterprise MIBs comply with the guidelines described in the relevant RFCs unless otherwise noted in the documentation. You can find the MIB module definition files and list of which MIBs are supported on each Cisco platform on the Cisco MIB website on Cisco.com.

SNMP Versions

Cisco IOS software supports the following versions of SNMP:

- SNMPv1— Simple Network Management Protocol: a Full Internet Standard, defined in RFC 1157. (RFC 1157 replaces the earlier versions that were published as RFC 1067 and RFC 1098.) Security is based on community strings.
- SNMPv2c—The community-string based Administrative Framework for SNMPv2. SNMPv2c (the "c" stands for "community") is an Experimental Internet Protocol defined in RFC 1901, RFC 1905, and RFC 1906. SNMPv2c is an update of the protocol operations and data types of SNMPv2p (SNMPv2 Classic) and uses the community-based security model of SNMPv1.
- SNMPv3—Version 3 of SNMP. SNMPv3 is an interoperable standards-based protocol defined in RFCs 3413 to 3415. SNMPv3 provides secure access to devices by a combination of authenticating and encrypting packets over the network.

  The security features provided in SNMPv3 are as follows:

  - Message integrity—Ensuring that a packet has not been tampered with in transit.
  - Authentication—Determining that the message is from a valid source.
  - Encryption—Scrambling the contents of a packet to prevent it from being learned by an unauthorized source.

Both SNMPv1 and SNMPv2c use a community-based form of security. The community of managers able to access the agent MIB is defined by an IP address access control list and password.

SNMPv2c support includes a bulk retrieval mechanism and detailed error message reporting to management stations. The bulk retrieval mechanism supports the retrieval of tables and large quantities of information, minimizing the number of round-trips required. The SNMPv2c improved error handling support includes expanded error codes that distinguish different kinds of error conditions; these conditions are reported through a single error code in SNMPv1. Error return codes now report the error type. Three kinds of exceptions are also reported: no such object exceptions, no such instance exceptions, and end of MIB view exceptions.

SNMPv3 is a security model, which is an authentication strategy that is set up for a user and the group in which the user resides. A security level is the permitted level of security within a security model. A combination of a security model and a security level will determine which security mechanism is employed when handling an SNMP packet. See Table 11 for a list of security levels available in SNMPv3.

Three security models are available: SNMPv1, SNMPv2c, and SNMPv3. Table 11 identifies what the combinations of security models and levels mean.

Table 11 SNMP Security Models and Levels

Model	Level	Authentication	Encryption	What Happens
v1	noAuthNoPriv	Community String	No	Uses a community string match for authentication.
v2c	noAuthNoPriv	Community String	No	Uses a community string match for authentication.
v3	noAuthNoPriv	Username	No	Uses a username match for authentication.
v3	authNoPriv	MD5 or SHA	No	Provides authentication based on the HMAC-MD5 or HMAC-SHA algorithms.
v3	authPriv	MD5 or SHA	DES	Provides authentication based on the HMAC-MD5 or HMAC-SHA algorithms. Provides DES 56-bit encryption in addition to authentication based on the CBC-DES (DES-56) standard.

Note SNMPv2p (SNMPv2 Classic) is not supported in Cisco IOS release 11.2, and later releases. SNMPv2c replaces the Party-based Administrative and Security Framework of SNMPv2p with a Community-based Administrative Framework. SNMPv2c retained the bulk retrieval and error handling capabilities of SNMPv2p.

You must configure the SNMP agent to use the version of SNMP supported by the management station. An agent can communicate with multiple managers; for this reason, you can configure the Cisco IOS software to support communications with one management station using the SNMPv1 protocol, one using the SNMPv2c protocol, and another using SMNPv3.

The SNMPv3 feature supports RFCs 1901 to 1908, 2104, 2206, 2213, 2214, and 2271 to 2275. For additional information on SNMPv3, refer to RFC 2570, *Introduction to Version 3 of the Internet-standard Network Management Framework* (note that this is not a standards document).

Detailed Interface Registration Information

The Interface Index Display for SNMP feature introduces new commands and command modifications that allow advanced users of SNMP to view information about the interface registrations directly on the managed agent. (For the purposes of this document, the agent is the routing device running Cisco IOS software.) In other words, the commands in this feature allow the user to display MIB information from the agent without using an external NMS.

This feature addresses three objects in the Interfaces MIB: the ifIndex object, the ifAlias object, and the ifName object. For the complete definition of these objects, see the IF-MIB.my file, available from the Cisco SNMPv2 MIB website at ftp://ftp.cisco.com/pub/mibs/v2/.

Interface Index

The ifIndex object (ifEntry 1) is called the Interface Index. The Interface Index (ifIndex) is a unique value, greater than zero, which identifies each interface (or subinterface) on the managed device. This value becomes the interface index identification number.

A Cisco IOS software command, **show snmp mib ifmib ifindex**, allows the user to view the SNMP Interface Index Identification numbers assigned to interfaces and subinterfaces using the CLI. This command provides a way to view these values without the need for a Network Management System.

Interface Alias

The ifAlias object (ifXEntry 18) is called the Interface Alias. The Interface Alias (ifAlias) is a user-specified description of an interface used for SNMP network management. The ifAlias is an object in the Interfaces Group MIB (IF-MIB) that can be set by a network manager to “name” an interface. The ifAlias value for an interface or subinterface can be set using the **description** command in interface configuration mode or subinterface configuration mode or by using a Set operation from an NMS. Previously, ifAlias descriptions for subinterfaces were limited to 64 characters. (The OLD-CISCO-INTERFACES-MIB allows up to 255 characters for the locIfDescr MIB variable, but this MIB does not support subinterfaces.) A new Cisco IOS software command, **snmp ifmib ifalias long**, configures the system to handle IfAlias descriptions of up to 256 characters. IfAlias descriptions appear in the output of the **show interfaces** CLI command.

Interface Name

The ifName object (ifXEntry 1) is the textual name of the interface. The value of this object is the name of the interface as assigned by the local device and is suitable for use in commands entered at the CLI. If there is no local name, or this object is otherwise not applicable, then this object contains a zero-length string. No commands introduced by this feature affect the ifName object, but it is discussed here to show its relation to the ifIndex and ifAlias objects. The purpose of the ifName object is to cross reference the CLI representation of a given interface.

The **show snmp mib** command shows all objects in the MIB on a Cisco device (similar to a mibwalk). The objects in the MIB tree are sorted using lexical ordering, meaning that object identifiers are sorted in sequential, numerical order. Lexical ordering is important when using the GetNext operation from an NMS because these operations take an object identifier (OID) or a partial OID as input and returns the next object from the MIB tree based on the lexical ordering of the tree.

SNMP Support for VPNs

The SNMP Support for VPNs feature allows the sending and receiving of SNMP notifications (traps and informs) using virtual private network (VPN) routing/forwarding (VRFs) tables. In particular, this feature adds support to Cisco IOS software for the sending and receiving of SNMP notifications (traps and informs) specific to individual VPNs.

A VPN is a network that provides high connectivity transfers on a shared system with the same usage guidelines as a private network. A VPN can be built on the Internet over IP, Frame Relay, or ATM networks.

A VRF stores per-VPN routing data. It defines the VPN membership of a customer site attached to the network access server (NAS). A VRF consists of an IP routing table, a derived Cisco Express Forwarding (CEF) table, and guidelines and routing protocol parameters that control the information that is included in the routing table.

The SNMP Support for VPNs feature provides configuration commands that allow users to associate SNMP agents and managers with specific VRFs. The specified VRF is used for the sending of SNMP notifications (traps and informs) and responses between agents and managers. If a VRF is not specified, the default routing table for the VPN is used.

Support for VPNs allows users to configure an SNMP agent to only accept SNMP requests from a certain set of VPNs. With this configuration, providers can provide network management services to their customers, so customers can manage all user VPN devices.

MIB Persistence

The MIB Persistence features allow the SNMP data of a MIB to be persistent across reloads; that is, MIB information retains the same set object values each time a networking device reboots. MIB Persistence is enabled by using the **snmp mib persist** command, and the MIB data of all MIBs that have had persistence enabled using this command is then written to NVRAM storage by using the **write mib-data** command. Any modified MIB data must be written to NVRAM memory using the **write mib-data** command.

Both Event and Expression MIBs allow you to configure a value for an object and to set up object definitions. Both also allow rows of data to be modified while the row is in an active state.

Scalar objects are stored every time they are changed, and table entries are stored only if the row is in an active state. Event MIB has two scalar objects and nine tables to be persisted into NVRAM. The tables include the following:

- mteEventNotificationTable
- mteEventSetTable
- mteEventTable
- mteObjectsTable
- mteTriggerBooleanTable
- mteTriggerDeltaTable
- mteTriggerExistenceTable
- mteTriggerTable
- mteTriggerThresholdTable

Expression MIB has two scalar objects and three tables to be stored in NVRAM. The scalars are expResourceDeltaMinimum and expResourceDeltaWildcardInstanceMaximum. The tables include the following:

- expExpressionTable
- expNameTable
- expObjectTable

It may take several seconds for the MIB data to be written to NVRAM. The length of time taken depends on the amount of MIB data.

Event MIB Persistence and Expression MIB Persistence both allow MIB objects to be saved from reboot to reboot, allowing long-term monitoring of specific devices and interfaces. You can configure object values that are preserved across reboots.

Circuit Interface Identification Persistence

The Circuit Interface MIB (CISCO-CIRCUIT-INTERFACE-MIB) provides a MIB object (cciDescr) that can be used to identify individual circuit-based interfaces for SNMP monitoring. The Circuit Interface Identification Persistence for SNMP feature maintains this user-defined name of the circuit across reboots, allowing the consistent identification of circuit interfaces. Circuit Interface Identification Persistence is enabled using the **snmp mib persist circuit** global configuration command.

Cisco IOS Release 12.2(2)T introduces the Circuit Interface Identification Persistence for SNMP feature. The Circuit Interface MIB (CISCO-CIRCUIT-INTERFACE-MIB) provides a MIB object (cciDescr) which can be used to identify individual circuit-based interfaces for SNMP monitoring. The Cisco Circuit Interface MIB was introduced in Cisco IOS Release 12.1(3)T .

The Circuit Interface Identification Persistence for SNMP feature maintains the user-defined name of the circuit (defined in the cciDescr object) across reboots, allowing for the consistent identification of circuits.

The Circuit Interface Identification Persistence for SNMP feature is a supplement to the Interface Index Persistence feature introduced in Cisco IOS Release 12.1(3)T and Cisco IOS Release 12.0(11)S. Circuit Interface Identification Persistence is enabled with the **snmp mib persist circuit** global configuration command. Use this command if you need to consistently identify circuits using SNMP across reboots. This command is disabled by default because this feature uses NVRAM memory.

In addition, the **show snmp mib ifmib ifindex** EXEC mode command allows you to display the Interfaces MIB ifIndex values directly on your system without a network management system; the **show snmp mib** EXEC mode command allows you to display a list of the MIB module identifiers registered directly on your system with a network management system. And the **snmp ifmib ifalias long** command allows you to specify a description for interfaces or subinterface of up to 256 characters in length. Prior to the introduction of this command, ifAlias descriptions for SNMP management were limited to 64 characters.

SNMP Notification Logging

Systems that support SNMP often need a mechanism for recording notification information as protection against lost notifications, whether those notificationsare traps or informs that exceed retransmission limits. The Notification Log MIB provides a common infrastructure for other MIBs in the form of a local logging function. The SNMP Notification Logging feature adds Cisco IOS CLI commands to change the size of the notification log, to set the global ageout value for the log, and to display logging summaries at the command line. The Notification Log MIB improves notification tracking and provides a central location for tracking all MIBs.

Note The Notification Log MIB supports notification logging on the default log only.

How to Configure SNMP Support tagger

There is no specific command that you use to enable SNMP. The first **snmp-server** command that you enter enables the supported versions of SNMP. All other configurations are optional.

Use the following tasks to configure SNMP support as needed.

- Setting Up System Information, page 187 (optional)

- Configuring SNMP Versions 1 and 2, page 188
- Configuring SNMP Version 3, page 191 (optional)
- Configuring the Router As an SNMP Manager, page 195 (optional)
- Enabling the SNMP Agent Shutdown Mechanism, page 198 (optional)
- Defining the Maximum SNMP Agent Packet Size, page 199 (optional)
- Disabling the SNMP Agent, page 200 (optional)
- Limiting the Number of TFTP Servers Used via SNMP, page 199 (optional)
- Configuring SNMP Notifications, page 201 (optional)
- Configuring Interface Index Display and Interface Indexes and Configuration of Long Name Support, page 207 (optional)
- Configuring SNMP Support for VPNs, page 211 (optional)
- Configuring MIB Persistence, page 212(optional)

Setting Up System Information

You can set the system contact, location, and serial number of the SNMP agent so that these descriptions can be accessed through the configuration file. Although the configuration items described below are optional, setting up this basic information is recommended as it may be useful when troubleshooting your configuration. In addition, the first snmp-server command that you issue enables SNMP on the device.

Use the following commands as needed.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **snmp-server contact** *text*
4. **snmp-server location** *text*
5. **snmp-server chassis-id** *number*

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	**snmp-server contact** *text* **Example:** `Router(config)# snmp-server contact NameOne`	Sets the system contact string.
Step 4	**snmp-server location** *text* **Example:** `Router(config)# snmp-server Location LocationOne`	Sets the system location string.
Step 5	**snmp-server chassis-id** *number* **Example:** `Router(config)# snmp-server chassis-id 987654`	Sets the system serial number.

Configuring SNMP Versions 1 and 2

When configuring SNMP version 1 and 2 you can optionally create or modify views for community strings to limit which MIB objects an SNMP manager can access. It is required that you establish an SNMP community string to define the relationship between the SNMP manager and the agent and that you define a host to be the recipient of SNMP notifications.

Perform the following tasks when configuring SNMP version 1 or version 2.

- Creating or Modifying an SNMP View Record, page 188 (optional)
- Creating or Modifying Access Control for an SNMP Community, page 189 (required)
- Configuring a Recipient of an SNMP Trap Operation, page 190 (required)

Creating or Modifying an SNMP View Record

You can assign views to community strings to limit which MIB objects an SNMP manager can access. You can use a predefined view or create your own view. If you are using a predefined view or no view at all, skip this task.

Use the following commands to create or modify an SNMP view record.

SUMMARY STEPS

1. **enable**

2. **configure terminal**
3. **snmp-server view** *view-name oid-tree* {**included** | **excluded**}
4. **no snmp-server view** *view-name oid-tree* {**included** | **excluded**}

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	**`snmp-server view`** *`view-name oid-tree`* {**`included`** | **`excluded`**}
	Example:
	`Router(config)# snmp-server view mib2 mib-2 included`
		This example creates a view that includes all objects in the MIB-II subtree.
		• You can enter this command multiple times for the same view record. Later lines take precedence when an object identifier is included in two or more lines

Step 4	**`no snmp-server view`** *`view-name oid-tree`* {**`included`** | **`excluded`**}
	Example:
	`Router(config)# no snmp-server view mib2 mib-2 included`
		Removes a server view.

Creating or Modifying Access Control for an SNMP Community

Use an SNMP community string to define the relationship between the SNMP manager and the agent. The community string acts like a password to regulate access to the agent on the router. Optionally, you can specify one or more of the following characteristics associated with the string:

- An access list of IP addresses of the SNMP managers that are permitted to use the community string to gain access to the agent.
- A MIB view, which defines the subset of all MIB objects accessible to the given community.
- Read and write or read-only permission for the MIB objects accessible to the community.

Use the following commands to create or modify a community string.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **snmp-server community** *string* [**view** *view-name*] [**ro** | **rw**] [**ipv6** *nacl*] [*access-list-number*]
4. **no snmp-server community** *string*

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	**`snmp-server community string`** [**`view`** *`view-name`*] [**`ro`** | **`rw`**] [**`ipv6`** *`nacl`*] [*`access-list-number`*] **Example:** `Router(config)# snmp-server community comaccess ro 4`	Defines the community access string. • You can configure one or more community strings.

Step 4	**`no snmp-server community`** *`string`*
	Example:
	`Router(config)# snmp-server community comaccess`
		Removes the community string from the configuration.

For an example of configuring a community string, see the "SNMP Configuration Examples" section.

Configuring a Recipient of an SNMP Trap Operation

SNMP notifications can be sent as traps or inform requests. Traps are unreliable because the receiver does not send acknowledgments when it receives traps. The sender cannot determine if the traps were received. However, a SNMP entity that receives an inform request acknowledges the message with a SNMP response protocol data unit (PDU). If the sender never receives the response, the inform request can be sent again. Thus, informs are more likely to reach their intended destination.

Compared to traps, informs consume more resources in the agent and in the network. Unlike a trap, which is discarded as soon as it is sent, an inform request must be held in memory until a response is received or the request times out. Also, traps are sent only once; an inform may be retried several times. The retries increase traffic and contribute to a higher overhead on the network.

If you do not enter a **snmp-server host** command, no notifications are sent. To configure the router to send SNMP notifications, you must enter at least one **snmp-server host** command. If you enter the command with no keywords, all trap types are enabled for the host.

To enable multiple hosts, you must issue a separate **snmp-server host** command for each host. You can specify multiple notification types in the command for each host.

When multiple **snmp-server host** commands are given for the same host and kind of notification (trap or inform), each succeeding command overwrites the previous command. Only the last **snmp-server host** command will be in effect. For example, if you enter an **snmp-server host inform** command for a host and then enter another **snmp-server host inform** command for the same host, the second command will replace the first.

The **snmp-server host** command is used in conjunction with the **snmp-server enable** command. Use the **snmp-server enable** command to specify which SNMP notifications are sent globally. For a host to receive most notifications, at least one **snmp-server enable** command and the **snmp-server host** command for that host must be enabled.

Some notification types cannot be controlled with the **snmp-server enable** command. For example, some notification types are always enabled and others are enabled by a different command. For example, the linkUpDown notifications are controlled by the **snmp trap link-status** command. These notification types do not require an **snmp-server enable** command.

A *notification-type* option's availability depends on the router type and Cisco IOS software features supported on the router. For example, the envmon notification type is available only if the environmental monitor is part of the system. To see what notification types are available on your system, use the command help ? at the end of the **snmp-server host** command.

Use the following commands to configure the recipient of an SNMP trap operation.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **snmp-server host** *host-id* [**traps** | **informs**][**version** {**1** | **2c** | **3** [**auth** | **noauth** | **priv**]}] *community-string* [**udp-port** *port-number*] [*notification-type*]

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	**snmp-server host** *host-id* [**traps** | **informs**][**version** {**1** | **2c** | **3** [**auth** | **noauth** | **priv**]}] *community-string* [**udp-port** *port-number*] [*notification-type*] **Example:** `Router(config)# snmp-server host 172.16.1.27 version 2c public`	Specifies whether you want the SNMP notifications sent as traps or informs, the version of SNMP to use, the security level of the notifications (for SNMPv3), and the recipient (host) of the notifications.

Configuring SNMP Version 3

When configuring SNMP version 3 and you want to use the SNMPv3 security mechanism for handling SNMP packets you need to establish SNMP groups and users with passwords.

Perform the following tasks to configure SNMP Version 3.

- Configuring Specifying SNMP-Server Group Names, page 192 (required)

- Configuring SNMP-Server Users, page 193 (required)

Configuring Specifying SNMP-Server Group Names

SNMPv3 is a security model. A security model is an authentication strategy that is set up for a user and the group in which the user resides.

No default values exist for authentication or privacy algorithms when you configure the **snmp-server group** command. Also, no default passwords exist. For information about specifying a Message Digest 5 (MD5) password, see the documentation of the **snmp-server user** command.

Use the following steps to specify a new SNMP group, or a table that maps SNMP users to SNMP views..

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **snmp group** [*groupname* {**v1** | **v2c** | **v3** [**auth** | **noauth** | **priv**]}][**read** *readview*] [**write** *writeview*] [**notify** *notifyview*] [**access** *access-list*]
4. **exit**
5. **show snmp group**

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	**snmp group** [*groupname* {**v1** | **v2c** | **v3** [**auth** | **noauth** | **priv**]}][**read** *readview*] [**write** *writeview*] [**notify** *notifyview*] [**access** *access-list*] **Example:** `Router(config)# snmp-server group group1 v3 auth access lmnop`	Configures the SNMP server group *group1*, enabling user authentication for members of the named access list *lmnop*.
Step 4	**exit** **Example:** `Router(config)# exit`	Exits global configuration mode.
Step 5	**show snmp group** **Example:** `Router# show snmp group`	Displays information about each SNMP group on the network.

Examples

The following example shows information about each SNMP group on the network.

```
Router# show snmp group

groupname: ILMI                             security model:v1
readview : *ilmi                            writeview: *ilmi
notifyview: <no notifyview specified>
row status: active

groupname: ILMI                             security model:v2c
readview : *ilmi                            writeview: *ilmi
notifyview: <no notifyview specified>
row status: active

groupname: public                           security model:v1
readview : <no readview specified>          writeview: <no writeview specified>
notifyview: *tv.FFFFFFFF.FFFFFFFF.FFFFFFFF0F
row status: active


groupname: public                           security model:v2c
readview : <no readview specified>          writeview: <no writeview specified>
notifyview: *tv.FFFFFFFF.FFFFFFFF.FFFFFFFF0F
row status: active
```

Configuring SNMP-Server Users

To configure a remote user, specify the IP address or port number for the remote SNMP agent of the device where the user resides. Also, before you configure remote users for a particular agent, configure the SNMP engine ID, using the snmp-server engineID command with the remote option. The remote agent's SNMP engine ID is needed when computing the authentication and privacy digests from the password. If the remote engine ID is not configured first, the configuration command will fail.

For the *privpassword* and *auth-password* arguments, the minimum length is one character; the recommended length is at least eight characters, and should include both letters and numbers.

SNMP passwords are localized using the SNMP engine ID of the authoritative SNMP engine. For informs, the authoritative SNMP agent is the remote agent. You need to configure the remote agent's SNMP engine ID in the SNMP database before you can send proxy requests or informs to it.

Working with Passwords and Digests

No default values exist for authentication or privacy algorithms when you configure the command. Also, no default passwords exist. The minimum length for a password is one character, although Cisco recommends using at least eight characters for security. If you forget a password, you cannot recover it and will need to reconfigure the user. You can specify either a plain-text password or a localized message digest 5 (MD5) digest.

If you have the localized MD5 or SHA digest, you can specify that string instead of the plain-text password. The digest should be formatted as aa:bb:cc:dd where aa, bb, and cc are hex values. Also, the digest should be exactly 16 octets long.

Use the following steps to configure a new user to an SNMP group.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **snmp-server user** *username groupname* [**remote** *ip-address* [**udp-port** *port*]] {**v1** | **v2c** | **v3** [**encrypted**] [**auth** {**md5** | **sha**} *auth-password*]} [**access** *access-list*]
4. **exit**
5. **show snmp user** [*username*]

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	**snmp-server user** *username groupname* [**remote** *ip-address* [**udp-port** *port*]] {**v1** | **v2c** | **v3** [**encrypted**] [**auth** {**md5** | **sha**} *auth-password*]} [**access** *access-list*] **Example:** `Router(config)# snmp-server user user1 group1 v3 auth md5 password123`	Configures a new user to an SNMP group withthe plain-text password “password123” for the user “user1” in the SNMPv3 group “group1”.
Step 4	**exit** **Example:** `Router(config)# exit`	Exits global configuration mode and returns to EXEC mode.
Step 5	**show snmp user** [*username*] **Example:** `Router#` **`show snmp user jimsmith`**	Displays the information about the configured charaterists of an SNMP user.

Example

The following example shows the information about the configured characteristics of the SNMP user1.

```
Router# show snmp user user1

User name: user1
Engine ID: 00000009020000000C025808
storage-type: nonvolatile       active access-list: 10
Rowstatus: active
```

```
Authentication Protocol: MD5
Privacy protocol: DES
Group name: group1
```

Configuring the Router As an SNMP Manager

The SNMP manager feature allows a router to act as a network management station. In other words, configuring a router as an SNMP manager allows it to act as an SNMP client. As an SNMP manager, the router can send SNMP requests to agents and receive SNMP responses and notifications from agents. When the SNMP manager process is enabled, the router can query other SNMP agents and process incoming SNMP traps.

Security Considerations

Most network security policies assume that routers will accept SNMP requests, send SNMP responses, and send SNMP notifications.

With the SNMP manager functionality enabled, the router may also send SNMP requests, receive SNMP responses, and receive SNMP notifications. Your security policy implementation may need to be updated prior to enabling this feature.

SNMP requests typically are sent to User Datagram Protocol (UDP) port 161. SNMP responses are typically sent from UDP port 161. SNMP notifications are typically sent to UDP port 162.

SNMP Sessions

Sessions are created when the SNMP manager in the router sends SNMP requests, such as inform requests, to a host, or receives SNMP notifications from a host. One session is created for each destination host. If there is no further communication between the router and host within the session timeout period, the session will be deleted.

The router tracks statistics, such as the average round-trip time required to reach the host, for each session. Using the statistics for a session, the SNMP manager in the router can set reasonable timeout periods for future requests, such as informs, for that host. If the session is deleted, all statistics are lost. If another session with the same host is later created, the request timeout value for replies will return to the default value.

Sessions consume memory. A reasonable session timeout value should be large enough that regularly used sessions are not prematurely deleted, yet small enough such that irregularly used, or one-time sessions, are purged expeditiously.

Enabling the SNMP Manager

Use the following commands to enable the SNMP manager process and set the session timeout value.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **snmp-server manager**
4. **snmp-server manager session-timeout** *seconds*

5. **exit**
6. **show snmp**
7. **show snmp sessions** [**brief**]
8. **show snmp pending**

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	`snmp-server manager`
	Example:
	`Router(config)# snmp-server manager`
		Enables the SNMP manager.

Step 4	`snmp-server manager session-timeout` *`seconds`*
	`Router(config)# snmp-server manager session-timeout 30`
		(Optional) Changes the session timeout value.

Step 5	`exit`
	Example:
	`Router(config)# exit`
		Exits global configuration mode.

Step 6	`show snmp`
	Example:
	`Router# show snmp`
		(Optional) Displays the status of SNMP communications.

Step 7	`show snmp sessions [brief]`
	Example:
	`Router# show snmp sessions`
		(Optional) Displays dispalys the status of SNMP sessions.

Step 8	`show snmp pending`
	Example:
	`Router# show snmp pending`
		(Optional) Dispalys the current set of pending SNMP requests.

Examples

The following example shows the status of SNMP communications.

```
Router# show snmp

Chassis: 01506199
```

```
37 SNMP packets input
    0 Bad SNMP version errors
    4 Unknown community name
    0 Illegal operation for community name supplied
    0 Encoding errors
    24 Number of requested variables
    0 Number of altered variables
    0 Get-request PDUs
    28 Get-next PDUs
    0 Set-request PDUs

78 SNMP packets output
    0 Too big errors (Maximum packet size 1500)
    0 No such name errors
    0 Bad values errors
    0 General errors
    24 Response PDUs
    13 Trap PDUs


SNMP logging: enabled
    Logging to 172.17.58.33.162, 0/10, 13 sent, 0 dropped.

SNMP Manager-role output packets
    4 Get-request PDUs
    4 Get-next PDUs
    6 Get-bulk PDUs
    4 Set-request PDUs
    23 Inform-request PDUs
    30 Timeouts
    0 Drops

SNMP Manager-role input packets
    0 Inform response PDUs
    2 Trap PDUs
    7 Response PDUs
    1 Responses with errors

SNMP informs: enabled
    Informs in flight 0/25 (current/max)
    Logging to 172.17.217.141.162
        4 sent, 0 in-flight, 1 retries, 0 failed, 0 dropped
    Logging to 172.17.58.33.162
        0 sent, 0 in-flight, 0 retries, 0 failed, 0 dropped
```

The following example dispalys the status of SNMP sessions.

```
Router# show snmp sessions

Destination: 172.17.58.33.162, V2C community: public
  Round-trip-times: 0/0/0 (min/max/last)
  packets output
    0 Gets, 0 GetNexts, 0 GetBulks, 0 Sets, 4 Informs
    0 Timeouts, 0 Drops
  packets input
    0 Traps, 0 Informs, 0 Responses (0 errors)

Destination: 172.17.217.141.162, V2C community: public, Expires in 575 secs
  Round-trip-times: 1/1/1 (min/max/last)
  packets output
    0 Gets, 0 GetNexts, 0 GetBulks, 0 Sets, 4 Informs
    0 Timeouts, 0 Drops
  packets input
    0 Traps, 0 Informs, 4 Responses (0 errors)
```

The following example shows the current set of pending SNMP requests.

```
Router# show snmp pending

req id: 47, dest: 172.17.58.33.161, V2C community: public, Expires in 5 secs

req id: 49, dest: 172.17.58.33.161, V2C community: public, Expires in 6 secs

req id: 51, dest: 172.17.58.33.161, V2C community: public, Expires in 6 secs

req id: 53, dest: 172.17.58.33.161, V2C community: public, Expires in 8 secs
```

Enabling the SNMP Agent Shutdown Mechanism

Using SNMP packets, a network management tool can send messages to users on virtual terminals and the console. This facility operates in a similar fashion to the **send** EXEC command; however, the SNMP request that causes the message to be issued to the users also specifies the action to be taken after the message is delivered. One possible action is a shutdown request. After a system is shut down, typically it is reloaded. Because the ability to cause a reload from the network is a powerful feature, it is protected by the **snmp-server system-shutdown** global configuration command. If you do not issue this command, the shutdown mechanism is not enabled.

Use the following command to enable the SNMP agent shutdown mechanism.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **snmp-server system-shutdown**

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	**snmp-server system-shutdown** **Example:** `Router(config)# snmp-server system-shutdown`	Enables system shutdown using the SNMP message reload feature.

Defining the Maximum SNMP Agent Packet Size

You can define the maximum packet size permitted when the SNMP agent is receiving a request or generating a reply.

Use the following commands to set the maximum permitted packet size.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **snmp-server packetsize** *byte-count*

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	`snmp-server packetsize` *byte-count* **Example:** `Router(config)# snmp-server packetsize 512`	Establishes the maximum packet size.

Limiting the Number of TFTP Servers Used via SNMP

You can limit the number of TFTP servers used for saving and loading configuration files via SNMP to the servers specified in an access list. Limiting the used TFTP servers in this way conserves system reources and centralized the operation for managability.

Use the following command to limit the number of TFTP servers.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **snmp-server tftp-server-list** *number*

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	**snmp-server tftp-server-list** *number* **Example:** `Router(config)# snmp-server tftp-server-list 12`	Limits the number of TFTP servers used for configuration file copies via SNMP to the servers in an access list.

Troubleshooting Tip

To monitor SNMP trap activity in real time for the purposes of troubleshooting, use the SNMP **debug** commands, including the **debug snmp packet** EXEC command. For documentation of SNMP **debug** commands, see the *Cisco IOS Debug Command Reference.*

Disabling the SNMP Agent

Use the following commands to disable any version of the SNMP agent.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **no snmp-server**

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	**no snmp-server** **Example:** `Router(config)# no snmp-server`	Disables SNMP agent operation.

Configuring SNMP Notifications

To configure the router to send SNMP traps or informs, perform the tasks described in the following sections:

- Configuring the Router to Send SNMP Notifications, page 201 (required)
- Changing Notification Operation Values, page 203 (optional)
- Controlling Individual RFC 1157 SNMP Traps, page 204 (optional)
- Configuring SNMP Notification Log Options, page 205 (optional)

Note Most Cisco IOS commands use the word "traps" in their command syntax. Unless there is an option within the command to specify either traps or informs, the keyword **traps** should be taken to mean either traps or informs, or both. Use the **snmp-server host** command to specify whether you want SNMP notifications to be sent as traps or informs.

The SNMP Proxy manager must be available and enabled on the device for informs to be used. The SNMP Proxy manager is shipped with PLUS software images only.

Configuring the Router to Send SNMP Notifications

Use the following commands to configure the router to send traps or informs to a host.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **snmp-server engineID remote** *remote-ip-address remote-engineID*
4. **snmp-server user** *username groupname* [**remote** *host* [**udp-port** *port*] {**v1** | **v2c** | **v3** [**encrypted**] [**auth** {**md5** | **sha**} *auth-password*]} [**access** *access-list*]

5. **snmp group** *groupname* {**v1** | **v2** | **v3** {**auth** | **noauth** | **priv**}} [**read** *readview*] [**write** *writeview*] [**notify** *notifyview*] [**access** *access-list*]
6. **snmp-server host** *host* [**traps** | **informs**] [**version** {**1** | **2c** | **3** [**auth** | **noauth** | **priv**]}] *community-string* [*notification-type*]
7. **snmp-server enable traps** [*notification-type* [*notification-options*]]

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	**snmp-server engineID remote** *remote-ip-address remote-engineID* **Example:** `Router(config)# snmp-server engineID remote 172.16.20.3 80000009030000B064EFE100`	Specifies the SNMP engine ID and configures the VRF name traps-vrf for SNMP communications with the remote device at 172.16.20.3.
Step 4	**snmp-server user** *username groupname* [**remote** *host* [**udp-port** *port*] {**v1** | **v2c** | **v3** [**encrypted**] [**auth** {**md5** | **sha**} *auth-password*]} [**access** *access-list*] **Example:** `Router(config)# snmp-server user abcd public remote 172.16.20.3 v3 encrypted auth md5 publichost remotehostusers`	Configures an SNMP user to be associated with the host created in Step 3. **Note** You cannot configure a remote user for an address without first configuring the engine ID for that remote host. This restriction is imposed in the design of these commands; if you try to configure the user before the host, you will receive a warning message and the command will not be executed.
Step 5	**snmp group** *groupname* {**v1** | **v2** | **v3** {**auth** | **noauth** | **priv**}} [**read** *readview*] [**write** *writeview*] [**notify** *notifyview*] [**access** *access-list*] **Example:** `Router(config)# snmp group GROUP1 v2c read viewA write viewA notify viewB`	Configures an SNMP group.

	Command or Action	Purpose
Step 6	**snmp-server host** *host* [**traps** | **informs**] [**version** {**1** | **2c** | **3** [**auth** | **noauth** | **priv**]}] *community-string* [*notification-type*] **Example:** `Router(config)# snmp-server host myhost.host3.com informs version 3 public`	Specifies whether you want the SNMP notifications sent as traps or informs, the version of SNMP to use, the security level of the notifications (for SNMPv3), and the recipient (host) of the notifications. • The **snmp-server host** command specifies which hosts will receive SNMP notifications, and whether you want the notifications sent as traps or inform requests.
Step 7	**snmp-server enable traps** [*notification-type* [*notification-options*]] **Example:** `Router(config)# snmp-server enable traps bgp`	Enables sending of traps or informs and specifies the type of notifications to be sent. • If a *notification-type* is not specified, all supported notification will be enabled on the router. • To discover which notifications are available on your router, enter the **snmp-server enable traps ?** command. • The **snmp-server enable traps** command globally enables the production mechanism for the specified notification types (such as Border Gateway Protocol (BGP) traps, config traps, entity traps, Hot Standby Router Protocol (HSR) traps, and so on).

Changing Notification Operation Values

You can specify a value other than the default for the source interface, message (packet) queue length for each host, or retransmission interval.

Use the following commands to change notification operation values as needed.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **snmp-server trap-source** *interface*
4. **snmp-server queue-length** *length*
5. **snmp-server trap-timeout** *seconds*
6. **snmp-server informs** [**retries** *retries*] [**timeout** *seconds*] [**pending** *pending*]

DETAILED STEPS

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	**`snmp-server trap-source`** *`interface`*
	Example:
	`Router(config)# snmp-server trap-source ethernet 2/1`
		This example shows how to set the IP address for the Ethernet interface in slot2, port 1 as the source for all SNMP notifications.

Step 4	**`snmp-server queue-length`** *`length`*
	Example:
	`Router(config)# snmp-server queue-length 50`
		Establishes the message queue length for each notification. This example show the queue length set to 50 entries.

Step 5	**`snmp-server trap-timeout`** *`seconds`*
	Example:
	`Router(config)# snmp-server trap-timeout 30`
		Defines how often to resend notifications on the retransmission queue.

Step 6	**`snmp-server informs`** `[`**`retries`** *`retries`*`] [`**`timeout`** *`seconds`*`] [`**`pending`** *`pending`*`]`
	Example:
	`Router(config)# snmp-server informs retries 10 timeout 30 pending 100`
		For inform requests, you can configure inform-specific operation values in addition to the operation values mentioned.
		- This example sets the maximum number of times to resend an inform request, the number of seconds to wait for an acknowledgment before resending, and the maximum number of informs waiting for acknowledgments at any one time.

Controlling Individual RFC 1157 SNMP Traps

Starting with Cisco IOS Release 12.1(3)T, you can globally enable or disable authenticationFailure, linkUp, linkDown, warmStart, and coldStart notifications (traps or informs) individually. (These traps constitute the “generic traps” defined in RFC 1157.)

To enable any of these notification types, use the following command in global configuration mode.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **snmp-server enable traps snmp** [**authentication**] [**linkup**] [**linkdown**] [**warmstart**] [**coldstart**]
4. **interface** *type slot/port*
5. **no snmp-server link status**

DETAILED STEPS

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	**`snmp-server enable traps snmp`** [**`authentication`**] [**`linkup`**] [**`linkdown`**] [**`warmstart`**] [**`coldstart`**] **Example:** `Router(config)# snmp-server enable traps snmp`	Enables RFC 1157 generic traps. When used without any of the optional keywords, enables authenticationFailure, linkUp, linkDown, warmStart, and coldStart traps. When used with keywords, enables only the trap types specified. • For example, to globally enable only linkUp and linkDown SNMP traps or informs for all interfaces, use the **snmp-server enable traps snmp linkup linkdown** form of this command.
Step 4	**`interface`** *type slot/port* **Example:** `Router(config)# interface Ethernet 0/1`	Enters interface cnfiguration mode for a specific interface.

Step 5	**`no snmp-trap link status`**
	Example:
	`Router(config-if)# no snmp-trap link status`
		Disables the sending of Link Up./Link Down notificatins specific interfaces.

Note that linkUp and linkDown notifications are enabled by default on specific interfaces, but will not be sent unless they are enabled globally.

Configuring SNMP Notification Log Options

Use the following commands to configure SNMP notification log options. These options all you to control the log size and timing values. The SNMP log can become very large and long if left unmodified.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **snmp mib notification-log default**
4. **snmp mib notification-log globalageout** *seconds*
5. **snmp mib notification-log globalsize** *size*
6. **exit**
7. **show snmp mib notification-log**

DETAILED STEPS

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	**`snmp mib notification-log default`**
	Example:
	`Router(config)# snmp mib notification-log default`
		Creates an unnamed SNMP notification log.

Step 4	**`snmp mib notification-log globalageout`** *`seconds`*
	Example:
	`Router(config)# snmp mib notification-log globalageout 20`
		Sets the maximum amount of time SNMP notification log entries remain in the system memory.
		- In this example, the system is configured to delete entries in the SNMP notification log that were logged more than 20 minutes ago.

Step 5	**`snmp mib notification-log globalsize`** *`size`*
	Example:
	`Router(config)# snmp mib notification-log globalsize 600`
		Sets the maximum number of entries that can be stored in all SNMP notification logs.

Step 6	**`exit`**
	Example:
	`Router(config)# exit`
		Exits global configuration mode.

Step 7	**`show snmp mib notification-log`**
	Example:
	`Router# show snmp mib notification-log`
		Displays information about the state of the local SNMP notification logging.

Example

This example show the information about the state of local SNMP notification logging.

```
Router# show snmp mib notification-log

GlobalAgeout 20, GlobalEntryLimit 600
Total Notifications logged in all logs 0
Log Name"", Log entry Limit 600, Notifications logged 0
Logging status enabled
Created by cli
```

Configuring Interface Index Display and Interface Indexes and Configuration of Long Name Support

The display of Interface Indexes lets advanced users of SNMP to view information about the interface registrations directly on the managed agent. In other words, the commands in this feature allow the you to display MIB information from the agent without using an external NMS.

Configuration of Long Alias Names for the interfaces lets users configure the ifAlias (the object defined in the MIB whose length is restricted to 64) up to 255 bytes

Prerequisites

The task presented in this section assumes you have SNMP enabled on your system.

Restrictions

The Interface Index Display and Interface Alias Long Name Support feature is not supported on all Cisco platforms. Use Cisco Feature Navigator to find information about platform support and Cisco IOS software image support.

Use the following commands to configure the IF-MIB to retain ifAlias values of longer than 64 characters and to configure the ifAlias values for an interface.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **snmp ifmib ifalias long**
4. **interface** *type number*
5. **description** *text-string*
6. **exit**
7. **show snmp mib**
8. **show snmp mib ifmib ifindex** [*interface-type*] [*slot*/][*port-adapter*/][*port*]

DETAILED STEPS

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	**`snmp ifmib ifalias long`**
	Example:
	`Router(config)# snmp ifmib ifalias long`
		Configures the Interfaces MIB (IF-MIB) on the system to return ifAlias values of longer than 64 characters to a Network Management System.

Step 4	**`interface`** *`type number`*
	Example:
	`Router(config)# interface ethernet 2/4`
		Enters interface configuration mode.
		• The form of this command varies depending on the interface being configured.

Step 5	**`description`** *`text-string`*
	Example:
	`Router(config)# description This text string description can be up to 256 characters long`
		• Configures a free-text description of the specified interface. This description can be up to 256 characters in length and is stored as the ifAlias object value in the IF-MIB.

Step 6	**`exit`**
	Example:
	`Router(config)# exit`
		Exits global configuration mode.

Step 7	**`show snmp mib`**
	Example:
	`Router# show snmp mib`
		Displays a list of the MIB module instance identifiers registered on your system.
		• The resulting display could be lengthy.

Step 8	**`show snmp mib ifmib ifindex`** `[`*`interface-type`*`] [`*`slot/`*`][`*`port-adapter/`*`][`*`port`*`]`
	Example:
	`Router# show snmp mib ifmib ifIndex Ethernet 2/0`
		Displays the Interfaces MIB ifIndex values registered on your system for all interfaces or the specified interface.

Examples

The following example shows a list of the MIB module instance identifiers registered on your system. The resulting display could be lengthy. Only a small portion is shown below.

```
Router# show snmp mib

system.1
system.2
sysUpTime
system.4
system.5
system.6
system.7
system.8
sysOREntry.2
sysOREntry.3
sysOREntry.4
interfaces.1
ifEntry.1
ifEntry.2
ifEntry.3
ifEntry.4
ifEntry.5
ifEntry.6
ifEntry.7
ifEntry.8
ifEntry.9
ifEntry.10
ifEntry.11

 --More--

  .

captureBufferEntry.2
captureBufferEntry.3
captureBufferEntry.4
captureBufferEntry.5
captureBufferEntry.6
captureBufferEntry.7
capture.3.1.1
eventEntry.1
eventEntry.2
eventEntry.3
eventEntry.4
eventEntry.5
eventEntry.6

eventEntry.7
logEntry.1
logEntry.2
logEntry.3
logEntry.4
rmon.10.1.1.2
rmon.10.1.1.3
rmon.10.1.1.4
rmon.10.1.1.5
rmon.10.1.1.6
rmon.10.1.1.7
rmon.10.2.1.2
rmon.10.2.1.3
rmon.10.3.1.2

--More--
```

The following examples show the outputs for the Interfaces MIB ifIndex values registered on your system for all interfaces or the specified interface.

The first example shows output for a specific interface:

```
Router# show snmp mib ifmib ifIndex Ethernet2/0

Ethernet2/0: Ifindex = 2
```

The next example shows output for all interfaces:

```
Router# show snmp mib ifmib ifindex
ATM1/0: Ifindex = 1
ATM1/0-aal5 layer: Ifindex = 12
ATM1/0-atm layer: Ifindex = 10
ATM1/0.0-aal5 layer: Ifindex = 13
ATM1/0.0-atm subif: Ifindex = 11
ATM1/0.9-aal5 layer: Ifindex = 32
ATM1/0.9-atm subif: Ifindex = 31
ATM1/0.99-aal5 layer: Ifindex = 36
ATM1/0.99-atm subif: Ifindex = 35
Ethernet2/0: Ifindex = 2
Ethernet2/1: Ifindex = 3
Ethernet2/2: Ifindex = 4
Ethernet2/3: Ifindex = 5
Null0: Ifindex = 14
Serial3/0: Ifindex = 6
Serial3/1: Ifindex = 7
Serial3/2: Ifindex = 8
Serial3/3: Ifindex = 9
```

Verifying Interface Index Display and Interface Index Display and IfAlias Long Name Support

Use the following steps to confirm that IfAlias Long Name Support has been enabled.

Step 1 Configure a description for an interface that is longer than 64 characters in length. See“Configuring SNMP Notification Log Options” section on page 205 for details.

Step 2 Perform an SNMP MIB walk for the ifMIB ifAlias variable from an NMS and check to see if the entire description is displayed in the values for ifXEntry.18.

Note The description for interfaces also appears in the output of the **more system:running config** EXEC mode command.

Troubleshooting Tips

An alternative to using the ifAlias value for the identification of interfaces across reboots is to use the cciDescr object in the Cisco Circuit Interface MIB (CISCO-CIRCUIT-INTERFACE-MIB.my). Note that this MIB object can be used only for circuit-based interfaces such as ATM or Frame Relay interfaces. Cisco IOS Release 12.2(2)T introduces the Circuit Interface Identification Persistence for SNMP feature, which maintains the user-defined name of the circuit (defined in the cciDescr object) across reboots, allowing for the consistent identification of circuit-based interfaces.

Configuring SNMP Support for VPNs

This section describes how to configure SNMP support for VPNs. The SNMP Support for VPNs feature provides configuration commands that allow users to associate SNMP agents and managers with specific VRFs. The specified VRF is used to send of SNMP notifications (traps and informs) and responses between agents and managers. If a VRF is not specified, the default routing table for the VPN is used.

Support for VPNs allows users to configure an SNMP agent to only accept SNMP requests from a certain set of VPNs. With this configuration, providers can provide network management services to their customers, so customers can manage all user VPN devices.

Restrictions

- This feature is not supported on all Cisco platforms. Use Cisco Feature Navigator to find information about platform support and Cisco IOS software image support.
- Not all MIBs are VPN aware. for more information about VPN aware MIBs see the following URL: http://www.cisco.com/univercd/cc/td/doc/product/software/ios123/123newft/123t/123t_2/gtsnmpvp.htm

Use the following commands to configure SNMP over a specific VPN.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **snmp-server host** *host-address* [**traps** | **informs**][**version** {**1** | **2c** | **3** [**auth** | **noauth** | **priv**]}] *community-string* [**udp-port** *port*][*notification-type*][**vrf** *vrf-name*]
4. **snmp-server engineID remote** *ip-address* [**udp-port** *udp-port-number*][**vrf** *vrf-name*] *engineid-string*
5. **exit**
6. **show snmp-server host**

DETAILED STEPS

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	**snmp-server host** *host-address* [**traps** | **informs**][**version** {**1** | **2c** | **3** [**auth** | **noauth** |**priv**]}] *community-string* [**udp-port** *port*][*notification-type*][**vrf** *vrf-name*] **Example:** `Router(config)# snmp-server host company.com public vrf trap-vrf`	Specifies the recipient of an SNMP notification operation and specifies the VRF table to be used for the sending of SNMP notifications.
Step 4	**snmp-server engineID remote** *ip-address* [**udp-port** *udp-port-number*][**vrf** *vrf-name*] *engineid-string* **Example:** `Router(config)# snmp-server engineID remote 172.16.20.3 vrf traps-vrf 80000009030000B064EFE100`	Configures a name for the remote SNMP engine on a router when configuring SNMP over a specific VPN for a remote SNMP user.
Step 5	**exit***g* **Example:** `Router(config)# exit`	Exits global configuration mode.
Step 6	**show snmp-server host** **Example:** `Router(config)# show snmp-server host`	Displays the SNMP configuration and verifies that the SNMP Support for VPNS feature is configured properly.

Configuring MIB Persistence

The MIB Persistence features allow the SNMP data of a MIB to be persistent across reloads; that is, MIB information retains the same set object values each time a networking device reboots. The following sections contain tasks for using Distributed Management Event and Expression MIB persistence.

- Enabling and Disabling Event MIB Persistence, page 213 (optional)
- Enabling and Disabling Expression MIB Persistence, page 214 (optional)

Prerequisites

The configuration tasks described in the next section assume that you have configured SNMP on your networking device and that values for Event MIB and Expression MIB have been configured by you or your application.

Restrictions

- If the number of MIB objects to persist increases, NVRAM storage capacity may be strained. Occasionally, the time taken to write MIB data to NVRAM may be longer than expected.
- The Distributed Management Event MIB Persistence feature is not supported on all Cisco platforms. Use Cisco Feature Navigator to find information about platform support and Cisco IOS software image support.

Enabling and Disabling Event MIB Persistence

Use the following command to configure Event MIB Persistence.

Note Event MIB Persistence is disabled by default.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **snmp mib persist event**
4. **no snmp mib persist event**
5. **exit**
6. **write mib-data**
7. **copy running-config startup-config**

DETAILED STEPS

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	**`snmp mib persist event`**
	Example:
	`Router(config)# snmp mib persist event`
		Enables MIB Persistence for Event MIB.

Step 4	**`no snmp mib persist event`**
	Example:
	`Router(config)# no snmp mib persist event`
		(Optional) Disables MIB Persistence for Event MIB.

Step 5	**`exit`**
	Example:
	`Router(config)# exit`
		Exits global configuration mode.

Step 6	**`write mib-data`**
	Example:
	`Router(config)# write mib-data`
		Saves Event MIB Persistence configuration data to NVRAM

Step 7	**`copy running-config startup-config`**
	Example:
	`Router(config)# copy running-config startup-config`
		Copies the running configuration to the startup configuration.

Enabling and Disabling Expression MIB Persistence

Use the following command to configure Expression MIB Persistence.

Note Expression MIB Persistence is disabled by default.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **snmp mib persist expression**
4. **no snmp mib persist expression**
5. **exit**
6. **write mib-data**
7. **copy running-config startup-config**
8. **more system:running-config**

DETAILED STEPS

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	**snmp mib persist expression** **Example:** `Router(config)# snmp mib persist expression`	Enables MIB Persistence for Expression MIB.
Step 4	**no snmp mib persist expression** **Example:** `Router(config)# no snmp mib persist expression`	(Optional) Disables MIB Persistence for Expression MIB.
Step 5	**exit** **Example:** `Router(config)# exit`	Exits global configuration mode.
Step 6	**write mib-data** **Example:** `Router(config)# write mib-data`	Saves Expression MIB Persistence configuration data to NVRAM
Step 7	**copy running-config startup-config** **Example:** `Router(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.
Step 8	**more system:running-config** **Example:** `Router(config)# more system:running-config`	Displays the currently running configuration. Use this command to verify MIB persistence configuration.

SNMP Configuration Examples

This section contains the following examples:

- Configuring SNMPv1, SNMPv2c, and SNMPv3: Example, page 215
- Configuring IfAlias Long Name Support: Example, page 217
- Configuring SNMP Support over VPNs: Example, page 218
- Enabling Event MIB Persistence: Example, page 218
- Enabling Expression MIB Persistence: Example, page 218

Configuring SNMPv1, SNMPv2c, and SNMPv3: Example

The following example enables SNMPv1, SNMPv2c, and SNMPv3. The configuration permits any SNMP manager to access all objects with read-only permissions using the community string named public. This configuration does not cause the router to send any traps.

```
snmp-server community public
```

The following example permits any SNMP to access all objects with read-only permission using the community string named public. The router also will send ISDN traps to the hosts 172.16.1.111 and 172.16.1.33 using SNMPv1 and to the host 172.16.1.27 using SNMPv2c. The community string named public is sent with the traps.

```
snmp-server community public
snmp-server enable traps isdn
snmp-server host 172.16.1.27 version 2c public
snmp-server host 172.16.1.111 version 1 public
snmp-server host 172.16.1.33 public
```

The following example allows read-only access for all objects to members of access list 4 that specify the comaccess community string. No other SNMP managers have access to any objects. SNMP Authentication Failure traps are sent by SNMPv2c to the host host3.com using the community string named public.

```
snmp-server community comaccess ro 4
snmp-server enable traps snmp authentication
snmp-server host host3.com version 2c public
```

The following example sends Entity MIB inform notifications to the host host3.com. The community string is restricted. The first line enables the router to send Entity MIB notifications in addition to any traps or informs previously enabled. The second line specifies that the notifications should be sent as inform requests, specifies the destination of these informs, and overwrites any previous **snmp-server host** commands for the host host3.com.

```
snmp-server enable traps entity
snmp-server host informs host3.com restricted entity
```

The following example sends the SNMP and Cisco environmental monitor enterprise-specific traps to address 172.30.2.160:

```
snmp-server enable traps
snmp-server host 172.30.2.160 public snmp envmon
```

The following example enables the router to send all traps to the host myhost.host3.com using the community string public:

```
snmp-server enable traps
snmp-server host myhost.host3.com public
```

The following example will not send traps to any host. The BGP traps are enabled for all hosts, but only the ISDN traps are enabled to be sent to a host.

```
snmp-server enable traps bgp
snmp-server host bob public isdn
```

The following example enables the router to send all inform requests to the host myhost.host3.com using the community string named public:

```
snmp-server enable traps
snmp-server host myhost.host3.com informs version 2c public
```

In the following example, the SNMP manager is enabled and the session timeout is set to a larger value than the default:

```
snmp-server manager
snmp-server manager session-timeout 1000
```

Configuring IfAlias Long Name Support: Example

In the following example a long description is applied toEethernet interface in slot 1, port adapter 0, and port 0:

```
Router# configure terminal
Router(config)# interface Ethernet1/0/0
Router(config-if)# description ethernet1/0/0 this is a test of a description that exceeds
64 characters in length
Router(config-if)# ip address 192.168.134.55 255.255.255.0
Router(config-if)# no ip directed-broadcast
Router(config-if)# no ip route-cache distributed
```

Assuming that ifAlias long name support is not yet enabled (the default), the following example shows the results of a mibwalk operation from an NMS:

```
***** SNMP QUERY STARTED *****
 .
 .
 .
 ifXEntry.18.10 (octets) (zero-length)
 ifXEntry.18.11 (octets) ethernet1/0/0 this is a test of a description that exceeds 64 ch
 ifXEntry.18.12 (octets) (zero-length)
 .
 .
 .
```

The following output shows the description that is displayed at the CLI:

```
Router# show interface Ethernet0/0/0

Ethernet1/0/0 is administratively down, line protocol is down
  Hardware is Lance, address is 0010.7b4d.7046 (bia 0010.7b4d.7046)
  Description: ethernet1/0/0 this is a test of a description that exceeds 64 chh
  MTU 1500 bytes, BW 10000 Kbit, DLY 1000 usec,
     reliability 252/255, txload 1/255, rxload 1/255
 .
 .
 .
```

In the following example, ifAlias long name support is enabled, and the description is displayed again:

```
Router(config)# snmp ifmib ifalias long
Router(config)# interface Ethernet1/0/0
Router(config-if)# description ethernet1/0/0 this is a test of a description that exceeds
64 characters in length
Router(config)# end
Router# show interface Ethernet1/0/0

Ethernet1/0/0 is administratively down, line protocol is down
  Hardware is Lance, address is 0010.7b4d.7046 (bia 0010.7b4d.7046)
  Description: ethernet1/0/0 this is a test of a description that exceeds 64 characters in
length
  MTU 1500 bytes, BW 10000 Kbit, DLY 1000 usec,
     reliability 252/255, txload 1/255, rxload 1/255
 .
 .
 .
***** SNMP QUERY STARTED *****
 .
 .
 .
 ifXEntry.18.10 (octets) (zero-length)
 ifXEntry.18.11 (octets) ethernet1/0/0 this is a test of a description that exceeds 64
characters in length
```

```
ifXEntry.18.12 (octets) (zero-length)
.
.
.
```

Configuring SNMP Support over VPNs: Example

The following example sends all SNMP notifications to xyz.com over the VRF named “trap-vrf”:

```
Router(config)# snmp-server host xyz.com vrf trap-vrf
```

The following example configures the VRF named “traps-vrf” for the remote server 172.16.20.3:

```
Router(config)# snmp-server engineID remote 172.16.20.3 vrf traps-vrf
80000009030000B064EFE100
```

Enabling Event MIB Persistence: Example

To enable Event MIB Persistence, use the **snmp mib persist event** command in global configuration mode:

```
Router(config)# snmp mib persist event
Router# write mib-data
```

Enabling Expression MIB Persistence: Example

To enable Expression MIB Persistence, use the **snmp mib persist expression** command in global configuration mode:

```
Router(config)# snmp mib persist expression
Router# write mib-data
```

Additional References

The following sections provide references related to Configuring Support for SNMP.

Related Documents

Related Topic	Document Title
SNMP commands	*Cisco IOS Configuration Fundamentals Command Reference*, Release 12.4.
Cisco IOS implementation of RFC 1724, RIP Version 2 MIB Extensions	*RIPv2 Monitoring with SNMP Using the RFC 1724 MIB Extensions* feature module
DSP Operational State Notifications for notifications to be generated when digital signaling processor (DSP) is used	*DSP Operational State Notifications* feature module

Standards

Standard	Title
CBC-DES (DES-56) standard	
STD: 58	*Structure of Management Information Version 2 (SMIv2)*

MIBs

MIB	MIBs Link
• Cisco SNMPv2 • Interfaces Group MIB (IF-MIB) • Circuit Interface Identification MIB • Ethernet-like Interfaces MIB • Event MIB • Expression MIB Support for Delta, Wildcarding, and Aggregation • Interfaces Group MIB Enhancements • MIB Enhancements for Universal Gateways and Access Servers • MSDP MIB • NTP MIB • Response Time Monitor MIB	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
RFC 1067	*A Simple Network Management Protocol*
RFC 1091	*Telnet terminal-type option*
RFC 1098	*Simple Network Management Protocol (SNMP)*
RFC 1157	*Simple Network Management Protocol (SNMP)*
RFC 1213	*Management Information Base for Network Management of TCP/IP-based internets:MIB-II*
RFC 1215	*Convention for defining traps for use with the SNMP*
RFC 1901	*Introduction to Community-based SNMPv2*
RFC 1905	*Common Management Information Services and Protocol over TCP/IP (CMOT)*
RFC 1906	*Telnet X Display Location Option*
RFC 1908	*Simple Network Management Protocol (SNMP)*
RFC 2104	*HMAC: Keyed-Hashing for Message Authentication*

RFC	Title
RFC 2206	*RSVP Management Information Base using SMIv2*
RFC 2213	*Integrated Services Management Information Base using SMIv2*
RFC 2214	*Integrated Services Management Information Base Guaranteed Service Extensions using SMIv2*
RFC 2271	*An Architecture for Describing SNMP Management Frameworks*
RFC 2570	*Introduction to Version 3 of the Internet-standard Network Management Framework*
RFC 2578	*Structure of Management Information Version 2 (SMIv2)*
RFC 2579	*Textual Conventions for SMIv2*
RFC 2580	*Conformance Statements for SMIv2*
RFC 3413	*SNMPv3 Applications*
RFC 3415	*View-based Access Control Model (VACM) for the Simple Network Management Protocol (SNMP)*

Technical Assistance

Description	Link
The Cisco Technical Support & Documentation website contains thousands of pages of searchable technical content, including links to products, technologies, solutions, technical tips, tools. and technical documentation. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/techsupport

Glossary

ifAlias — SNMP Interface Alias. The ifAlias is an object in the Interfaces MIB (IF-MIB). The ifAlias is an alias name for the interface as specified by a network manager that provides a nonvolatile description for the interface. For a complete definition, see the IF-MIB.my file.

ifIndex — SNMP Interface Index. The ifIndex is an object in the Interfaces MIB (IF-MIB). The ifIndex is a unique integer assigned to every interface (including subinterfaces) on the managed system when the interface registers with the IF-MIB. For a complete definition, see the IF-MIB.my file.

OID — MIB object identifier. An object identifier is expressed as a series of integers or text strings. Technically, the numeric form is the *object name* and the text form is the *object descriptor*. In practice, both are called object identifiers, or OIDs. For example, the object name for the interfaces MIB is '1.3.6.1.2.1.2', and the object descriptor is 'iso.internet.mgmt.mib-2.interfaces', but either can be referred to as the OID. OIDs can also be expressed as a combination of the two, such as 'iso.internet.2.1.2'.

Note See *Internetworking Terms and Acronyms* for terms not included in this glossary.

Feature Information for Configuring SNMP Support

Table 12 lists the features in this module and provides links to specific configuration information. Only features that were introduced or modified inCisco IOS Release 12.(1) or a later release appear in the table.

For information on a feature in this technology that is not documented here, see the "SNMP Configuration Features Roadmap."

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

Cisco IOS software images are specific to a Cisco IOS software release, a feature set, and a platform. Use Cisco Feature Navigator to find information about platform support and Cisco IOS software image support. Access Cisco Feature Navigator at http://www.cisco.com/go/fn. You must have an account on Cisco.com. If you do not have an account or have forgotten your username or password, click **Cancel** at the login dialog box and follow the instructions that appear.

Note Table 12 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 12 Feature Information for Configuring SNMP Support

Feature Name	Releases	Feature Information
Distributed Management Event and Expression MIB Persistence	12.0(5)T 12.0(12)S 12.1(3)T 12.2(4)T 12.2(4)T3	The MIB Persistence features allow the SNMP data of a MIB to be persistent across reloads; that is, MIB information retains the same set object values each time a networking device reboots. MIB Persistence is enabled by using the **snmp mib persist** command, and the MIB data of all MIBs that have had persistence enabled using this command is then written to NVRAM storage by using the **write mib-data** command. Any modified MIB data must be written to NVRAM memory using the **write mib-data** command. The following sections provide information about this module: • "MIB Persistence" section on page 185 . • "Configuring MIB Persistence" section on page 212.

Table 12 Feature Information for Configuring SNMP Support (continued)

Feature Name	Releases	Feature Information
Interface Index Display and Interface Alias Long Name Support for SNMP	12.2(2)T	The Interface Index Display for SNMP feature introduces new commands and command modifications that allow advanced users of SNMP to view information about the interface registrations directly on the managed agent. (For the purposes of this document, the agent is the routing device running Cisco IOS software.) In other words, the commands in this feature allow the user to display MIB information from the agent without using an external NMS. This feature addresses three objects in the Interfaces MIB: the *ifIndex* object, the *ifAlias* object, and the *ifName* object. For the complete definition of these objects, see the IF-MIB.my file, available from the Cisco SNMPv2 MIB website at ftp://ftp.cisco.com/pub/mibs/v2/. The following sections provide information about this feature: • "Detailed Interface Registration Information" section on page 183 .. • "Configuring Interface Index Display and Interface Indexes and Configuration of Long Name Support" section on page 207.
SNMP Notification Logging	12.0(22)S 12.2(13)T	The SNMP Notification Logging feature adds Cisco IOS command-line interface (CLI) commands to change the size of the notification log, to set the global ageout value for the log, and to display logging summaries at the command line. The following sections provide information about this feature: • "SNMP Notification Logging" section on page 186. • "Configuring SNMP Notifications" section on page 201.
SNMP Support for VPNs	12.0(23)S 12.2(2)T	The SNMP Support for VPNs feature allows the sending and receiving of SNMP notifications (traps and informs) using VPN routing/forwarding (VRFs) tables. In particular, this feature adds support to Cisco IOS software for the sending and receiving of SNMP notifications (traps and informs) specific to individual Virtual Private Networks (VPNs). The following sections provide information about this feature: • "SNMP Support for VPNs" section on page 184. • "Configuring SNMP Support for VPNs" section on page 211.

Table 12 Feature Information for Configuring SNMP Support (continued)

Feature Name	Releases	Feature Information
Circuit Interface Identification Persistence for SNMP feature	12.1(3)T	This feature can be used to identify individual circuit-based interfaces for SNMP monitoring. The following section provides information about this feature: • "Circuit Interface Identification Persistence" section on page 186.

Interface Index Display and Interface Alias Long Name Support for SNMP

Feature History

Release	Modification
12.2(2)T	This feature was introduced.

This document describes the Interface Index Display and Interface Alias Long Name Support for SNMP feature in Cisco IOS Release 12.2(2)T. It includes the following sections:

- Feature Overview
- Supported Platforms
- Supported Standards, MIBs, and RFCs
- Prerequisites
- Configuration Tasks
- Monitoring and Maintaining SNMP Interface Identification Values
- Configuration Examples
- Command Reference
- Glossary

Feature Overview

The Simple Network Management Protocol (SNMP) is the language for communication between a managing system running a network management application and a managed system running an agent. Between them they share the concept of a Management Information Base (MIB) that defines the information the agent can make available to the manager.

SNMP network management is based on the Internet Network Management Framework. This framework defines a model in which a managing system called a *manager* communicates with a managed system. The manager—typically referred to as the Network Management System, or NMS —runs a network management application, and the managed system runs an *agent*, which answers requests from the manager, and generates notifications to the manager.

The Management Information Base (MIB) defines all the information about a managed system that a NMS can view or modify. The MIB is located on the managed system and can consist of standard and proprietary portions. The agent and manager each have their own view of the MIB. The NMS can be configured to periodically update its MIB view from all managed agents.

The MIB shared by the manager and agent typically consists of a collection of MIB modules. (MIB modules are also referred to as “MIBs”.) For example, the Interfaces MIB (IF-MIB.my) is a MIB module found in the MIB that exists for most Cisco IOS software-based devices.

An SNMP MIB is an abstract data base, that is, it is a conceptual specification for information that management application can read and modify. The SNMP agent translates between the internal data structures and formats of the managed system and the external data structures and formats defined for the MIB. The SNMP MIB is organized as a tree structure with conceptual tables.

A MIB object, also sometimes called variable, is a leaf in the MIB tree. Each leaf represent an individual item of data. Examples of objects are counters and protocol status. Leaf objects are connected to branch points.

The Interface Index Display for SNMP feature introduces new commands and command modifications that allow advanced users of SNMP to view information about the interface registrations directly on the managed agent. (For the purposes of this document, the agent is the routing device running Cisco IOS software.) In other words, the commands in this feature allow the user to display MIB information from the agent without using an external NMS.

This feature addresses three objects in the Interfaces MIB: the *ifIndex* object, the *ifAlias* object, and the *ifName* object. For the complete definition of these objects, see the IF-MIB.my file, available from the Cisco SNMPv2 MIB website at ftp://ftp.cisco.com/pub/mibs/v2/.

The ifIndex object (ifEntry 1) is called the Interface Index. The Interface Index (ifIndex) is a unique value, greater than zero, which identifies each interface (or subinterface) on the managed device. This value becomes the interface index identification number.

A new Cisco IOS software command, **show snmp mib ifmib ifindex**, allows the user to view the SNMP Interface Index Identification numbers assigned to interfaces and subinterfaces using the CLI. This provides a way to view these values without the need for a Network Management System.

The ifAlias object (ifXEntry 18) is called the Interface Alias. The Interface Alias (ifAlias) is a user-specified description of an interface used for SNMP network management. The ifAlias is an object in the Interfaces Group MIB (IF-MIB) which can be set by a network manager to “name” an interface. The ifAlias value for an interface or subinterface can be set using the **description** command in interface configuration mode or subinterface configuration mode, or by using a Set operation from an NMS. Prior to this release, ifAlias descriptions for subinterfaces were limited to 64 characters. (The OLD-CISCO-INTERFACES-MIB allows up to 255 characters for the locIfDescr MIB variable, but this MIB does not support subinterfaces.) A new Cisco IOS software command, **snmp ifmib ifalias long**, configures the system to handle IfAlias descriptions of up to 256 characters. IfAlias descriptions appear in the output of the **show interfaces** CLI command.

The ifName object (ifXEntry 1) is the textual name of the interface. The value of this object is the name of the interface as assigned by the local device and is suitable for use in commands entered at the CLI. If there is no local name, or this object is otherwise not applicable, then this object contains a zero-length string. No commands introduced by this feature impact the ifName object, but it is discussed here to show its relation to the ifIndex and ifAlias objects. The purpose of the ifName object is to cross reference the CLI representation of a given interface.

The **show snmp mib** command shows all objects in the MIB on a Cisco device (similar to a mibwalk). The objects in the MIB tree are sorted using *lexical ordering*. This means that object identifiers are sorted in sequential, numerical order. Lexical ordering is important when using the GetNext operation from an NMS because these operations takes an object identifier (OID) or a partial OID as input and returns the next object from the MIB tree based on the lexical ordering of the tree.

The **show snmp mib** command will display the *instance identifiers* for all the MIB objects on the system. The instance identifier is the final part of the OID. An object can have one or more instance identifiers. Before displaying the instance identifier, the system attempts to find the best match with the list of table names. The MIB module table names are registered when the system initializes.

Cisco IOS Release 12.2(2)T also introduces the Circuit Interface Identification Persistence for SNMP feature. The Circuit Interface MIB (CISCO-CIRCUIT-INTERFACE-MIB) provides a MIB object (cciDescr) which can be used to identify individual circuit-based interfaces for SNMP monitoring. The Cisco Circuit Interface MIB was introduced in Cisco IOS Release 12.1(3)T .

The Circuit Interface Identification Persistence for SNMP feature maintains the user-defined name of the circuit (defined in the cciDescr object) across reboots, allowing for the consistent identification of circuits.

The Circuit Interface Identification Persistence for SNMP feature is a supplement to the Interface Index Persistence feature introduced in Cisco IOS Release 12.1(3)T and Cisco IOS Release 12.0(11)S. Circuit Interface Identification Persistence is enabled with the **snmp mib persist circuit** global configuration command. Use this command if you need to consistently identify circuits using SNMP across reboots. This command is disabled by default because this feature uses NVRAM memory.

Benefits

- The **show snmp mib ifmib ifindex** EXEC mode command allows you to display the Interfaces MIB ifIndex values directly on your system without the need for a network management system.
- The **show snmp mib** EXEC mode command allows you to display a list of the MIB module instance identifiers registered directly on your system with the need for a network management system.
- The **snmp ifmib ifalias long** command allows you to specify a description for interfaces or subinterface of up to 256 characters in length. Prior to the introduction of this command, ifAlias descriptions for SNMP management were limited to 64 characters.

Related Features and Technologies

- The “Circuit Interface Identification MIB” feature, Cisco IOS Release 12.1(3)T
- The “IfIndex Persistence” feature, Cisco IOS Release 12.1(5)T
- The Internetwork Performance Monitor (IPM) application

Related Documents

- The “Configuring SNMP Support” chapter of the *Cisco IOS Configuration Fundamentals Configuration Guide*, Release 12.2.
- The “SNMP Commands” chapter of the *Cisco IOS Configuration Fundamentals Command Reference*, Release 12.2.

Supported Platforms

Interface Index Display and Interface Alias Long Name Support is supported on the following platforms:

- Cisco 800 Series Routers

- Cisco 1000 Series Routers
- Cisco 1400 Series Routers
- Cisco 1600 Series Routers
- Cisco 1600R Series Routers
- Cisco 1700 Series Routers
- Cisco 2500 Series Routers
- Cisco 2600 Series Modular Access Routers
- Catalyst 2800 Series Switches
- Cisco 3620 Routers
- Cisco 3640 Routers
- Cisco 3660 Multiservice Platform
- Cisco MC3810 Multiservice Access Concentrators
- Cisco 4500M Series Routers
- Cisco AS5300 Series Universal Access Servers
- Cisco AS5400 Series Universal Gateways
- Cisco AS5800 Universal Access Servers
- Cisco 6400 Universal Access Concentrators
- Cisco 7100 VPN Gateway Series Routers
- Cisco 7200 Series Routers
- Cisco 7500 Series Routers
- Cisco LightStream 1010 ATM Switches
- Cisco RPM images
- Cisco VG200 Gateways
- Catalyst 5000 Series Switches
- Catalyst c5rsfc images
- Catalyst c6msm images
- Catalyst 8510 Series Switches
- Catalyst 8500 Series Multiservice Switch Routers (cat8510 and cat8540 images)
- Cisco ONS 15100 Series (regen images)
- Cisco uBR 7200 Series Universal Broadband Routers
- Cisco uBR 924 Cable Access Routers
- Cisco 12000 Series Routers

The Circuit Interface Identification Persistence feature is supported on the following platforms:

- Cisco 1600 Series and 1600R Series Routers
- Cisco 2500 Series,
- Cisco 2600 Series,
- Cisco 3620, 3640, and 3660 Series
- Cisco 6400 Series

- Cisco 7500 Series
- Cisco AS5300
- Cisco uBR 7200 Series Universal Broadband Routers
- Cisco 12000 Series

Determining Platform Support Using Feature Navigator

Cisco IOS software is packaged in feature sets that support specific platforms. To get updated information regarding platform support for this feature, access Feature Navigator. Feature Navigator dynamically updates the list of supported platforms as new platform support is added for the feature.

Feature Navigator is a web-based tool that enables you to quickly determine which Cisco IOS software images support a specific set of features and which features are supported in a specific Cisco IOS image.

To access Feature Navigator, you must have an account on Cisco.com. If you have forgotten or lost your account information, e-mail the Contact Database Administration group at cdbadmin@cisco.com. If you want to establish an account on Cisco.com, go to http://www.cisco.com/register and follow the directions to establish an account.

Feature Navigator is updated when major Cisco IOS software releases and technology releases occur. As of May 2001, Feature Navigator supports M, T, E, S, and ST releases. You can access Feature Navigator at the following URL:

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

Supported Standards, MIBs, and RFCs

Standards

No new or modified standards are supported by this feature.

MIBs

- Cisco Circuit Interface MIB (CISCO-CIRCUIT-INTERFACE-MIB.my)
- Interfaces MIB (IF-MIB.my)

To obtain lists of supported MIBs by platform and Cisco IOS release, and to download MIB modules, go to the Cisco MIB website on Cisco.com at the following URL:

http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml

RFCs

No new of modified RFCs are supported by this feature.

Prerequisites

The tasks presented in this document assume you have SNMP enabled on your system. For information on configuring SNMP, see the documents listed in the Related Documents section.

Configuration Tasks

- Configuring IfAlias Long Name Support (required)
- Verifying IfAlias Long Name Support (optional)

Configuring IfAlias Long Name Support

To configure the IF-MIB to retain ifAlias values of longer than 64 characters, use the following command in global configuration mode:

Command	Purpose
`Router(config)# snmp ifmib ifalias long`	Configures the Interfaces MIB (IF-MIB) on the system to return ifAlias values of longer than 64 characters to a Network Management System.

To configure the ifAlias for an interface, use the following command in interface configuration mode or subinterface configuration mode:

Command	Purpose
`Router(config-if)# description text-string`	Configures a free-text description of the specified interface. This description can be up to 256 characters in length, and is stored as the ifAlias object value in the IF-MIB.

Verifying IfAlias Long Name Support

To confirm that IfAlias Long Name Support has been enabled, you can optionally perform the following steps:

Step 1 Configure a description for an interface that is longer than 64 characters in length.

Step 2 Perform an SNMP MIB walk for the ifMIB ifAlias variable from an NMS and check to see if the entire description is displayed in the values for ifXEntry.18.

Note that the description for interfaces also appears in the output of the **more system:running config** EXEC mode command.

Troubleshooting Tips

An alternative to using the ifAlias value for the identification of interfaces across reboots is to use the *cciDescr* object in the Cisco Circuit Interface MIB (CISCO-CIRCUIT-INTERFACE-MIB.my). Note that this MIB object can be used only for circuit-based interfaces such as ATM or Frame Relay interfaces.

Cisco IOS Release 12.2(2)T introduces the Circuit Interface Identification Persistence for SNMP feature, which maintains the user-defined name of the circuit (defined in the cciDescr object) across reboots, allowing for the consistent identification of circuit-based interfaces.

Monitoring and Maintaining SNMP Interface Identification Values

To monitor SNMP interface identification values, use the following commands in EXEC mode, as needed:

Command	Purpose
`Router# show snmp mib`	Displays a list of the MIB module instance identifiers registered on your system.
`Router# show snmp mib ifmib ifindex [interface-type] [slot/][port-adapter/][port]`	Displays the Interfaces MIB ifIndex values registered on your system for all interfaces or the specified interface.[1]
`Router# show interface [interface-type] [slot/][port-adapter/][port]`	Displays system information for all interfaces or the specified interface, including the user-specified description (ifAlias).[1]

[1] The availability of the *slot* and *port-adapter* arguments depends on the hardware setup of your system.

Configuration Examples

This section provides the following configuration example:

- Configuring IfAlias Long Name Support Example

Configuring IfAlias Long Name Support Example

In the following example a long description is applied to ethernet interface in slot 1, port adapter 0, and port 0:

```
Router# configure terminal
Router(config)# interface Ethernet1/0/0
Router(config-if)# description ethernet1/0/0 this is a test of a description that exceeds
64 characters in length
Router(config-if)# ip address 192.168.134.55 255.255.255.0
Router(config-if)# no ip directed-broadcast
Router(config-if)# no ip route-cache distributed
```

Assuming that ifAlias long name support is not yet enabled (the default), the following example shows the results of a mibwalk operation from an NMS:

```
***** SNMP QUERY STARTED *****
 .
 .
 .
 ifXEntry.18.10 (octets) (zero-length)
 ifXEntry.18.11 (octets) ethernet1/0/0 this is a test of a description that exceeds 64 ch
 ifXEntry.18.12 (octets) (zero-length)
 .
 .
 .
```

The following output shows the description that is displayed at the CLI:

```
Router# show interface Ethernet0/0/0

Ethernet1/0/0 is administratively down, line protocol is down
  Hardware is Lance, address is 0010.7b4d.7046 (bia 0010.7b4d.7046)
  Description: ethernet1/0/0 this is a test of a description that exceeds 64 chh
  MTU 1500 bytes, BW 10000 Kbit, DLY 1000 usec,
     reliability 252/255, txload 1/255, rxload 1/255
 .
 .
 .
```

In the following example, ifAlias long name support is enabled, and the description is displayed again:

```
Router(config)# snmp ifmib ifalias long
Router(config)# interface Ethernet1/0/0
Router(config-if)# description ethernet1/0/0 this is a test of a description that exceeds
64 characters in length
Router(config)# end
Router# show interface Ethernet1/0/0

Ethernet1/0/0 is administratively down, line protocol is down
  Hardware is Lance, address is 0010.7b4d.7046 (bia 0010.7b4d.7046)
  Description: ethernet1/0/0 this is a test of a description that exceeds 64 characters in
length
  MTU 1500 bytes, BW 10000 Kbit, DLY 1000 usec,
     reliability 252/255, txload 1/255, rxload 1/255
 .
 .
 .
***** SNMP QUERY STARTED *****
 .
 .
 .
 ifXEntry.18.10 (octets) (zero-length)
 ifXEntry.18.11 (octets) ethernet1/0/0 this is a test of a description that exceeds 64
characters in length
 ifXEntry.18.12 (octets) (zero-length)
 .
 .
 .
```

Command Reference

The following new commands are pertinent to this feature. To see the command pages for these commands and other commands used with this feature, go to the *Cisco IOS Master Commands List*, Release 12.4, at http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124mindx/124index.htm.

New Commands

- **snmp ifmib ifalias long**
- **snmp mib persist circuit**
- **show snmp mib**
- **show snmp mib ifmib ifindex**

Glossary

ifAlias — SNMP Interface Alias. The ifAlias is an object in the Interfaces MIB (IF-MIB). The ifAlias is an 'alias' name for the interface as specified by a network manager that provides a non-volatile description for the interface. For a complete definition, see the IF-MIB.my file.

ifIndex — SNMP Interface Index. The ifIndex is an object in the Interfaces MIB (IF-MIB). The ifIndex is a unique integer assigned to every interface (including subinterfaces) on the managed system when the interface registers with the IF-MIB. For a complete definition, see the IF-MIB.my file.

OID — MIB object identifier. An object identifier is expressed as a series of integers or text strings. Technically, the numeric form is the *object name* and the text form is the *object descriptor*. In practice, both are called object identifiers, or OIDs. For example, the object name for the interfaces MIB is ‘1.3.6.1.2.1.2’, and the object descriptor is ‘iso.internet.mgmt.mib-2.interfaces’, but either can be referred to as the OID. OIDs can also be expressed as a combination of the two, such as ‘iso.internet.2.1.2’.

SNMP Support for VPNs

Feature History

Feature History	
Release	**Modification**
12.2(2)T	This feature was introduced.
12.0(23)S	This feature was integrated into Cisco IOS Release 12.0 S.

The document describes the SNMP Support for VPNs feature in Cisco IOS Release 12.2(2)T. It includes the following sections:

- Feature Overview, page 235
- Benefits, page 236
- Supported Platforms, page 236
- Supported Standards, MIBs, and RFCs, page 237
- Configuration Tasks, page 237
- Configuration Examples, page 238
- Command Reference, page 238

Feature Overview

The SNMP Support for VPNs feature allows the sending and receiving of SNMP notifications (traps and informs) using VPN routing/forwarding (VRFs) tables. In particular, this feature adds support to Cisco IOS software for the sending and receiving of SNMP notifications (traps and informs) specific to individual Virtual Private Networks (VPNs).

The Simple Network Management Protocol (SNMP) is an application-layer protocol that provides a message format for communication between SNMP managers and agents.

A Virtual Private Network (VPN) is a network that provides high connectivity transfers on a shared system with the same usage guidelines as a private network. A VPN can be built on the Internet over IP, Frame Relay, or ATM networks.

A VRF stores per-VPN routing data. It defines the VPN membership of a customer site attached to the network access server (NAS). A VRF consists of an IP routing table, a derived Cisco Express Forwarding (CEF) table, and guidelines and routing protocol parameters that control the information that is included in the routing table.

The SNMP Support for VPNs feature provides configuration commands that allow users to associate SNMP agents and managers with specific VRFs. The specified VRF is used for the sending of SNMP notifications (traps and informs) and responses between agents and managers. If a VRF is not specified, the default routing table for the VPN is used.

Benefits

This feature allows users to configure an SNMP agent to only accept SNMP requests from a certain set of VPNs. With this configuration, providers can provide network management services to their customers, so customers can manage all user VPN devices.

Related Documents

For details on configuring SNMP, refer to the following documents:

- *Cisco IOS Configuration Fundamentals Configuration Guide*, Release 12.2
- *Cisco IOS Configuration Fundamentals Command Reference,* Release 12.2

For information about configuring a VRF table, refer to the "Configuring Multiprotocol Label Switching" chapter of the *Cisco IOS Switching Services Configuration Guide,* Release 12.2.

Supported Platforms

This feature is supported in images for the following platforms:

- Cisco 800 series
- Cisco 1000 series
- Cisco 1400 series
- Cisco 1600 series
- Cisco 1700 series
- Cisco 2600 series
- Cisco 2900 series
- Cisco 3620 routers
- Cisco 3640 routers
- Cisco 3660 routers
- Cisco 3800 series
- Cisco 4000 series
- Cisco 7100 series
- Cisco 7200 series
- Cisco AS5300
- Cisco AS5800
- Cisco AS5350
- Cisco LightStream1010 ATM switch

- Cisco RPM Images
- Cisco VG200
- Cisco 8510 switch
- Cisco 8540 switch
- Cisco 15104 ONS (regen images)

Supported Standards, MIBs, and RFCs

Standards

No new or modified standards are supported by this feature.

MIBs

No new or modified MIBs are supported by this feature.

To obtain lists of supported MIBs by platform and Cisco IOS release, and to download MIB modules, go to the Cisco MIB website on Cisco.com at the following URL:

http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml

RFCs

No new or modified RFCs are supported by this feature.

Configuration Tasks

See the following sections for configuration tasks for the SNMP Support over VPNs feature. Each task in the list is identified as either required or optional:

- Configuring SNMP Support for a VPN (required)
- Verifying SNMP Support for VPNs (optional)

Configuring SNMP Support for a VPN

To configure SNMP over a specific VPN, use the following command in global configuration mode:

Command	Purpose
Router(config)# **snmp-server host** *host-address* [**traps** | **informs**][**version** {**1** | **2c** | **3** [**auth** | **noauth** |**priv**]}] *community-string* [**udp-port** *port*][*notification-type*][**vrf** *vrf-name*]	Specifies the recipient of an SNMP notification operation and specifies the VRF table to be used for the sending of SNMP notificiations.

To configure SNMP over a specific VPN for a remote SNMP user, use the following command in global configuration mode:

Command	Purpose
`Router(config)# snmp-server engineID remote ip-address [udp-port udp-port-number][vrf vrf-name] engineid-string`	Configures a name for the remote SNMP engine on a router.

Verifying SNMP Support for VPNs

To verify that the SNMP Support over VPNs feature is configured properly, use the **show snmp-server host** EXEC command.

Configuration Examples

This section provides the following configuration example:

- Configuring SNMP Support over VPNs Example

Configuring SNMP Support over VPNs Example

The following example sends all SNMP notifications to xyz.com over the VRF named “trap-vrf”:

```
Router(config)# snmp-server host xyz.com vrf trap-vrf
```

The following example configures the VRF named “traps-vrf” for the remote server 172.16.20.3:

```
Router(config)# snmp-server engineID remote 172.16.20.3 vrf traps-vrf
80000009030000B064EFE100
```

Command Reference

The following modified commands are pertinent to this feature. To see the command pages for these commands and other commands used with this feature, go to the *Cisco IOS Master Commands List*, Release 12.4, at http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124mindx/124index.htm.

- **snmp-server engineID remote**
- **snmp-server host**
- **snmp-server user**

Distributed Management Event and Expression MIB Persistence

Feature History

Release	Modification
12.0(5)T	Expression MIB Support was introduced.
12.1(3)T, 12.0(12)S	Event MIB Support was introduced.
12.2(4)T	Expression MIB Persistence is introduced. Event MIB Persistence is introduced. Event MIB is made compliant with RFC 2981.
12.2(4)T3	Support was added for the Cisco 7500 series.

This document describes the Distributed Management Event and Expression MIB Persistence features in Cisco IOS Release 12.2(4)T3. It includes the following sections:

- Feature Overview, page 239
- Supported Platforms, page 240
- Supported Standards, MIBs, and RFCs, page 241
- Prerequisites, page 242
- Configuration Tasks, page 242
- Configuration Examples, page 243
- Command Reference, page 244

Feature Overview

The MIB Persistence features allow the SNMP data of a MIB to be persistent across reloads; that is, MIB information retains the same set object values each time a networking device reboots. MIB Persistence is enabled by using the **snmp mib persist** command, and the MIB data of all MIBs that have had persistence enabled using this command is then written to NVRAM storage by using the **write mib-data** command. Any modified MIB data must be written to NVRAM memory using the **write mib-data** command.

Both Event and Expression MIBs allow you to configure a value for an object and to set up object definitions. Both also allow rows of data to be modified while the row is in an active state.

Scalar objects are stored every time they are changed, and table entries are stored only if the row is in an active state. Event MIB has two scalar objects and nine tables to be persisted into NVRAM. The tables are mteTriggerTable, mteTriggerDeltaTable, mteTriggerExistenceTable, mteTriggerBooleanTable, mteTriggerThresholdTable, mteObjectsTable, mteEventTable, mteEventNotificationTable, and mteEventSetTable.

Expression MIB has two scalar objects and three tables to be stored in NVRAM. The scalars are expResourceDeltaMinimum and expResourceDeltaWildcardInstanceMaximum. The tables are expNameTable, expExpressionTable, and expObjectTable.

It may take several seconds for the MIB data to be written to NVRAM. The length of time taken depends on the amount of MIB data.

Benefits

Event MIB Persistence and Expression MIB Persistence both allow MIB objects to be saved from reboot to reboot, which allows long-term monitoring of specific devices and interfaces. You can configure object values that are preserved across reboots.

Restrictions

If the number of MIB objects to persist increases, NVRAM storage capacity may be strained. Occasionally, the time taken to write MIB data to NVRAM may be longer than expected.

Related Features and Technologies

- Event MIB
- Expression MIB
- SNMP
- Network management

Related Documents

For detailed information about configuring SNMP, see the following documents:

- The “Configuring SNMP Support” chapter of *Cisco IOS Configuration Fundamentals Configuration Guide,* Release 12.2
- The “SNMP Commands” chapter of *Cisco IOS Configuration Fundamentals Command Reference,* Release 12.2

Supported Platforms

The Distributed Management Event MIB Persistence feature is supported on the Cisco 7200 series platform.

The Distributed Management Expression MIB Persistence feature is supported on the following platforms:

- Cisco 2500 series
- Cisco 3620 series
- Cisco 3640 series
- Cisco 3660 series
- Cisco 7200 series
- Cisco 7500 series (supported in Release 12.2(4)T3 and above)

Platform Support Through Feature Navigator

Cisco IOS software is packaged in feature sets that support specific platforms. To get updated information regarding platform support for these features, access Feature Navigator. Feature Navigator dynamically updates the list of supported platforms as new platform support is added for these features.

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Feature Navigator is updated when major Cisco IOS software releases and technology releases occur. As of May 2001, Feature Navigator supports M, T, E, S, and ST releases. You can access Feature Navigator at the following URL:

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

Supported Standards, MIBs, and RFCs

Standards

No new or modified standards are supported by these features.

MIBs

Two MIBs are supported by these features:

- Expression MIB
- Event MIB (EVENT-MIB.my)

  Prior to this release, Event MIB support in Cisco IOS software was based on the IETF internet draft version. In Cisco IOS Release 12.2(4)T3, the Cisco implementation of the EVENT-MIB has been modified to comply with the finalized version of the Event MIB, as defined in RFC 2981. For details, see RFC 2981, available through the IETF web site at http://www.ietf.org.

To obtain lists of supported MIBs by platform and Cisco IOS release, and to download MIB modules, go to the Cisco MIB website on Cisco.com at the following URL:

http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml

Note that these features do not change any existing MIBs or add any new MIBs.

RFCs

- Event MIB: RFC 2981, “Event MIB”

- Expression MIB: RFC 2982, “Distributed Management Expression MIB”

Prerequisites

The configuration tasks described in the next section assume that you have configured SNMP on your networking device and that values for Event MIB and Expression MIB have been configured by you or your application.

Configuration Tasks

See the following sections for configuration tasks for the Distributed Management Event and Expression MIB Persistence features. Each task in the list is identified as either required or optional.

- Configuring Event MIB Persistence (optional)
- Configuring Expression MIB Persistence (optional)

Configuring Event MIB Persistence

Event MIB Persistence is disabled by default. To enable Event MIB Persistence, use the following commands:

	Command	Purpose
Step 1	`Router(config)# snmp mib persist event`	Enables MIB Persistence for Event MIB.
Step 2	`Router# write mib-data`	Saves Event MIB Persistence configuration data to NVRAM.
Step 3	`Router# copy running-config startup-config`	Copies the running configuration to the startup configuration.

To disable Event MIB Persistence after enabling it, use the following commands:

	Command	Purpose
Step 1	`Router(config)# no snmp mib persist event`	Disables MIB Persistence for Event MIB.
Step 2	`Router# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Configuring Expression MIB Persistence

Expression MIB Persistence is disabled by default. To enable Event MIB Persistence, use the following commands:

	Command	Purpose
Step 1	`Router(config)# snmp mib persist expression`	Enables MIB Persistence for Expression MIB.
Step 2	`Router# write mib-data`	Saves Expression MIB Persistence configuration data to NVRAM.
Step 3	`Router# copy running-config startup-config`	Copies the running configuration to the startup configuration.

To disable Expression MIB Persistence after enabling it, use the following commands:

	Command	Purpose
Step 1	`Router(config)# no snmp mib persist expression`	Disables MIB Persistence for Expression MIB.
Step 2	`Router# write mib-data`	Saves Expression MIB Persistence configuration data to NVRAM.
Step 3	`Router# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Verifying Event and Expression MIB Persistence

To verify that Event MIB Persistence and Expression MIB Persistence configurations have been set, enter the **more system:running-config** command.

Configuration Examples

This section provides the following configuration examples:

- Enabling Event MIB Persistence Example
- Enabling Expression MIB Persistence Example

Enabling Event MIB Persistence Example

To enable Event MIB Persistence, use the **snmp mib persist event** command in global configuration mode:

```
Router(config)# snmp mib persist event
Router# write mib-data
```

Enabling Expression MIB Persistence Example

To enable Expression MIB Persistence, use the **snmp mib persist expression** command in global configuration mode:

```
Router(config)# snmp mib persist expression
Router# write mib-data
```

Command Reference

The following new commands are pertinent to this feature. To see the command pages for these commands and other commands used with this feature, go to the *Cisco IOS Master Commands List*, Release 12.4, at http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124mindx/124index.htm.

New Commands

- **snmp mib persist**
- **write mib-data**

SNMP Notification Logging

Feature History

Release	Modification
12.0(22)S	This feature was introduced.
12.2(13)T	This feature was integrated into Cisco IOS Release 12.2(13)T.

This document describes the SNMP Notification Logging feature in Cisco IOS Release 12.0(22)S. It includes the following sections:

Feature Overview

Systems that support Simple Network Management Protocol (SNMP) often need a mechanism for recording notification information as a hedge against lost notifications, whether those are traps or informs that exceed retransmission limits. The Notification Log MIB provides a common infrastructure for other MIBs in the form of a local logging function. The SNMP Notification Logging feature adds Cisco IOS command-line interface (CLI) commands to change the size of the notification log, to set the global ageout value for the log, and to display logging summaries at the command line.

Note This MIB only supports notification logging on the default log.

Benefits

- Improves notification tracking.
- Provides a central location for tracking all MIBs.

Related Documents

- *Cisco IOS Configuration Fundamentals Command Reference*, Release 12.2
- *Cisco IOS Configuration Fundamentals Configuration Guide*, Release 12.2

Supported Platforms

- Cisco 12000 series

Determining Platform Support Through Cisco Feature Navigator

Cisco IOS software is packaged in feature sets that are supported on specific platforms. To get updated information regarding platform support for this feature, access Cisco Feature Navigator. Cisco Feature Navigator dynamically updates the list of supported platforms as new platform support is added for the feature.

Cisco Feature Navigator is a web-based tool that enables you to quickly determine which Cisco IOS software images support a specific set of features and which features are supported in a specific Cisco IOS image. You can search by feature or release. Under the release section, you can compare releases side by side to display both the features unique to each software release and the features in common.

To access Feature Navigator, you must have an account on Cisco.com. If you have forgotten or lost your account information, send a blank e-mail to cco-locksmith@cisco.com. An automatic check will verify that your e-mail address is registered with Cisco.com. If the check is successful, account details with a new random password will be e-mailed to you. Qualified users can establish an account on Cisco.com by following the directions at http://www.cisco.com/register.

Cisco Feature Navigator is updated regularly when major Cisco IOS software releases and technology releases occur. For the most current information, go to the Cisco Feature Navigator home page at the following URL: http://www.cisco.com/go/fn.

Availability of Cisco IOS Software Images

Platform support for particular Cisco IOS software releases is dependent on the availability of the software images for those platforms. Software images for some platforms may be deferred, delayed, or changed without prior notice. For updated information about platform support and availability of software images for each Cisco IOS software release, refer to the online release notes or, if supported, Cisco Feature Navigator.

Supported Standards, MIBs, and RFCs

Standards

No now or modified standards are supported by this feature.

MIBs

No new or modified MIBs are supported by this feature.

To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL:

http://tools.cisco.com/ITDIT/MIBS/servlet/index

If Cisco MIB Locator does not support the MIB information that you need, you can also obtain a list of supported MIBs and download MIBs from the Cisco MIBs page at the following URL:

http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml

To access Cisco MIB Locator, you must have an account on Cisco.com. If you have forgotten or lost your account information, send a blank e-mail to cco-locksmith@cisco.com. An automatic check will verify that your e-mail address is registered with Cisco.com. If the check is successful, account details with a new random password will be e-mailed to you. Qualified users can establish an account on Cisco.com by following the directions found at this URL:

http://www.cisco.com/register

RFCs

- RFC3014, *Notification Log MIB*

Configuration Tasks

None

Configuration Examples

None

Command Reference

The following new commands are pertinent to this feature. To see the command pages for these commands and other commands used with this feature, go to the *Cisco IOS Master Commands List*, Release 12.4, at http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124mindx/124index.htm.

New Commands

- **show snmp notification-log mib**
- **snmp mib notification-log default**
- **snmp mib notification-log globalageout**
- **snmp mib notification-log globalsize**

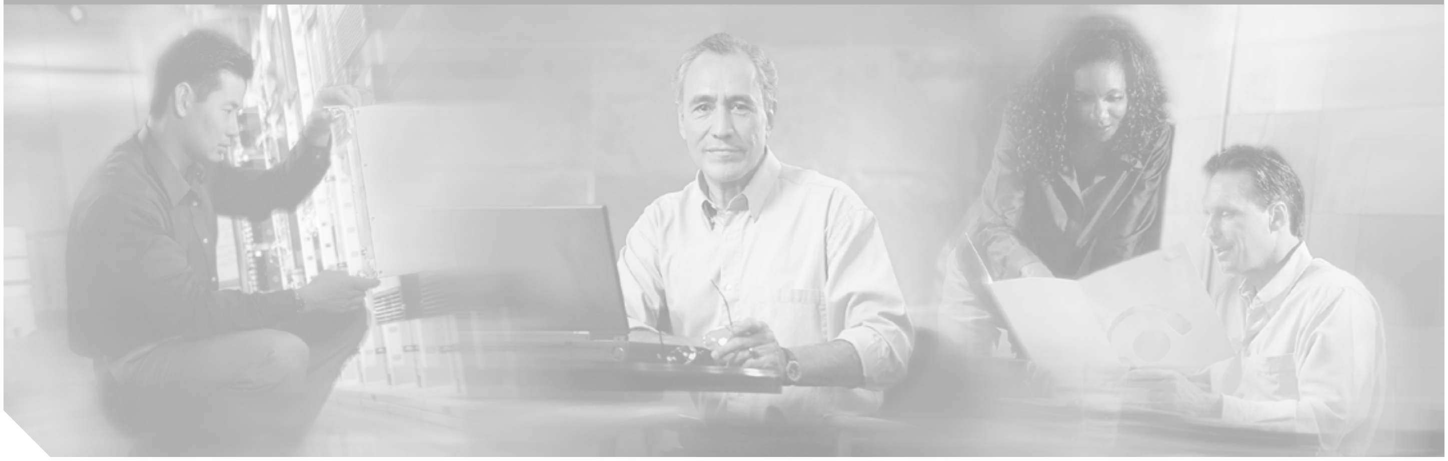
Glossary

SNMP—Simple Network Management Protocol. Network management protocol used almost exclusively in TCP/IP networks. SNMP provides a means to monitor and control network devices, and to manage configurations, statistics collection, performance, and security.

VACM—View-based access control mechanism for SNMP. This mechanism is described in RFC2575.

MIB—Management Information Base. The MIBs referred to in this document are MIB modules. These modules contain definitions of management information for use by SNMP network management systems.

Managed system—An SNMP agent.



Part 3: Configuring Cisco Discovery Protocol (CDP)

Configuring Cisco Discovery Protocol

This chapter describes how the Cisco Discovery Protocol (CDP) works with Simple Network Management Protocol (SNMP) to identify other devices in your network in Cisco IOS Release 12.2.

For further details on the commands mentioned in this chapter, refer to the *Cisco IOS Configuration Fundamentals Command Reference*.

Configuring the Cisco Discovery Protocol

CDP is primarily used to obtain protocol addresses of neighboring devices and discover the platform of those devices. CDP can also be used to display information about the interfaces your router uses. CDP is media- and protocol-independent, and runs on all Cisco-manufactured equipment including routers, bridges, access servers, and switches.

Use of SNMP with the CDP MIB allows network management applications to learn the device type and the SNMP agent address of neighboring devices, and to send SNMP queries to those devices. CDP uses the CISCO-CDP-MIB.

CDP runs on all media that support Subnetwork Access Protocol (SNAP), including LAN, Frame Relay, and ATM physical media. CDP runs over the data link layer only. Therefore, two systems that support different network-layer protocols can learn about each other.

Each device configured for CDP sends periodic messages, known as advertisements, to a multicast address. Each device advertises at least one address at which it can receive SNMP messages. The advertisements also contain time-to-live, or holdtime, information, which indicates the length of time a receiving device should hold CDP information before discarding it. Each device also listens to the periodic CDP messages sent by others in order to learn about neighboring devices and determine when their interfaces to the media go up or down.

CDP Version-2 (CDPv2) is the most recent release of the protocol and provides more intelligent device tracking features. These features include a reporting mechanism that allows for more rapid error tracking, thereby reducing costly downtime. Reported error messages can be sent to the console or to a logging server, and cover instances of unmatching native VLAN IDs (IEEE 802.1Q) on connecting ports, and unmatching port duplex states between connecting devices. Refer tothe *Cisco IOS Software System Error Messages* document for detailed examples of CDP error messages.

CDPv2 **show** commands can provide detailed output on VLAN Trunking Protocol (VTP) management domain and duplex modes of neighbor devices, CDP-related counters, and VLAN IDs of connecting ports.

VTP is a discovery technique deployed by switches where each switch advertises its management domain on its trunk ports, its configuration revision number, and its known VLANs and their specific parameters. A VTP domain is made up of one or more interconnected devices that share the same VTP domain name. A switch can be configured to be in only one VTP domain.

Type-Length-Value fields (TLVs) are blocks of information embedded in CDP advertisements. Table 19 summarizes the TLV definitions for CDP advertisements.

Table 13 Type-Length-Value Definitions for CDPv2

TLV	Definition
Device-ID TLV	Identifies the device name in the form of a character string.
Address TLV	Contains a list of network addresses of both receiving and sending devices.
Port-ID TLV	Identifies the port on which the CDP packet is sent.
Capabilities TLV	Describes the functional capability for the device in the form of a device type, for example, a switch.
Version TLV	Contains information about the software release version on which the device is running.
Platform TLV	Describes the hardware platform name of the device, for example, Cisco 4500.
IP Network Prefix TLV	Contains a list of network prefixes to which the sending device can forward IP packets. This information is in the form of the interface protocol and port number, for example, Eth 1/0.
VTP Management Domain TLV	Advertises the system's configured VTP management domain name-string. Used by network operators to verify VTP domain configuration in adjacent network nodes.
Native VLAN TLV	Indicates, per interface, the assumed VLAN for untagged packets on the interface. CDP learns the native VLAN for an interface. This feature is implemented only for interfaces that support the IEEE 802.1Q protocol.
Full/Half Duplex TLV	Indicates status (duplex configuration) of CDP broadcast interface. Used by network operators to diagnose connectivity problems between adjacent network elements.

CDP Configuration Task List

To configure CDP, perform any of the optional tasks in the following sections:

- Setting the CDP Transmission Timer and Hold Time
- Reenabling CDP on a Local Router
- Reenabling CDP Version-2 Advertisements
- Reenabling CDP on an Interface
- Monitoring and Maintaining CDP

The the end of this chapter for "CDP Configuration Examples."

Note The **cdp enable**, **cdp timer**, and **cdp run** global configuration commands affect the operation of the IP on-demand routing feature (that is, the **router odr** global configuration command). For more information on the **router odr** command, see the "On-Demand Routing Commands" chapter in the Release 12.2 *Cisco IOS IP Command Reference, Volume 2 of 3: Routing Protocols* document.

Setting the CDP Transmission Timer and Hold Time

To set the frequency of CDP transmissions and the hold time for CDP packets, use the following commands in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# cdp timer seconds`	Specifies frequency of transmission of CDP updates.
Step 2	`Router(config)# cdp holdtime seconds`	Specifies the amount of time a receiving device should hold the information sent by your device before discarding it.

Reenabling CDP on a Local Router

CDP is enabled on Cisco devices by default. If you prefer not to use the CDP device discovery capability, you can disable it with the **no cdp run** command.

To reenable CDP after disabling it, use the following command in global configuration mode:

Command	Purpose
`Router(config)# cdp run`	Enables CDP on the system.

Reenabling CDP Version-2 Advertisements

The broadcasting of CDPv2 advertisements is enabled on Cisco routers by default. You can disable CDPv2 advertisements with the **no cdp advertise-v2** command.

To reenable CDPv2 advertisements, use the following command in global configuration mode:

Command	Purpose
`Router(config)# cdp advertise-v2`	Enables CDPv2 advertising functionality on the system.

Reenabling CDP on an Interface

CDP is enabled by default on all supported interfaces (except for Frame Relay multipoint subinterfaces) to send and receive CDP information. However, some interfaces, such as ATM interfaces, do not support CDP.

You can disable CDP on an interface that supports CDP by using the **no cdp enable** command.

To reenable CDP on an interface after disabling it, use any of the following command in interface configuration mode, as needed:

Command	Purpose
`Router(config-if)# cdp enable`	Enables CDP on an interface.

Monitoring and Maintaining CDP

To monitor and maintain CDP on your device, use one or more of the following commands in privileged EXEC mode:

Command	Purpose
`Router# clear cdp counters`	Resets the traffic counters to zero.
`Router# clear cdp table`	Deletes the CDP table of information about neighbors.
`Router# show cdp`	Displays the interval between transmissions of CDP advertisements, the number of seconds the CDP advertisement is valid for a given port, and the version of the advertisement.
`Router# show cdp entry device-name [protocol | version]`	Displays information about a specific neighbor. Display can be limited to protocol or version information.
`Router# show cdp interface [type number]`	Displays information about interfaces on which CDP is enabled.
`Router# show cdp neighbors [type number] [detail]`	Displays the type of device that has been discovered, the name of the device, the number and type of the local interface (port), the number of seconds the CDP advertisement is valid for the port, the device type, the device product number, and the port ID. Issuing the **detail** keyword displays information on the native VLAN ID, the duplex mode, and the VTP domain name associated with neighbor devices.
`Router# show cdp traffic`	Displays CDP counters, including the number of packets sent and received and checksum errors.
`Router# show debugging`	Displays information about the types of debugging that are enabled for your router. Refer to the *Cisco IOS Debug Command Reference* for more information about CDP **debug** commands.

CDP Configuration Examples

The following sections provide CDP configuration examples:

- Example: Setting the CDP Transmission Timer and Hold Time
-

Example: Setting the CDP Transmission Timer and Hold Time

In the following example, the user sets the cdp timer to send updates every 30 seconds to neighboring routers and sets the router to show that the updates are working correctly:

```
Router(config)# cdp timer 30
Router(config)# exit
Router# show cdp interface
Serial0 is up, line protocol is up
Encapsulation is HDLC
Sending CDP packets every 30 seconds
Holdtime is 180 seconds
```

In the following example, the user sets the holdtime to be 90 seconds and sets the router to show that the updates are working correctly:

```
Router(config)# cdp holdtime 90
Router(config)# exit
Router# show cdp interface
Serial0 is up, line protocol is up
Encapsulation is HDLC
Sending CDP packets every 30 seconds
Holdtime is 90 seconds
```

Example: Monitoring and Maintaining CDP

The following example shows a typical series of steps for viewing information about CDP neighbors.

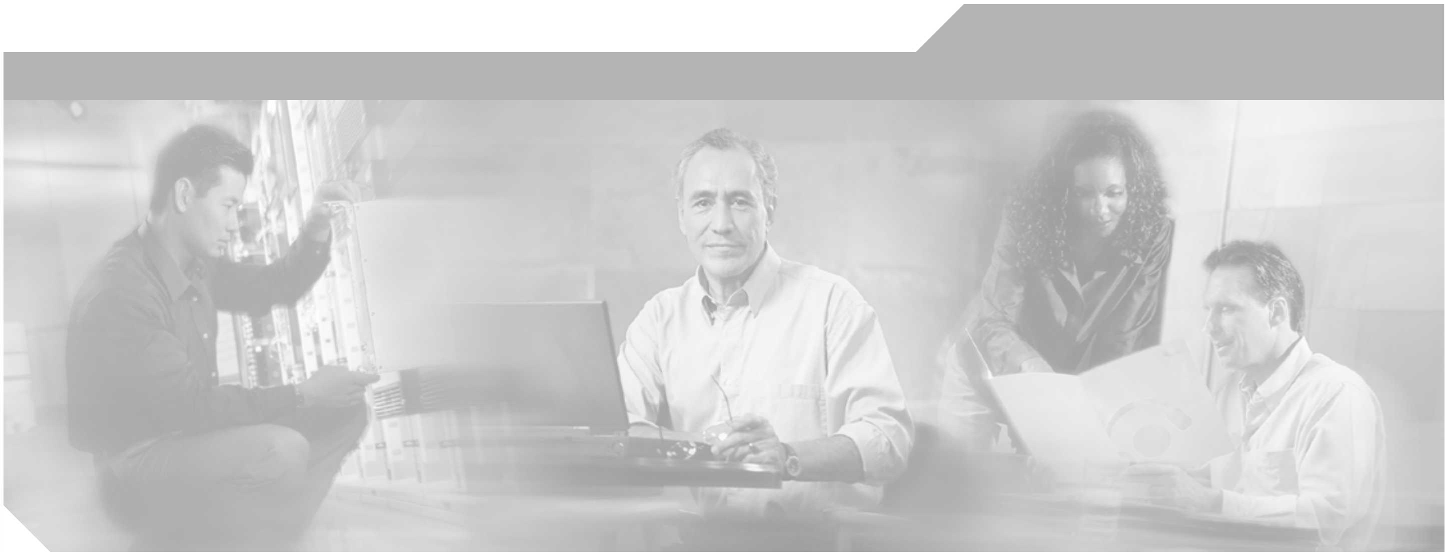
Table 20 describes the significant fields shown in the output of the **show cdp neighbors** command.

```
C3660-2> show cdp
Global CDP information:
        Sending CDP packets every 60 seconds
        Sending a holdtime value of 180 seconds
        Sending CDPv2 advertisements is  enabled

C3660-2> show cdp neighbors
Capability Codes: R - Router, T - Trans Bridge, B - Source Route Bridge
                  S - Switch, H - Host, I - IGMP, r - Repeater

Device ID        Local Intrfce     Holdtme    Capability  Platform  Port ID
C2950-1          Fas 0/0            148         S I       WS-C2950T-Fas 0/15
RX-SWV.cisco.com Fas 0/1            167         T S       WS-C3524-XFas 0/13

C3660-2> show cdp neighbors detail
-------------------------
Device ID: C2950-1
Entry address(es):
Platform: Cisco WS-C2950T-24,  Capabilities: Switch IGMP
Interface: FastEthernet0/0,  Port ID (outgoing port): FastEthernet0/15
Holdtime : 139 sec

Version :
Cisco IOS C2950 Software (C2950-I6Q4L2-M), Version 12.1(9)EA1, RELEASE SOFTWARE
 .
 .
 .
C3660-2> show cdp traffic
CDP counters :
        Total packets output: 81684, Input: 81790
        Hdr syntax: 0, Chksum error: 0, Encaps failed: 0
        No memory: 0, Invalid packet: 0, Fragmented: 0
        CDP version 1 advertisements output: 0, Input: 0
        CDP version 2 advertisements output: 81684, Input: 81790
C3660-2>
```

Table 20 describes the significant fields shown in the output of the show cdp neighbors command.

Table 14 show cdp neighbors Field Descriptions

Field	Definition
Device ID	The name of the neighbor device and either the MAC address or the serial number of this device.
Local Intrfce	The protocol being used by the connectivity media.
Holdtme	The remaining amount of time (in seconds) the current device will hold the CDP advertisement from a sending router before discarding it.
Capability (Capability Codes)	Capability (type of routing device) of the listed neighboring device. The capability types that can be discovered are: R—Router T—Transparent bridge B—Source-routing bridge S—Switch H—Host I— device is using IGMP r—Repeater
Platform	The product number of the device.
Port ID	The protocol and port number of the device.



Part 4: Configuring RMON Support

Configuring RMON Support

This chapter describes the Remote Monitoring (RMON) MIB agent specification, and how it can be used in conjunction with Simple Network Management Protocol (SNMP) to monitor traffic using alarms and events.

For a complete description of the RMON commands mentioned in this chapter, refer to the "RMON Commands" chapter in the "System Management" part of the Release 12.2 *Cisco IOS Configuration Fundamentals Command Reference*. To locate documentation of other commands that appear in this chapter, use the command reference master index or search online.

Configuring RMON Support

The RMON option identifies activity on individual nodes and allows you to monitor all nodes and their interaction on a LAN segment. Used in conjunction with the SNMP agent in a router, RMON allows you to view both traffic that flows through the router and segment traffic not necessarily destined for the router. Combining RMON alarms and events (classes of messages that indicate traffic violations and various unusual occurrences over a network) with existing MIBs allows you to choose where proactive monitoring will occur.

Note Full RMON packet analysis (as described in RFC 1757) is supported only on an Ethernet interface of Cisco 2500 series routers and Cisco AS5200 series universal access servers. RMON requires that SNMP be configured (you must be running a version of SNMP on the server that contains the RMON MIB). A generic RMON console application is recommended in order to take advantage of the RMON network management capabilities. This feature supports RFCs 1757 and 2021.

RMON can be very data- and processor-intensive. Users should measure usage effects to ensure that router performance is not degraded by RMON and to minimize excessive management traffic overhead. Native mode in RMON is less intensive than promiscuous mode.

All Cisco IOS software images ordered without the explicit RMON option include limited RMON support (RMON alarms and event groups only). Images ordered with the RMON option include support for all nine management groups (statistics, history, alarms, hosts, hostTopN, matrix, filter, capture, and event). As a security precaution, support for the capture group allows capture of packet header information only; data payloads are not captured.

In Cisco IOS 12.1, the RMON agent was rewritten to improve performance and add some new features. Table 15 highlights some of the improvements implemented.

Table 15 RMON MIB Updates

Prior to the RMON MIB Update in Cisco IOS Release 12.1	New functionality in Cisco IOS Release 12.1
RMON configurations do not persist across reboots. Information is lost after a new session on the RMON server.	RMON configurations persist across reboots. Information is preserved after a new session on the RMON server.
Packet analysis applies only on the MAC header of the packet.	Complete packet capture is performed with analysis applied to all frames in packet.
Only RMON I MIB objects are used for network monitoring.	RMON I and selected RMON II objects are used for network monitoring.

RMON MIB features include the following:

- usrHistory group. This MIB group is similar to the RMON etherHistory group except that the group enables the user to specify the MIB objects that are collected at each interval.
- partial probeConfig group. This MIB group is a subset of the probeConfig group implemented in read-only mode. These objects implement the simple scalars from this group. Table 16 details new partial probeConfig group objects.

Table 16 partial probeConfig Group Objects

Object	Description
probeCapabilities	The RMON software groups implemented.
probeSoftwareRev	The current version of Cisco IOS running on the device.
probeHardwareRev	The current version of the Cisco device.
probeDateTime	The current date and time.
probeResetControl	Initiates a reset.
probeDownloadFile	The source of the image running on the device.
probeDownloadTFTPServer	The address of the server that contains the Trivial File Transfer Protocol (TFTP) file that is used by the device to download new versions of Cisco IOS software.
probeDownloadAction	Specifies the action of the commands that cause the device to reboot.
probeDownloadStatus	The state of a reboot.
netDefaultGateway	The router mapped to the device as the default gateway.
hcRMONCapabilities	Specifies the features mapped to this version of RMON.

Configuring RMON Alarm and Event Notifications

To enable RMON on an Ethernet interface, use the following command in interface configuration mode:

Command	Purpose
`Router(config-if)#` **`rmon`** `{`**`native`** `|` **`promiscuous`**`}`	Enables RMON.

In native mode, RMON monitors only the packets normally received by the interface. In promiscuous mode, RMON monitors all packets on the LAN segment.

The default size of the queue that holds packets for analysis by the RMON process is 64 packets. To change the size of the queue, use the following command in global configuration mode:

Command	Purpose
`Router(config)#` **`rmon queuesize`** *`size`*	Changes the size of the RMON queue.

To set an RMON alarm or event, us the following commands in global configuration mode, as needed:

Command	Purpose
`Router(config)#` **`rmon alarm`** *`number variable interval`* `{`**`delta`** `|` **`absolute`**`}` **`rising-threshold`** *`value`* `[`*`event-number`*`]` **`falling-threshold`** *`value`* `[`*`event-number`*`] [`**`owner`** *`string`*`]`	Sets an alarm on a MIB object.
`Router(config)#` **`rmon event`** *`number`* `[`**`log`**`] [`**`trap`** *`community`*`] [`**`description`** *`string`*`] [`**`owner`** *`string`*`]`	Adds or removes an event in the RMON event table.

You can set an alarm on any MIB object in the access server. To disable an alarm, you must enable the **no** form of this command on each alarm you configure. You cannot disable all the alarms you configure at once. Refer to RFC 1757 to learn more about alarms and events and how they interact with each other.

The RMON MIB defines two traps, the risingAlarm and fallingAlarm traps generated when an RMON alarmEntry risingThreshold or fallingThreshold event occurs. Thresholds allow you to minimize the number of notifications sent on the network. Alarms are triggered when a problem exceeds a set rising threshold value. No more alarm notifications are sent until the agent recovers, as defined by the falling threshold value. This means that notifications are not sent each time a minor failure or recovery occurs.

Configuring RMON Groups

RMON tables can be created for buffer capture, filter, hosts, and matrix information. The buffer capture table details a list of packets captured off a channel or a logical data or events stream. The filter table details a list of packet filter entries that screen packets for specified conditions as they travel between interfaces. The hosts table details a list of host entries. The matrix table details a list of traffic matrix entries indexed by source and destination MAC addresses.

To gather RMON statistics for these data types, use the following commands in interface configuration mode, as needed:

Command	Purpose
`Router(config-if)#` **`rmon collection history`** {**`controlEntry`** *`integer`*} [**`owner`** *`ownername`*] [**`buckets`** *`bucket-number`*] [**`interval`** *`seconds`*]	Enables an RMON history group of statistics on an interface.
`Router(config-if)#` **`rmon collection host`** {**`controlEntry`** *`integer`*} [**`owner`** *`ownername`*]	Enables an RMON host collection group of statistics on an interface.
`Router(config-if)#` **`rmon collection matrix`** {**`controlEntry`** *`integer`*} [**`owner`** *`ownername`*]	Enables an RMON matrix group of statistics on an interface.
`Router(config-if)#` **`rmon collection rmon1`** {**`controlEntry`** *`integer`*} [**`owner`** *`ownername`*]	Enables all possible autoconfigurable RMON statistic collections on an interface.

To specifically monitor these commands, use the **show rmon capture**, **show rmon filter**, **show rmon hosts**, and **show rmon matrix** EXEC commands listed in the following table.

Monitoring and Verifying RMON Configuration

To display the current RMON status, use one or more of the following commands in EXEC mode:

Command	Function

`Router>` **`show rmon`**
or
`Router>` **`show rmon task`**
	Displays general RMON statistics.

`Router>` **`show rmon alarms`**	Displays the RMON alarm table.
`Router>` **`show rmon capture`**	Displays the RMON buffer capture table and current configuration. Available only on Cisco 2500 series routers and Cisco AS5200 access servers.
`Router>` **`show rmon events`**	Displays the RMON event table.
`Router>` **`show rmon filter`**	Displays the RMON filter table. Available only on Cisco 2500 series routers and Cisco AS5200 access servers.
`Router>` **`show rmon history`**	Displays the RMON history table. Available only on Cisco 2500 series routers and Cisco AS5200 access servers.
`Router>` **`show rmon hosts`**	Displays the RMON hosts table. Available only on Cisco 2500 series routers and Cisco AS5200 access serverss.
`Router>` **`show rmon matrix`**	Display the RMON matrix table and values associated with RMON variables. Available only on Cisco 2500 series routers and Cisco AS5200 access servers.
`Router>` **`show rmon statistics`**	Display the RMON statistics table. Available only on Cisco 2500 series routers and Cisco AS5200 access servers.
`Router>` **`show rmon topn`**	Display the RMON top-n hosts table. Available only on Cisco 2500 series routers and Cisco AS5200 access servers.

RMON Configuration Examples

This section provides the following examples:

- Alarm and Event Example
- show rmon Command Example

Alarm and Event Example

The following example enables the **rmon event** global configuration command:

```
Router(config)# rmon event 1 log trap eventtrap description “High ifOutErrors” owner
owner_a
```

This example creates RMON event number 1, which is defined as “High ifOutErrors”, and generates a log entry when the event is triggered by an alarm. The user “owner_a” owns the row that is created in the event table by this command. This example also generates an SNMP trap when the event is triggered.

The following example configures an RMON alarm using the **rmon alarm** global configuration command:

```
Router(config)# rmon alarm 10 ifEntry.20.1 20 delta rising-threshold 15 1
falling-threshold 0 owner owner_a
```

This example configures RMON alarm number 10. The alarm monitors the MIB variable ifEntry.20.1 once every 20 seconds until the alarm is disabled, and checks the change in the rise or fall of the variable. If the ifEntry.20.1 value shows a MIB counter increase of 15 or more, such as from 100000 to 100015, the alarm is triggered. The alarm in turn triggers event number 1, which is configured with the **rmon event** command. Possible events include a log entry or an SNMP trap. If the ifEntry.20.1 value changes by 0, the alarm is reset and can be triggered again.

show rmon Command Example

To display the RMON buffer capture table and current configuration, enter the **show rmon capture** EXEC command (Cisco 2500 series routers and Cisco AS5200 access servers only). A sample configuration follows:

```
Router# show rmon capture

Buffer 1 is active, owned by John Smith
Captured data is from channel 1
Slice size is 128, download size is 128
Download offset is 0
Full Status is full, full action is wrapWhenFull
Granted -1 octets out of -1 requested
Buffer has been on since 18:59:48, and has captured 522 packets
Current capture buffer entries:
Packet 3271 was captured 2018256 ms since buffer was turned on
Its length is 184 octets and has a status type of 0
Packet ID is 3721, and contains the following data:
03 00 00 00 00 0100 A0CC 3C9D DF00 A6F0 03
Packet 3722 was captured 2018452 ms since buffer was turned on
Its length is 64 octets and has a status type of 0
Packet ID is 3722, and contains the following data:
01 80C2 0000 0000 6009 FDFE D300 2642 03
```

To view values associated with RMON variables, enter the **show rmon matrix** EXEC command (Cisco 2500 series routers and Cisco AS5200 access servers only). The following is a sample output:

```
Router# show rmon matrix

Matrix 1 is active and owned by
Monitors ifEntry.1.1
Table size is 42, last time an entry was deleted was at 11:18:09
Source addr is 0000.0c47.007b, dest addr is ffff.ffff.ffff
Transmitted 2 pkts, 128 octets, 0 errors
Source addr is 0000.92a8.319e, dest addr is 0060.5c86.5b82
Transmitted 2 pkts, 384 octets, 1 error
```

For an explanation of the fields in the examples, refer to the respective command descriptions in the “RMON Commands” chapter of the Release 12.2 *Cisco IOS Configuration Fundamentals Command Reference*.

Network Analysis Module (NM-NAM)

The Network Analysis Module (NM-NAM) feature is a network module that monitors and analyzes network traffic for a system using extended Remote Monitoring (RMON) standards, RMON2, and other Management Information Bases (MIBs).

Note The Network Analysis Module (NAM) is available in multiple hardware forms for some Cisco routers and Catalyst switches. This document applies only to the NAM for branch routers, also known as modular access, multiservice, or integrated services routers.

NAM provides Layer 2 to Layer 7 visibility into network traffic for remote troubleshooting, real-time traffic analysis, application performance monitoring, capacity planning, and managing network-based services, including quality of service (QoS) and Voice over IP (VoIP). The NAM Traffic Analyzer is software that is embedded in the NM-NAM that gives you browser-based access to the RMON1, RMON2, DSMON, and voice monitoring features of the NAM.

Feature History for NM-NAM

Release	Modification
12.3(4)XD	This feature was introduced on the following platforms: Cisco 2600XM series, Cisco 2691, Cisco 3660, Cisco 3725, and Cisco 3745.
12.3(7)T	This feature was integrated into Cisco IOS Release 12.3(7)T.
12.3(8)T4	This feature was implemented on the following platforms: Cisco 2811, Cisco 2821, and Cisco 2851.
12.3(11)T	This feature was implemented on the Cisco 3800 series.

Finding Support Information for Platforms and Cisco IOS Software Images

Use Cisco Feature Navigator to find information about platform support and Cisco IOS software image support. Access Cisco Feature Navigator at http://www.cisco.com/go/fn. You must have an account on Cisco.com. If you do not have an account or have forgotten your username or password, click **Cancel** at the login dialog box and follow the instructions that appear.

Contents

Prerequisites for the Network Analysis Module (NM-NAM)

- Install Cisco IOS Release 12.3(4)XD, Cisco IOS Release 12.3(7)T, or a later release.
- Install the NM-NAM network module. Make sure that the network module is properly seated and that the EN (enable) and PWR (power) LEDs come on. Refer to the *Cisco Network Modules Hardware Installation Guide*.
- For Cisco 2691, Cisco 3725, and Cisco 3745 routers only, make sure that the router runs ROM Monitor (ROMMON) Version 12.2(8r)T2 or a later version. This ROMMON version contains a fix that prevents the router from resetting all the network modules when it is reloaded. Refer to the *ROM Monitor Download Procedures for Cisco 2691, Cisco, 3631, Cisco 3725, and Cisco 3745 Routers*.

Restrictions for the Network Analysis Module (NM-NAM)

General Restrictions

- Cisco IOS Release 12.3(4)XD, Cisco IOS Release 12.3(7)T, or a later release is required.
- Network Analysis Module Release 3.2 or a later release is required.
- Only one NM-NAM can be installed in the router at any time.
- SNMPv3 is not supported.
- Online insertion and removal (OIR), or hot swapping network modules, is supported on some platforms. To find out if your router supports hot swapping, refer to the *Network Modules Quick Start Guide*.

Traffic Monitoring Restrictions for the Internal NAM Interface

The following restrictions apply only to traffic that is monitored through the internal NAM interface:

- Only IP traffic can be monitored.
- The NAM Traffic Analyzer (web GUI) provides Layer 3 and higher layer information about the original packets. The Layer 2 header is modified by the router when it forwards the packets to the NAM, so the Layer 2 information that the NAM records is not applicable to the original packets.
- When Network Address Translation (NAT) is used, the router forwards packets containing the NAT “inside” network addresses to the NAM.

- When access control lists are used:
  - Packets dropped by an inbound access list are not forwarded to the NAM.
  - Packets dropped by an outbound access list are forwarded to the NAM for analysis.
- The NAM does *not* monitor the following:
  - Packets that are dropped by the Cisco IOS because of errors
  - Outbound IP multicast, IP broadcast, and User Datagram Protocol (UDP) flooding packets
  - Packets in generic routing encapsulation (GRE) tunnels

Note The previous restrictions (in the "Traffic Monitoring Restrictions for the Internal NAM Interface" section) do not apply to traffic monitored through the external NAM interface.

Information About the Network Analysis Module (NM-NAM)

To configure and manage the NM-NAM, you should understand the following concepts:

- NM-NAM Hardware, page 267
- NAM User Interfaces, page 268
- NAM Network Interfaces, page 269
- NM-NAM Operating Topologies and IP Address Assignments, page 270
- NAM CLI, page 275

Note For NM-NAM features and benefits, supported hardware and software, and other product information, refer to the *Cisco Branch Router Network Analysis Module Data Sheet*.

NM-NAM Hardware

For information on hardware installation and cable connections, refer to the *Cisco Network Modules Hardware Installation Guide*.

Specifications

Table 17 NM-NAM Specifications

Specification	Description
Processor	500 Mhz Intel Mobile Pentium III
SDRAM	256 MB
Internal disk storage	NM-NAM 20 GB IDE
Dimensions (H x W x D)	1.55 x 7.10 x 7.2 in. (3.9 x 18.0 x 19.3 cm)
Weight	1.5 lb (0.7 kg) (maximum)
Operating temperature	3° to 104°F (0° to 40°C)

Table 17 NM-NAM Specifications (continued)

Specification	Description
Nonoperating temperature	–40° to 185°F (–40° to 85°C)
Humidity	5 to 95% noncondensing
Operating altitude	0 to 10,000 ft (0 to 3,000 m)

Faceplate and LEDs

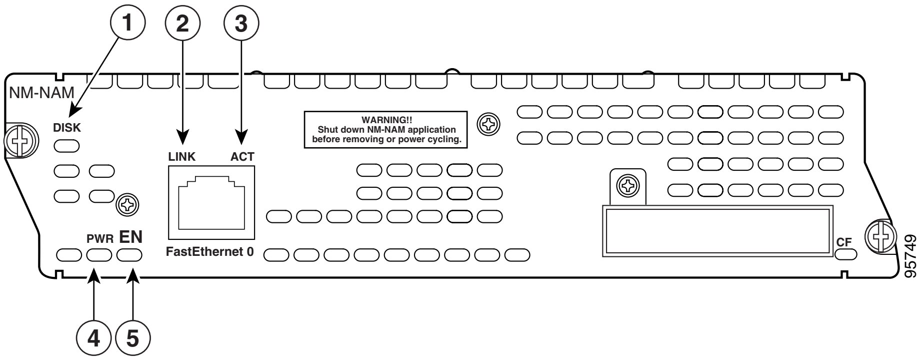

1
2
3
NM-NAM
DISK
WARNING!!
Shut down NM-NAM application before removing or power cycling.
LINK
ACT
PWR
EN
FastEthernet 0
CF
95749
4
5

Figure 11 NM-NAM Faceplate and LEDs

Figure 11 Callout	LED	Indicates
1	DISK	There is activity on the hard drive.
2	LINK	The Fast Ethernet connection is available to the network module.
3	ACT	There is activity on the Fast Ethernet connection.
4	PWR	Power is available to the network module.
5	EN	The module has passed self-test and is available to the router.

NAM User Interfaces

The NAM has three user interfaces:

- Web GUI—The NAM Traffic Analyzer provides a browser-based GUI to configure and monitor the NAM.
- CLI—A NAM-specific command-line interface is used to configure NAM. It can be accessed through a NAM console session from the router or through Telnet or Secure Shell Protocol (SSH) over the network.
- SNMP—The NAM supports SNMPv1 and SNMPv2c access to the RMON MIBs. Note that the NAM Simple Network Management Protocol (SNMP) agent is separate from the SNMP agent in the router; the agents use different IP addresses and have independent communities.

NAM Network Interfaces

The NAM uses three interfaces for communication (see Figure 12):

- Analysis-Module Interface
- Internal NAM Interface
- External NAM Interface

Note The NM-NAM does not have an external console port. To access the NAM console, open a NAM console session from the router or use Telnet or SSH over the network. The lack of an external console port on the NM-NAM means that the initial boot configuration is possible only through the router.

Figure 12 NAM Network Interfaces

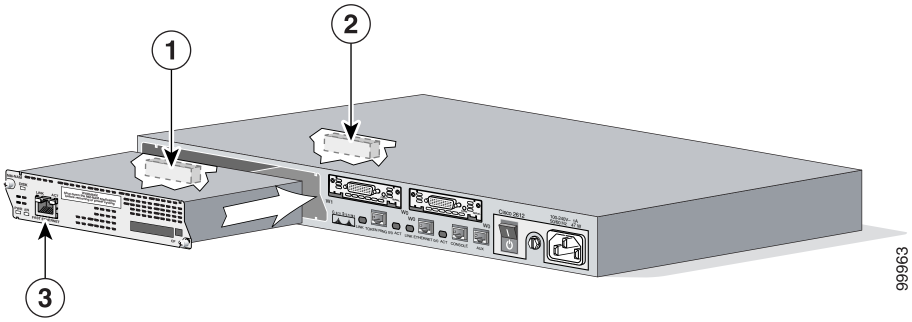


Figure 12 Callout	Interface	Location	Configure and Manage From
1	Internal NAM interface	NM-NAM internal	NAM CLI
2	Analysis-Module interface	Router internal	Cisco IOS CLI
3	External NAM interface	NM-NAM faceplate	NAM CLI

Analysis-Module Interface

The Analysis-Module interface is used to access the NAM console for the initial configuration. After configuring the NAM IP parameters, the Analysis-Module interface is typically used only during NAM software upgrades and while troubleshooting if the NAM Traffic Analyzer is inaccessible.

Visible only to the Cisco IOS software on the router, the Analysis-Module interface is an internal Fast Ethernet interface on the router that connects to the internal NAM interface. The Analysis-Module interface is connected to the router's Peripheral Component Interconnect (PCI) backplane, and all configuration and management of the Analysis-Module interface must be performed from the Cisco IOS CLI.

Internal NAM Interface

The internal NAM interface is used for monitoring traffic that passes through router interfaces. You can also select the internal NAM interface as the management interface for the NAM.

Visible only to the NAM software on the NM-NAM, the internal NAM interface is the Fast Ethernet interface on the NM-NAM that connects to the Analysis-Module interface on the router. The internal NAM interface is connected to the PCI bus on the NM-NAM, and all configuration and management of the internal NAM interface must be performed from the NAM software.

External NAM Interface

The external NAM interface can be used to monitor LAN traffic. You can also select the external NAM interface as the management interface for the NAM.

Visible only to the NAM software on the NM-NAM, the external NAM interface is the Fast Ethernet interface on the NM-NAM faceplate (see Figure 11 on page 268). The external NAM interface supports data requests and data transfers from outside sources, and it provides direct connectivity to the LAN through an RJ-45 connector. All configuration and management of the external NAM interface must be performed from the NAM software.

NM-NAM Operating Topologies and IP Address Assignments

This section includes the following topics:

- Management Traffic—Choose One of the NM-NAM Interfaces, page 270
- Monitored Traffic—Use One or Both of the NM-NAM Interfaces, page 271
- Sample Operating Topologies, page 272

Management Traffic—Choose One of the NM-NAM Interfaces

Select either the internal or external NAM interface to handle management traffic such as IP, HTTP, SNMP, Telnet, and SSH. You cannot send management traffic through both NAM interfaces at the same time.

How you assign IP addresses on the NAM network interfaces depends on which NAM interface, internal or external, you use for management traffic. See the following sections:

- Internal NAM Interface for Management Traffic—How to Assign IP Addresses, page 270
- External NAM Interface for Management Traffic—How to Assign IP Addresses, page 271

Internal NAM Interface for Management Traffic—How to Assign IP Addresses

If you select the internal NAM interface to handle management traffic:

- For the Analysis-Module interface (in Cisco IOS CLI), assign an IP address from a routable subnet. To conserve IP address space, you can configure the Analysis-Module as an IP unnumbered interface and borrow the IP address of another router interface, such as a Fast Ethernet or loopback interface. The borrowed IP address must come from a routable subnet.
- For the NAM system (in NAM CLI), assign an IP address from the same subnet that is assigned to the Analysis-Module interface.

External NAM Interface for Management Traffic—How to Assign IP Addresses

If you select the external NAM interface to handle management traffic:

- For the Analysis-Module interface (in Cisco IOS CLI), we recommend that you use the IP unnumbered interface configuration to borrow the IP address of another router interface. The subnet does not need to be routable.
- For the NAM system (in NAM CLI), assign an IP address from the subnet that is connected to the external NAM interface.

Monitored Traffic—Use One or Both of the NM-NAM Interfaces

You can use either or both the internal and external NAM interfaces for monitoring traffic:

- Internal NAM Interface—Monitor LAN and WAN Traffic, page 271
- External NAM Interface—Monitor LAN Traffic, page 271

The same interface can be used for both management traffic and monitored traffic simultaneously.

Internal NAM Interface—Monitor LAN and WAN Traffic

When you monitor traffic through the internal NAM interface, you must enable NAM packet monitoring on each router interface that you want to monitor. NAM packet monitoring uses Cisco Express Forwarding (CEF) to send a copy of each packet that is received or sent out of the router interface to the NAM.

Note Some restrictions apply when monitoring traffic through the internal NAM interface. See the "Traffic Monitoring Restrictions for the Internal NAM Interface" section on page 266.

Monitoring traffic through the internal NAM interface enables the NAM to see any encrypted traffic after it has already been decrypted by the router.

Note Traffic sent through the internal NAM interface—and the router's Analysis-Module interface—uses router resources such as CPU, SDRAM bandwidth, and backplane PCI bandwidth. Therefore, we recommend that you use the internal NAM interface to monitor WAN interfaces, and use the external NAM interface to monitor LAN interfaces.

External NAM Interface—Monitor LAN Traffic

Monitoring traffic through the external NAM interface does not impact router resources. Therefore, we recommend that you use the external NAM interface to monitor LAN traffic.

To monitor ports on Ethernet switching cards or modules (NM-16ESW-*x*, NMD-36ESW-*x*, HWIC-4ESW, or HWIC-D-9ESW), configure a Switched Port Analyzer (SPAN) session whose destination is the Ethernet switch port that connects to the external NAM interface. For more information about configuring SPAN for these cards and modules, refer to the following documents:

- *16- and 36-Port Ethernet Switch Module for Cisco 2600 Series, Cisco 3600 Series, and Cisco 3700 Series*, Cisco IOS feature module
- *Cisco HWIC-4ESW and HWIC-D-9ESW EtherSwitch Interface Cards*, Cisco IOS feature module

Sample Operating Topologies

In each of the following topologies, the router's LAN interface is monitored through the external NAM interface, and the router's WAN interface is monitored through the internal NAM interface:

- NAM Management Interface Is Internal and Analysis-Module Interface Is Assigned an IP Address, page 272
- NAM Management Interface Is Internal and Analysis-Module Interface Is IP Unnumbered, page 273
- NAM Management Interface Is External and Analysis-Module Interface Is IP Unnumbered, page 274

To see sample configurations for the following topologies, see the "Configuration Examples for the Network Analysis Module (NM-NAM)" section on page 311.

NAM Management Interface Is Internal and Analysis-Module Interface Is Assigned an IP Address

Figure 13 shows a sample topology, in which:

- The internal NAM interface is used for management traffic.
- IP addresses from the same routable subnet are assigned to the Analysis-Module interface and the NAM system.

Figure 13 Sample Topology: NAM Management Interface Is Internal and Analysis-Module Interface Is Assigned an IP Address

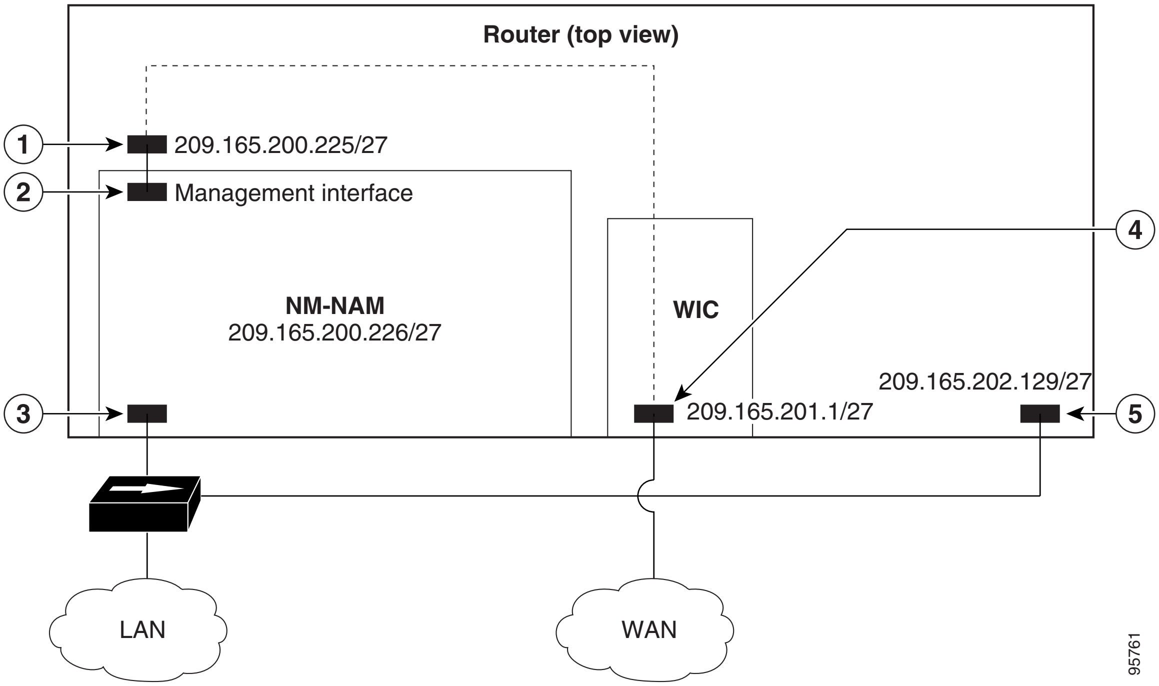


Figure 13 Callout	**Interface**	**Location**
1	Analysis-Module interface	Router internal
2	Internal NAM interface (**management**)	NM-NAM internal

Figure 13 Callout	Interface	Location
3	External NAM interface	NM-NAM faceplate
4	Serial interface	WAN interface card (WIC)
5	Fast Ethernet interface	Router rear panel

NAM Management Interface Is Internal and Analysis-Module Interface Is IP Unnumbered

Figure 14 shows a sample topology, in which:

- The internal NAM interface is used for management traffic.
- IP addresses from the same routable subnet are assigned to the Analysis-Module interface and the NAM system.
- To conserve IP address space, the Analysis-Module interface is configured as IP unnumbered to borrow the IP address of the Fast Ethernet interface.

Figure 14 Sample Topology: NAM Management Interface Is Internal and Analysis-Module Interface Is IP Unnumbered

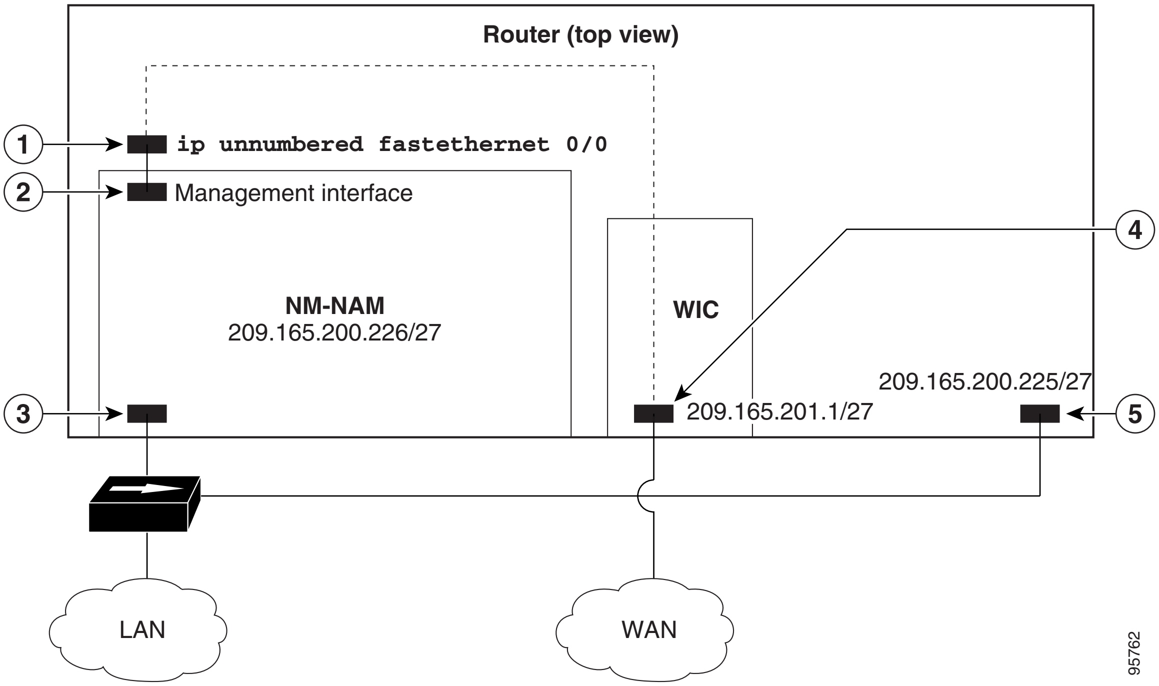


Figure 14 Callout	Interface	Location
1	Analysis-Module interface	Router internal
2	Internal NAM interface (**management**)	NM-NAM internal
3	External NAM interface	NM-NAM faceplate

Figure 14 Callout	Interface	Location
4	Serial interface	WAN interface card (WIC)
5	Fast Ethernet interface	Router rear panel

NAM Management Interface Is External and Analysis-Module Interface Is IP Unnumbered

Figure 15 shows a sample topology where:

- The external NAM interface is used for management traffic.
- The Analysis-Module interface is configured as IP unnumbered to borrow an IP address from the loopback interface.
- The borrowed loopback interface IP address is not routable.
- The NAM system is configured with an IP address from the LAN subnet that is connected to the external NAM interface.

Figure 15 Sample Topology: NAM Management Interface Is External and Analysis-Module Interface Is IP Unnumbered

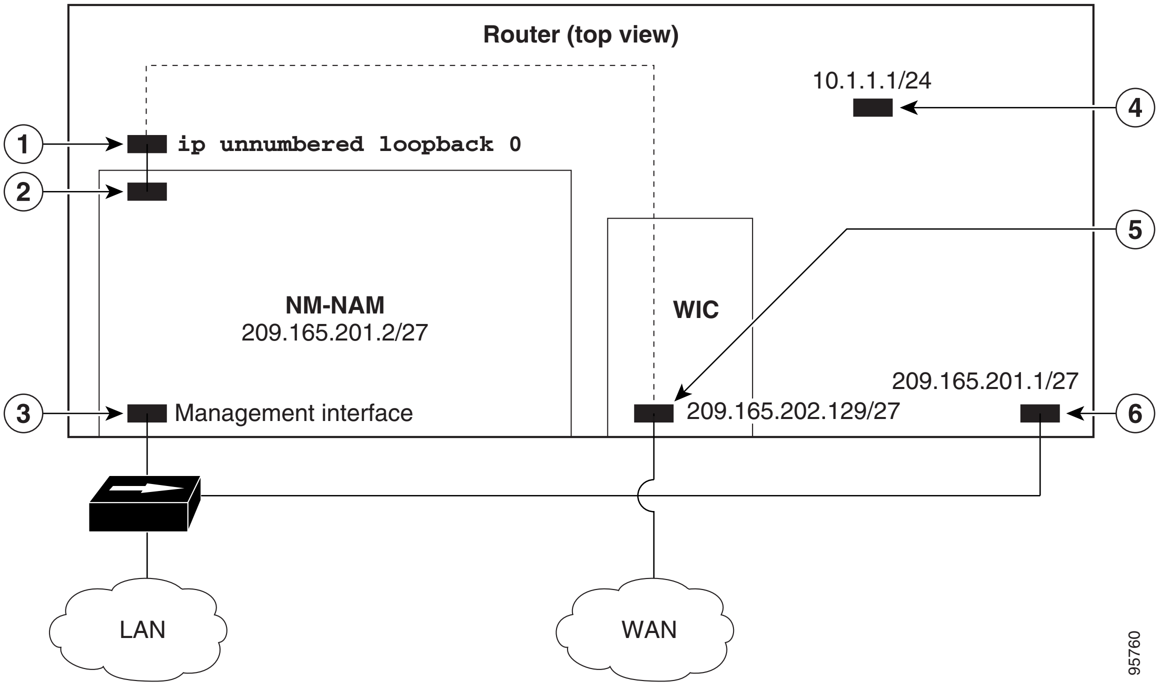


Figure 15 Callout	Interface	Location
1	Analysis-Module interface	Router internal
2	Internal NAM interface	NM-NAM internal
3	External NAM interface (**management**)	NM-NAM faceplate
4	Loopback interface	Router internal

Figure 15 Callout	Interface	Location
5	Serial interface	WAN interface card (WIC)
6	Fast Ethernet interface	Router rear panel

NAM CLI

This section includes the following topics:

- NAM CLI Access
- NAM CLI Prompt
- Basic NAM CLI Commands
- NAM CLI Context-Sensitive Help

NAM CLI Access

There are three ways to access the NAM CLI:

- Open a NAM console session from the router in which the NM-NAM is installed—See the "Opening and Closing a NAM Console Session from the Router" section on page 282.
- Telnet—See the "Opening and Closing a Telnet or SSH Session to the NAM" section on page 302.
- SSH—See the "Opening and Closing a Telnet or SSH Session to the NAM" section on page 302.

Until you properly configure the NAM IP parameters, the only way to access the NAM CLI is by opening a NAM console session from the router.

NAM CLI Prompt

The NAM CLI prompt is `root@`*`nam-system-hostname`*`#`. For example, if the NAM system hostname is configured as "nam1," then the NAM CLI prompt appears as `root@nam1#`.

If the NAM system hostname has not yet been configured, the NAM CLI prompt is `root@localhost#`.

Basic NAM CLI Commands

Table 18 briefly describes the basic NAM CLI commands that are used for initial configuration and maintenance of the NM-NAM. For a complete description of all NAM CLI commands, refer to the *Network Analysis Module Command Reference* for your NAM software release.

Note Although NAM CLI commands appear similar to Cisco IOS commands, the commands described in Table 18 operate in the NAM CLI only.

Table 18 Basic NAM CLI Commands

NAM CLI Command	Purpose
exsession on	Enables outside logins (Telnet).
exsession on ssh	Enables outside logins (SSH).

Table 18 Basic NAM CLI Commands (continued)

NAM CLI Command	Purpose
ip address	Sets the system IP address.
ip broadcast	Sets the system broadcast address.
ip domain	Sets the system domain name.
ip gateway	Sets the system default gateway address.
ip host	Sets the system hostname.
ip http secure server enable	Enables the secure HTTP server.
ip http server enable	Enables the HTTP server.
ip interface external	Selects the external NAM interface for management traffic.
ip interface internal	Selects the internal NAM interface for management traffic.
ip nameserver	Sets the system name server address.
password root	Sets a new password to access the root (read/write) level of NAM.
patch	Downloads and installs a software patch.
ping	Checks connectivity to a network device.
show ip	Displays the NAM IP parameters.

NAM CLI Context-Sensitive Help

Table 19 shows how to use the NAM CLI context-sensitive help.

Table 19 NAM CLI Context-Sensitive Help Commands

NAM CLI Command	Purpose

`(prompt)# ?`
or
`(prompt)# help`
	Displays a list of commands available for the command mode.

`(prompt)# abbreviated-command-entry<Tab>`	Lists commands in the current mode that begin with a particular character string.
`(prompt)# command ?`	Lists the available syntax options (arguments and keywords) for the command.
`(prompt)# command keyword ?`	Lists the next available syntax option for the command.

How to Configure and Manage the Network Analysis Module (NM-NAM)

This section contains the following procedures:

- Configuring the Analysis-Module Interface on the Router, page 277 (required)
- Disabling AAA Login Authentication on the NAM Console Line, page 280 (optional)
- Opening and Closing a NAM Console Session from the Router, page 282 (required for initial configuration)
- Configuring the NM-NAM, page 285 (required for initial configuration)
- Configuring a Static Route to the NAM Through the Analysis-Module Interface, page 289 (required for using the internal NAM interface for management traffic)
- Enabling NAM Packet Monitoring, page 291 (required for monitoring traffic through the internal NAM interface)
- Enabling and Accessing the NAM Traffic Analyzer, page 293 (required)
- Changing the NAM Root Password, page 296 (optional)
- Resetting the NAM Root Password to the Default Value, page 298 (optional)
- Opening and Closing a Telnet or SSH Session to the NAM, page 302 (optional)
- Upgrading the NAM Software, page 305 (optional)

Configuring the Analysis-Module Interface on the Router

This section describes how to configure the Analysis-Module interface on the router. For general information on the Analysis-Module interface, see the "Analysis-Module Interface" section on page 269.

For information on assigning the IP address of the Analysis-Module interface, see the "NM-NAM Operating Topologies and IP Address Assignments" section on page 270.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ip address** *ip-address mask*
5. **interface analysis-module** *slot*/**0**
6. **ip unnumbered** *interface number*
   or
   ip address *ip-address mask*
7. **no shutdown**
8. **end**
9. **show ip interface brief**
   or
   show running-config

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 loopback 0`	(Optional) Configures an interface, and enters interface configuration mode. • Perform this step if you plan to configure the Analysis-Module interface as an IP unnumbered interface. • This step configures the router interface (such as a loopback or Fast Ethernet interface) whose IP address you plan to borrow for the IP unnumbered Analysis-Module interface.
Step 4	**ip address** *ip-address mask* **Example:** `Router(config-if)# ip address 10.20.30.40 255.255.255.0`	(Optional) Sets an IP address and mask for the interface. • Perform this step if you plan to configure the Analysis-Module interface as an IP unnumbered interface. • If you plan to use the internal NAM interface for management traffic, this IP address must come from a routable subnet.
Step 5	**interface analysis-module** *slot***/0** **Example:** `Router(config)# interface analysis-module 1/0`	Configures the Analysis-Module interface. • This is the Fast Ethernet interface on the router that is connected to the internal NM-NAM interface.

Step 6	**ip unnumbered** *interface number*
	or
	ip address *ip-address mask*
	Example:
	`Router(config-if)# ip unnumbered loopback 0`
	Example:
	`Router(config-if)# ip address 10.20.30.40 255.255.255.0`
		Configures the Analysis-Module interface as IP unnumbered and specifies the interface whose IP address is borrowed by the Analysis-Module interface.
		or
		Sets an IP address and mask on the Analysis-Module interface.
		• Use the **ip unnumbered** command if you performed Step 3 and Step 4.

	Command or Action	Purpose
Step 7	**no shutdown** **Example:** `Router(config-if)# no shutdown`	Activates the Analysis-Module interface.

Step 8	**end**
	Example:
	`Router(config-if)# end`
	`Router#`
		Returns to privileged EXEC mode.

Step 9	**show ip interface brief**
	or
	show running-config
	Example:
	`Router# show ip interface brief`
	Example:
	`Router# show running-config`
		Displays the IP addresses and summary status of the interfaces.
		or
		Displays the contents of the currently running configuration file.
		• Verify that you properly configured the Analysis-Module interface.
		• If you configured the Analysis-Module interface as IP unnumbered, then use the **show running-config** command to verify proper configuration of both the Analysis-Module interface and the interface whose IP address you borrowed for the Analysis-Module interface.

Tip To avoid losing your configuration at the next system reload or power cycle, save the running configuration to the startup configuration by entering the **copy run start** command in privileged EXEC mode.

Examples

This section provides the following examples:

- Configuring the Analysis-Module Interface—Routable Subnet: Example, page 279
- Configuring the Analysis-Module Interface—IP Unnumbered with Routable Subnet: Example, page 280
- Configuring the Analysis-Module Interface—IP Unnumbered with Subnet That Is Not Routable: Example, page 280
- Sample Output for the show ip interface brief Command, page 280

Configuring the Analysis-Module Interface—Routable Subnet: Example

In the following example, the Analysis-Module interface is configured with a routable IP address. The NM-NAM is installed in router slot 2.

```
!
interface Analysis-Module 2/0
 ip address 209.165.200.230 255.255.255.224
 no shutdown
```

Configuring the Analysis-Module Interface—IP Unnumbered with Routable Subnet: Example

In the following example, the Analysis-Module interface is IP unnumbered and borrows the IP address of the Fast Ethernet interface. The IP address is from a routable subnet, and the NM-NAM is installed in router slot 1.

```
!
interface FastEthernet 0/0
 ip address 209.165.202.129 255.255.255.224
 no shutdown
!
interface Analysis-Module 1/0
 ip unnumbered FastEthernet 0/0
 no shutdown
!
```

Configuring the Analysis-Module Interface—IP Unnumbered with Subnet That Is Not Routable: Example

In the following example, the Analysis-Module interface is IP unnumbered and borrows a loopback interface IP address that is not routable. The NM-NAM is installed in router slot 3.

```
!
interface loopback 0
 ip address 10.20.30.40 255.255.255.0
!
interface Analysis-Module 3/0
 ip unnumbered loopback 0
 no shutdown
!
```

Sample Output for the show ip interface brief Command

```
Router# show ip interface brief

Interface                  IP-Address      OK?   Method       Status         Protocol
FastEthernet0/0            172.20.105.213  YES   NVRAM        up             up
FastEthernet0/1            172.20.105.53   YES   NVRAM        up             up
Analysis-Module2/0         10.1.1.1        YES   manual       up             up
Router#
```

What to Do Next

If you configured authentication, authorization, and accounting (AAA) on your router, then proceed to the "Disabling AAA Login Authentication on the NAM Console Line" section on page 280.

Otherwise, proceed to the "Opening and Closing a NAM Console Session from the Router" section on page 282.

Disabling AAA Login Authentication on the NAM Console Line

If you configured authentication, authorization, and accounting (AAA) on your router, then you may have to log in twice to open a NAM console session from the router: first with your AAA username and password, and second with the NAM login and password.

If you do not want to log in twice to open a NAM console session from the router, then disable AAA login authentication on the router's NAM console line by performing the steps in this section.

Note, however, that if your router contains both the NM-NAM and the NM-CIDS, the Cisco intrusion detection system network module, then AAA can be a useful tool for centrally controlling access to both network modules. For information about AAA, refer to the *Cisco IOS Security Configuration Guide*.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **aaa authentication login** *list-name* **none**
4. **line** *number*
5. **login authentication** *list-name*
6. **end**
7. **show running-config**

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	`aaa authentication login` *`list-name`* `none`
	Example:
	`Router(config)# aaa authentication login nam none`
		Creates a local authentication list.
		• The **none** keyword specifies no authentication for this list.

Step 4	`line` *`number`*
	Example:
	`Router(config)# line 33`
		Enters line configuration mode for the line to which you want to apply the authentication list.
		• The *number* value is determined by the slot number in which the NM-NAM is installed:
		number = (32 x *slot*) + 1

Step 5	`login authentication` *`list-name`*
	Example:
	`Router(config-line)# login authentication nam`
		Applies the authentication list to the line.
		• Specify the list name that you configured in Step 3.

Step 6	`end`
	Example:
	`Router(config-line)# end`
	`Router#`
		Returns to privileged EXEC mode.

Step 7	`show running-config`
	Example:
	`Router# show running-config`
		Displays the contents of the currently running configuration file.
		• Verify that you configured the local authentication list and applied it to the line associated with the NM-NAM.

What to Do Next

Proceed to the "Opening and Closing a NAM Console Session from the Router" section on page 282.

Opening and Closing a NAM Console Session from the Router

This section describes how to open and close a NAM console session from the router.

SUMMARY STEPS

1. **enable**
2. **service-module analysis-module** *slot*/**0 session**
3. Press **Return**.
   or
   If a username prompt appears, then log in with your AAA username and password.
4. At the login prompt, enter **root**.
5. At the password prompt, enter your password.
   or
   If you have not changed the password from the factory-set default, enter **root** as the root password.
6. Perform the tasks that you need to perform in the NAM CLI. When you want to end the NAM console session and return to the Cisco IOS CLI, complete Step 7 through Step 10.
7. **exit**
8. Hold **Ctrl-Shift** and press **6**. Release all keys, and then press **x**.
9. **disconnect**
10. Press **Enter**.

DETAILED STEPS

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

Step 2	**service-module analysis-module** *slot*/**0 session**
	Example:
	`Router# service-module analysis-module 1/0 session`
	Example:
	`Router# service-module analysis-module 1/0 session clear`
	`[confirm]`
	` [OK]`
	`Router# service-module analysis-module 1/0 session`
		Establishes a console session with the NAM.
		• If you cannot open a NAM console session, make sure that the NAM console line is clear by first entering the **service-module analysis-module** *slot*/**0 session clear** command in privileged EXEC mode.

	Command or Action	Purpose

Step 3	Press **Return**.
	or
	If a username prompt appears, then log in with your AAA username and password.
	Example:
	`Trying 10.1.1.1, 2065 ... Open`
	`<Press Return>`
	
	`Cisco Network Analysis Module (NM-NAM)`
	
	`nam1.cisco.com login:`
	Example:
	`Trying 10.1.1.1, 2065... Open`
	`User Access Verification`
	
	`Username: myaaausername`
	`Password: <myaaapassword>`
	`Cisco Network Analysis Module (NM-NAM)`
	
	`nam1.cisco.com login:`
		Activates the NAM console line.
		or
		Completes AAA login authentication and activates the NAM console line.
		• If AAA is configured on your router and you do not want to log in twice to access the NAM console, then complete the steps in the "Disabling AAA Login Authentication on the NAM Console Line" section on page 280.

Step 4	At the login prompt, enter **root**. **Example:** `login: root`	Accesses the root (read/write) level of NAM.
Step 5	At the password prompt, enter your password. or If you have not changed the password from the factory-set default, enter **root** as the root password. **Example:** `Password: <root>`	—
Step 6	Perform the tasks that you need to perform in the NAM CLI. When you want to end the NAM console session and return to the Cisco IOS CLI, complete Step 7 through Step 10.	For initial configuration tasks, see the "Configuring the NM-NAM" section on page 285. For help using NAM CLI commands, see the "NAM CLI Context-Sensitive Help" section on page 276.

Step 7	**`exit`**
	Example:
	`root@localhost(sub-custom-filter-capture)# exit`
	`root@localhost# exit`
	
	`login:`
		Logs out of the NAM system or leaves a subcommand mode.
		• If you are in a subcommand mode, continue to enter the **exit** command until you see the NAM login prompt.

	Command or Action	Purpose

Step 8	Hold **Ctrl-Shift** and press **6**. Release all keys, and then press **x**.
	Example:
	`login: <suspend keystroke>`
	`Router#`
		Suspends and closes the Telnet session.

Step 9	**`disconnect`**
	Example:
	`Router# disconnect`
		Disconnects a line.

Step 10	Press **Enter**.
	Example:
	`Closing connection to 10.20.30.40 [confirm]`
	`<Enter>`
		Confirms that you want to disconnect the line.

Examples

This section provides the following examples:

- Opening and Closing a NAM Console Session When AAA Authentication Is Not Configured or Is Disabled on the NAM Console Line: Example, page 284
- Opening and Closing a NAM Console Session When AAA Authentication Is Configured and Enabled on the NAM Console Line: Example, page 285

Opening and Closing a NAM Console Session When AAA Authentication Is Not Configured or Is Disabled on the NAM Console Line: Example

In the following example, a NAM console session is opened and closed from the router. The NM-NAM is installed in router slot 2.

```
Router# service-module analysis-module 2/0 session
Trying 10.1.1.1, 2065 ... Open


Cisco Network Analysis Module (NM-NAM)

nam1.cisco.com login: root
Password: <password>
Terminal type: vt100

Cisco Network Analysis Module (NM-NAM) Console, 3.2
Copyright (c) 1999-2003 by cisco Systems, Inc.

WARNING! Default password has not been changed!
root@nam1.cisco.com#
root@nam1.cisco.com# exit


Cisco Network Analysis Module (NM-NAM)

nam1.cisco.com login: <suspend keystroke>
Router# disconnect
Closing connection to 10.1.1.1 [confirm] <Enter>
Deleting login session
```

Opening and Closing a NAM Console Session When AAA Authentication Is Configured and Enabled on the NAM Console Line: Example

In the following example, a NAM console session is opened and closed from the router. The NM-NAM is installed in router slot 2.

```
Router# service-module analysis-module 2/0 session
Trying 10.1.1.1, 2065 ... Open
User Access Verification

Username: myaaausername
Password: <myaaapassword>
Cisco Network Analysis Module (NM-NAM)

nam1.cisco.com login: root
Password: <nampassword>
Terminal type: vt100

Cisco Network Analysis Module (NM-NAM) Console, 3.2
Copyright (c) 1999-2003 by cisco Systems, Inc.

WARNING! Default password has not been changed!
root@nam1.cisco.com#
root@nam1.cisco.com# exit



Cisco Network Analysis Module (NM-NAM)

nam1.cisco.com login: <suspend keystroke>
Router# disconnect
Closing connection to 10.1.1.1 [confirm] <Enter>
Deleting login session
```

Troubleshooting Tips

Make sure that the NAM console line is clear by entering the **service-module analysis-module** *slot*/**0 session clear** command in privileged EXEC mode.

What to Do Next

Proceed to the "Configuring the NM-NAM" section.

Configuring the NM-NAM

This section describes how to configure the NM-NAM to establish network connectivity and configure IP parameters. This task must be performed from the NAM CLI. For more advanced NAM configuration, use the NAM Traffic Analyzer (web GUI) or refer to the *Network Analysis Module Command Reference* for your NAM software release.

For information on assigning IP addresses, see the "NM-NAM Operating Topologies and IP Address Assignments" section on page 270.

Prerequisites

Before performing this task, access the NAM console by performing Step 1 through Step 5 in the "Opening and Closing a NAM Console Session from the Router" section on page 282.

SUMMARY STEPS

1. **ip interface** {**internal** | **external**}
2. **ip address** *ip-address subnet-mask*
3. **ip broadcast** *broadcast-address*
4. **ip gateway** *ip-address*
5. **exsession on**
or
exsession on ssh
6. **ip domain** *name*
7. **ip host** *name*
8. **ip nameserver** *ip-address* [*ip-address*][*ip-address*]
9. **ping** {*host* | *ip-address*}
10. **show ip**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**ip interface** {**internal** | **external**}
	Example:
	`root@localhost# ip interface internal`
	Example:
	`root@localhost# ip interface external`
		Specifies which NAM interface will handle management traffic.

Step 2	**ip address** *ip-address subnet-mask* **Example:** `root@localhost# ip address 172.20.104.126 255.255.255.248`	Configures the NAM system IP address. • For information on assigning the IP address, see the "Management Traffic—Choose One of the NM-NAM Interfaces" section on page 270.
Step 3	**ip broadcast** *broadcast-address* **Example:** `root@localhost# ip broadcast 10.255.255.255`	(Optional) Configures the NAM system broadcast address.
Step 4	**ip gateway** *ip-address* **Example:** `root@localhost# ip gateway 172.20.104.125`	Configures the NAM system default gateway address.

	Command or Action	Purpose

Step 5	**exsession on**
	or
	exsession on ssh
	Example:
	`root@localhost# exsession on`
	Example:
	`root@localhost# exsession on ssh`
		(Optional) Enables outside logins.
		• **exsession on** enables Telnet access.
		• **exsession on ssh** enables SSH access.
		Note The NAM software K9 crypto patch is required to configure the **ssh** option. You can download the patch from Cisco.com.

Step 6	**ip domain** *name* **Example:** `root@localhost# ip domain cisco.com`	(Optional) Sets the NAM system domain name.
Step 7	**ip host** *name* **Example:** `root@localhost# ip host nam1`	(Optional) Sets the NAM system hostname.
Step 8	**ip nameserver** *ip-address* [*ip-address*][*ip-address*] **Example:** `root@nam1# ip nameserver 209.165.201.1`	(Optional) Sets one or more NAM system name servers. • We recommend that you configure a name server for the NAM system to resolve Domain Name System (DNS) requests.

Step 9	**ping** {*host* | *ip-address*}
	Example:
	`root@nam1# ping 10.20.30.40`
		Checks connectivity to a network device.
		• Verify connectivity to the router or another known host.

Step 10	**show ip** **Example:** `root@nam1# show ip`	Displays the NAM IP parameters. • Verify that you properly configured the NM-NAM.

Examples

This section provides the following examples:

- Configuring the NM-NAM: Example, page 288
- Checking Network Connectivity with Ping: Example, page 288
- Sample Output for the show ip NAM CLI Command, page 288

Configuring the NM-NAM: Example

In the following example, the external NAM interface is used for management traffic. The HTTP server and Telnet access are enabled. The resulting NAM CLI prompt is `root@nam1.cisco.com#`.

```
!
ip address 172.20.105.215 255.255.255.192
!
ip host "nam1"
!
ip domain "cisco.com"
!
ip gateway 172.20.105.210
!
ip broadcast 10.255.255.255
!
ip nameserver 209.165.201.29
!
ip interface external
!
ip http server enable
!
exsession on
!
```

Checking Network Connectivity with Ping: Example

```
root@nam1.cisco.com# ping 172.20.105.213

PING 172.20.105.213 (172.20.105.213) from 172.20.105.215 : 56(84) bytes of data.
64 bytes from 172.20.105.213: icmp_seq=0 ttl=255 time=353 usec
64 bytes from 172.20.105.213: icmp_seq=1 ttl=255 time=289 usec
64 bytes from 172.20.105.213: icmp_seq=2 ttl=255 time=284 usec
64 bytes from 172.20.105.213: icmp_seq=3 ttl=255 time=283 usec
64 bytes from 172.20.105.213: icmp_seq=4 ttl=255 time=297 usec

--- 172.20.105.213 ping statistics ---
5 packets transmitted, 5 packets received, 0% packet loss
round-trip min/avg/max/mdev = 0.283/0.301/0.353/0.028 ms
root@nam1.cisco.com#
```

Sample Output for the show ip NAM CLI Command

```
root@nam1.cisco.com# show ip

IP address:            172.20.105.215
Subnet mask:           255.255.255.192
IP Broadcast:          10.255.255.255
IP Interface:          External
DNS Name:              nam1.cisco.com
Default Gateway:       172.20.105.210
Nameserver(s):         209.165.201.29
HTTP server:           Enabled
HTTP secure server:    Disabled
HTTP port:             80
HTTP secure port:      443
TACACS+ configured:    No
Telnet:                Enabled
SSH:                   Disabled
root@nam1.cisco.com#
```

What to Do Next

If you selected the internal NAM interface to handle management traffic in Step 1, then proceed to the "Configuring a Static Route to the NAM Through the Analysis-Module Interface" section on page 289.

If you plan to monitor traffic through the internal NAM interface, then proceed to the "Enabling NAM Packet Monitoring" section on page 291.

If you do not plan to monitor traffic through the internal NAM interface, then proceed to the "Enabling and Accessing the NAM Traffic Analyzer" section on page 293.

Configuring a Static Route to the NAM Through the Analysis-Module Interface

This section describes how to ensure that the router can route packets to the NAM by configuring a static route through the Analysis-Module interface.

If you select the internal NAM interface to handle management traffic, then configuring a static route to the NAM through the Analysis-Module interface is:

- Required when the Analysis-Module interface is IP unnumbered.
- Recommended when the Analysis-Module interface is assigned a unique IP address.

If you select the external NAM interface to handle management traffic, then you do not need to perform this task. Proceed to the "What to Do Next" section on page 291.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip route** *nam-ip-address mask* **analysis-module** *slot/unit*
4. **end**
5. **ping** {*nam-ip-address* | *nam-hostname*}

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.

	Command or Action	Purpose
Step 3	**ip route** *nam-ip-address mask* **analysis-module** *slot***/***unit* **Example:** `Router(config)# ip route 172.20.105.215 255.255.255.192 analysis-module 1/0`	Establishes a static route to the NAM.

Step 4	**end**
	Example:
	`Router(config-if)# end`
	`Router#`
		Returns to privileged EXEC mode.

Step 5	**ping** {*nam-ip-address* | *nam-hostname*}
	Example:
	`Router# ping 172.20.105.215`
		Verifies network connectivity to the NAM.

Examples

This section provides the following examples:

- Configuring a Static Route to the NAM Through the Analysis-Module Interface: Example, page 290
- Verifying Network Connectivity with Ping: Example, page 290

Configuring a Static Route to the NAM Through the Analysis-Module Interface: Example

In the following example, a static route is configured to the NAM whose system IP address is 172.20.105.215. The NM-NAM is installed in router slot 1.

```
!
ip route 172.20.105.215 255.255.255.192 analysis-module 1/0
!
interface FastEthernet 0/0
 ip address 209.165.202.129 255.255.255.224
 no shutdown
!
interface Analysis-Module 1/0
 ip unnumbered FastEthernet 0/0
 no shutdown
!
```

Verifying Network Connectivity with Ping: Example

In the following example, entering the **ping** command verifies network connectivity to the NAM with IP address 172.20.105.215.

```
Router# ping 172.20.105.215

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.20.105.215, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
Router#
```

What to Do Next

If you plan to monitor traffic through the internal NAM interface, then proceed to the "Enabling NAM Packet Monitoring" section on page 291.

If you do not plan to monitor traffic through the internal NAM interface, then proceed to the "Enabling and Accessing the NAM Traffic Analyzer" section on page 293.

Enabling NAM Packet Monitoring

This section describes how to enable NAM packet monitoring on router interfaces that you want to monitor through the internal NAM interface.

When you enable NAM packet monitoring on an interface, CEF sends an extra copy of each IP packet that is received or sent out on that interface to the NAM through the Analysis-Module interface on the router and the internal NAM interface.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip cef**
4. **interface** *type slot/port*
   or
   interface *type slot/wic-slot/port*
5. **analysis-module monitoring**
6. Repeat Step 4 and Step 5 for each interface that you want the NAM to monitor.
7. **end**
8. **show running-config**

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 cef`
	Example:
	`Router(config)# ip cef`
		Enables the CEF switching path.

	Command or Action	Purpose
Step 4	**interface** *type slot***/***port* or **interface** *type slot***/***wic-slot***/***port* **Example:** `Router(config)# interface serial 0/0`	Selects an interface for configuration.
Step 5	**analysis-module monitoring** **Example:** `Router(config-if)# analysis-module monitoring`	Enables NAM packet monitoring on the interface.
Step 6	Repeat Step 4 and Step 5 for each interface that you want the NAM to monitor through the internal NAM interface.	—

Step 7	**end**
	Example:
	`Router(config-if)# end`
	`Router#`
		Returns to privileged EXEC mode.

Step 8	**show running-config** **Example:** `Router# show running-config`	Displays the contents of the currently running configuration file. • Verify that you enabled the CEF switching path and enabled packet monitoring on the correct interfaces.

Example

This section provides the following example:

- Enabling NAM Packet Monitoring: Example, page 292

Enabling NAM Packet Monitoring: Example

In the following example, NAM packet monitoring is enabled on the serial interfaces:

```
interface Serial 0/0
 ip address 172.20.105.213 255.255.255.240
 ip route-cache flow
 speed auto
 full-duplex
 analysis-module monitoring
 no mop enabled
!
interface Serial 0/1
 ip address 172.20.105.53 255.255.255.252
 ip route-cache flow
 duplex auto
 speed auto
 analysis-module monitoring
!
interface Analysis-Module 2/0
 ip address 10.1.1.1 255.255.255.0
 hold-queue 60 out
!
```

What to Do Next

Proceed to the "Enabling and Accessing the NAM Traffic Analyzer" section on page 293.

Enabling and Accessing the NAM Traffic Analyzer

This section describes how to enable and access the NAM Traffic Analyzer (web GUI).

Prerequisites

- Make sure that your web browser supports your NAM software release. For a list of supported browsers, refer to the NAM software release notes.
- If you plan to use the HTTP secure server (HTTPs), then you must first download and install the NAM software K9 crypto patch. Until you install the patch, the **ip http secure** commands are disabled. You can download the NAM software K9 crypto patch from Cisco.com.

Restrictions

You can use the HTTP server or the HTTP secure server, but you cannot use both simultaneously.

SUMMARY STEPS

1. Open a NAM console session from the router. See the "Opening and Closing a NAM Console Session from the Router" section on page 282.
   or
   Open a Telnet or SSH session to the NAM. See the "Opening and Closing a Telnet or SSH Session to the NAM" section on page 302.
2. **ip http server enable**
   or
   ip http secure server enable
3. Enter a web username.
   or
   Press **Return** to enter the default web username "admin".
4. Enter a password.
5. Enter the password again.
6. On your PC, open a web browser.
7. In the web browser, enter the NAM system IP address or hostname as the URL.

DETAILED STEPS

	Command or Action	Purpose
Step 1	Open a NAM console session from the router. See the "Opening and Closing a NAM Console Session from the Router" section on page 282. or Open a Telnet or SSH session to the NAM. See the "Opening and Closing a Telnet or SSH Session to the NAM" section on page 302.	Accesses the NAM CLI.

Step 2	**`ip http server enable`**
	or
	`ip http secure server enable`
	Example:
	`root@localhost# ip http server enable`
	Example:
	`root@localhost# ip http secure server enable`
		Enables the HTTP server.
		or
		Enables the HTTP secure server (HTTPs).

Step 3	Enter a web username.
	or
	Press **Return** to enter the default web username "admin".
	Example:
	`Please enter a web administrator user name [admin]: joeadmin`
	Example:
	`Please enter a web administrator user name [admin]: <cr>`
		Configures a web username.
		• The NAM requires at least one web username and password configuration.
		• If NAM does not prompt you for a web username and password, then at least one web username and password combination was previously configured.

Step 4	Enter a password. **Example:** `New password: <adminpswd>`	Configures a password for the web username.
Step 5	Enter the password again. **Example:** `Confirm password: <adminpswd>`	Confirms the password for the web username.

	Command or Action	Purpose
Step 6	On your PC, open a web browser.	—

Step 7	In the web browser, enter the NAM system IP address or hostname as the URL.
	Example:
	`http://172.20.105.215/`
	Example:
	`https://172.20.105.215/`
	Example:
	`http://nam1/`
		Opens the NAM Traffic Analyzer in your web browser.
		• You are automatically redirected to the NAM Traffic Analyzer login page.

Examples

This section provides the following examples:

- Enabling the NAM Traffic Analyzer: Example, page 295
- Accessing the NAM Traffic Analyzer: Example, page 295

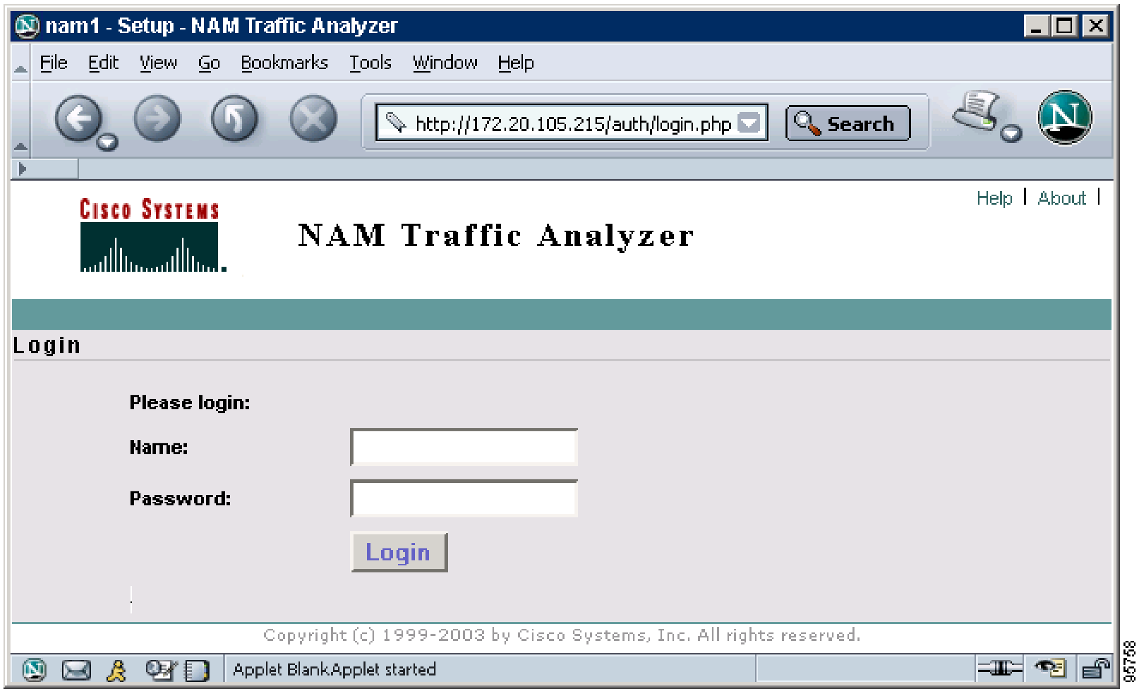
Enabling the NAM Traffic Analyzer: Example

```
root@nam1# ip http server enable
Enabling HTTP server...

No web users are configured.
Please enter a web administrator user name [admin]: <cr>
New password: <pswd>
Confirm password: <pswd>

User admin added.
Successfully enabled HTTP server.
root@nam1#
```

Accessing the NAM Traffic Analyzer: Example

Figure 16 shows the NAM Traffic Analyzer login page that appears when you enter the NAM system IP address or hostname as the URL in a web browser.

Figure 16 Sample NAM Traffic Analyzer Login Page


nam1 - Setup - NAM Traffic Analyzer
File Edit View Go Bookmarks Tools Window Help
http://172.20.105.215/auth/login.php
Search
Help | About |
Cisco Systems
NAM Traffic Analyzer
Login
Please login:
Name:
Password:
Login
Copyright (c) 1999-2003 by Cisco Systems, Inc. All rights reserved.
Applet BlankApplet started
95758

What to Do Next

For information on the NAM Traffic Analyzer, refer to the *User Guide for the Network Analysis Module Traffic Analyzer* for your NAM software release. This document is available on Cisco.com and as online help within the NAM Traffic Analyzer application.

Changing the NAM Root Password

This section describes how to set a new password to access the root (read/write) level of NAM, where you can enter NAM CLI commands. The factory-set default root password is “root”.

Prerequisites

Before performing this task, access the NAM console by performing Step 1 through Step 5 in the “Opening and Closing a NAM Console Session from the Router” section on page 282.

SUMMARY STEPS

1. **password root**
2. Enter the new password.
3. Enter the new password again.
4. **exit**
5. At the login prompt, enter **root**.
6. At the password prompt, enter your password.

DETAILED STEPS

	Command or Action	Purpose

Step 1	**`password root`**
	Example:
	`root@localhost.cisco.com# password root`
		Starts the process of changing the NAM's root (read/write) level password.

Step 2	Enter the new password. **Example:** `New UNIX password: <password>`	Enters the new password.
Step 3	Enter the new password again. **Example:** `Retype new UNIX password: <password>`	Confirms the new password.

Step 4	**`exit`**
	Example:
	`root@localhost# exit`
		Logs out of the NAM system.

Step 5	At the login prompt, enter **root**. **Example:** `login: root`	Accesses the root (read/write) level of NAM.
Step 6	At the password prompt, enter your password. **Example:** `Password: <password>`	Verifies that the new password is accepted.

Examples

This section provides the following examples:

- Changing the NAM Root Password: Example, page 297
- Verifying the NAM Root Password: Example, page 298

Changing the NAM Root Password: Example

```
root@nam1.cisco.com# password root
Changing password for user root
New UNIX password: <rtpswd>
Retype new UNIX password: <rtpswd>
passwd:all authentication tokens updated successfully
root@nam1.cisco.com#
root@nam1.cisco.com# exit
```

Verifying the NAM Root Password: Example

```
nam1.cisco.com login: root
Password: <rtpswd>
Terminal type: vt100

Cisco Network Analysis Module (NM-NAM) Console, 3.2
Copyright (c) 1999-2003 by cisco Systems, Inc.

root@nam1.cisco.com#
root@nam1.cisco.com# exit
```

Troubleshooting Tips

If you forget the NAM root password, see the "Resetting the NAM Root Password to the Default Value" section on page 298.

Resetting the NAM Root Password to the Default Value

This section describes how to reset the NAM root password to the default value of "root". Use this procedure when you cannot remember the NAM root password but need to access the NAM CLI.

Note This procedure requires that you reload the NAM software.

SUMMARY STEPS

1. **enable**
2. **service-module analysis-module** *slot*/**0 reload**
3. **y**
4. **service-module analysis-module** *slot*/**0 session**
5. When prompted, enter ******* to change the boot configuration.
6. **boot flash**
7. When prompted to select from the helper menu, enter **6**.
8. When prompted to select from the helper menu, enter **r**.
9. **y**
10. Hold **Ctrl-Shift** and press **6**. Release all keys, and then press **x**.
11. **disconnect**
12. Press **Enter**.

DETAILED STEPS

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

Step 2	**service-module analysis-module** *slot*/**0 reload**
	Example:
	`Router# service-module analysis-module 1/0`
	`reload`
		Reloads the software on the NM-NAM.

Step 3	**y** **Example:** `Do you want to proceed with reload?[confirm] y`	Confirms that you want to proceed with the NAM software reload.

Step 4	**service-module analysis-module** *slot*/**0 session**
	Example:
	`Router# service-module analysis-module 1/0`
	`session`
	Example:
	`Router# service-module analysis-module 1/0`
	`session clear`
	`[confirm]`
	` [OK]`
	`Router# service-module analysis-module 1/0`
	`session`
		Establishes a console session with the NAM.
		• Perform this step immediately after reloading the NAM software.
		• If you cannot open a NAM console session, make sure that the NAM console line is clear by first entering the **service-module analysis-module** *slot*/**0 session clear** command in privileged EXEC mode.

Step 5	When prompted, enter *** to change the boot configuration.
	Example:
	`Please enter '***' to change boot`
	`configuration: ***`
		Interrupts the boot loader.
		• Enter *** immediately after the prompt appears.
		• If you do not enter *** in time to interrupt the boot loader, then the NAM login prompt eventually appears. Complete Step 10 through Step 12 to return to the Cisco IOS CLI on the router, and then retry this task, starting with Step 2.

Step 6	**boot flash** **Example:** `ServicesEngine boot-loader> boot flash`	Loads the NAM helper image. • This command is entered in the boot loader CLI, which is separate from the NAM CLI and Cisco IOS CLI.
Step 7	When prompted to select from the helper menu, enter **6**. **Example:** `Selection [12345678rh]: 6`	Selects the menu option to reset the root password to the default value of “root”.

	Command or Action	Purpose
Step 8	When prompted to select from the helper menu, enter **r**. **Example:** `Selection [12345678rh]:r`	Selects the menu option to exit the helper and reset the NAM.

Step 9	**`y`**
	Example:
	`About to exit and reset Services Engine.`
	`Are you sure? [y/N] y`
		Confirms that you want to exit the helper and reset the NAM.
		• This time, ignore the prompt to enter ***.

Step 10	Hold **Ctrl-Shift** and press **6**. Release all keys, and then press **x**.
	Example:
	`login: <suspend keystroke>`
	`Router#`
		Suspends and closes the Telnet session.

Step 11	**`disconnect`**
	Example:
	`Router# disconnect`
		Disconnects a line.

Step 12	Press **Enter**.
	Example:
	`Closing connection to 10.20.30.40 [confirm]`
	`<Enter>`
		Confirms that you want to disconnect the line.

Example

This section provides the following example:

- Resetting the NAM Root Password to the Default Value: Example, page 300

Resetting the NAM Root Password to the Default Value: Example

```
Router# service-module analysis-module 1/0 reload
Do you want to proceed with reload?[confirm] y
Trying to reload Service Module Analysis-Module1/0.

Router# service-module analysis-module 1/0 session
Trying 172.20.104.87, 2033 ... Open
.
<debug output omitted>
.
Booting from flash..., please wait.

[BOOT-ASM]
7

Please enter '***' to change boot configuration: ***

 ServicesEngine Bootloader Version :1.0.6aN
ServicesEngine boot-loader> boot flash
.
<debug output omitted>
.
===============================================================================
Cisco Systems, Inc.
Services engine helper utility for NM-NAM
Version 1.1(1) [200311111641]

-----
Main menu
1 - Download application image and write to HDD
2 - Download application image and reformat HDD
3 - Download bootloader and write to flash
4 - Download helper and write to flash
5 - Display software versions
6 - Reset application image CLI passwords to default
7 - Change file transfer method (currently ftp/http)
8 - Show upgrade log
9 - Send Ping
r - Exit and reset Services Engine
h - Exit and shutdown Services Engine

Selection [123456789rh]: 6
Restored default CLI passwords of application image.
===============================================================================
Cisco Systems, Inc.
Services engine helper utility for NM-NAM
Version 1.1(1) [200311111641]

-----
Main menu
1 - Download application image and write to HDD
2 - Download application image and reformat HDD
3 - Download bootloader and write to flash
4 - Download helper and write to flash
5 - Display software versions
6 - Reset application image CLI passwords to default
7 - Change file transfer method (currently ftp/http)
8 - Show upgrade log
9 - Send Ping
r - Exit and reset Services Engine
h - Exit and shutdown Services Engine

Selection [123456789rh]: r
About to exit and reset Services Engine.
Are you sure? [y/N] y
INITSending all processes the TERM signal...
Sending all processes the KILL signal...
Unmounting file systems:
Please stand by while rebooting the system...
Restarting system.
.
<debug output omitted>
.
Cisco Network Analysis Module (NM-NAM)

nam1.cisco.com login: <suspend keystroke>
Router#
Router# disconnect
Closing connection to 10.1.1.1 [confirm] <Enter>
Deleting login session
```

Troubleshooting Tips

If you have trouble opening a NAM console session from the router, make sure that the NAM console line is clear by entering the **service-module analysis-module** *slot*/**0 session clear** command in privileged EXEC mode.

What to Do Next

Verify that the default root password of "root" is accepted by performing Step 1 through Step 5 in the "Opening and Closing a NAM Console Session from the Router" section on page 282.

To change the NAM root password, see the "Changing the NAM Root Password" section on page 296.

Opening and Closing a Telnet or SSH Session to the NAM

This section describes how to open and close a Telnet or SSH session to the NAM. This task is not commonly performed, because you would typically use the NAM Traffic Analyzer (web GUI) to monitor and maintain the NAM. If, however, you cannot access the NAM Traffic Analyzer, then you might want to use Telnet or SSH to troubleshoot from the NAM CLI.

If your NM-NAM is not properly configured for Telnet or SSH access (see the following Prerequisites section), then you can open a Telnet session to the router in which the NM-NAM is installed, and then open a NAM console session from the router. See the "Opening and Closing a NAM Console Session from the Router" section on page 282.

Prerequisites

- Configure the NAM system IP address. Optionally, set the NAM system hostname. See the "Configuring the NM-NAM" section on page 285.
- Verify NAM network connectivity by performing one of the following ping tests:
  - From a host beyond the gateway, ping the NAM system IP address.
  - From the NAM CLI, ping the NAM system default gateway.

Telnet Prerequisites

- Enter the **exsession on** NAM CLI command. See Step 5 of the "Configuring the NM-NAM" section on page 285.

SSH Prerequisites

- Install the NAM software K9 crypto patch, which you can download from Cisco.com.
- Enter the **exsession on ssh** NAM CLI command. See Step 5 of the "Configuring the NM-NAM" section on page 285.

SUMMARY STEPS

1. **telnet** {*ip-address* | *hostname*}
   or
   ssh {*ip-address* | *hostname*}
2. At the login prompt, enter **root**.
3. At the password prompt, enter your password.
   or
   If you have not changed the password from the factory-set default, enter **root** as the root password.
4. Perform the tasks that you need to perform in the NAM CLI. When you want to end the Telnet or SSH session to the NAM and return to the Cisco IOS CLI, complete Step 5 and Step 6.
5. **exit**
6. **logout**

DETAILED STEPS

	Command or Action	Purpose

Step 1	`telnet {ip-address | hostname}`
	or
	`ssh {ip-address | hostname}`
	Example:
	`Router# telnet 10.20.30.40`
	Example:
	`Router# ssh 10.20.30.40`
		Logs in to a host that supports Telnet.
		or
		Starts an encrypted session with a remote networking device.
		• Use the NAM system IP address or NAM system hostname.

Step 2	At the login prompt, enter **root**. **Example:** `login: root`	Accesses the root (read/write) level of NAM.
Step 3	At the password prompt, enter your password. or If you have not changed the password from the factory-set default, enter **root** as the root password. **Example:** `Password: root`	—
Step 4	Perform the tasks that you need to perform in the NAM CLI. When you want to end the Telnet or SSH session to the NAM and return to the Cisco IOS CLI, complete Step 5 and Step 6.	For help using NAM CLI commands, see the "NAM CLI Context-Sensitive Help" section on page 276.

	Command or Action	Purpose

Step 5	**`exit`**
	Example:
	`root@localhost(sub-custom-filter-capture)# exit`
	`root@localhost#`
		Leaves a subcommand mode.
		• Return to command mode.

Step 6	**`logout`**
	Example:
	`root@localhost# logout`
	`Connection closed by foreign host.`
		Logs out of the NAM system.

Examples

This section provides the following examples:

- Opening and Closing a Telnet Session to the NAM Using the NAM System IP Address: Example, page 304
- Opening and Closing an SSH Session to the NAM Using the NAM System Hostname: Example, page 304

Opening and Closing a Telnet Session to the NAM Using the NAM System IP Address: Example

```
Router> telnet 172.20.105.215
Trying 172.20.105.215 ... Open

Cisco Network Analysis Module (NM-NAM)

login: root
Password: <password>
Terminal type: vt100

Cisco Network Analysis Module (NM-NAM) Console, 3.2
Copyright (c) 1999-2003 by cisco Systems, Inc.

WARNING! Default password has not been changed!
root@nam.cisco.com#
root@nam.cisco.com# logout

[Connection to 172.20.105.215 closed by foreign host]
Router>
```

Opening and Closing an SSH Session to the NAM Using the NAM System Hostname: Example

```
host [/home/user] ssh -l root nmnam2
root@nmnam2's password: <password>
Terminal type: vt100

Cisco Network Analysis Module (NM-NAM) Console, 3.2
Copyright (c) 1999-2003 by cisco Systems, Inc.

WARNING! Default password has not been changed!
root@nmnam2.cisco.com#
root@nmnam2.cisco.com# logout

Connection to nmnam2 closed.
host [/home/user]
```

Upgrading the NAM Software

This section describes how to upgrade the NAM software. This task is performed from the NAM CLI.

NAM Software Images

The NM-NAM contains three NAM software images:

- NAM application image on the hard drive—Source of the NAM Traffic Analyzer and NAM CLI
- Helper image in flash memory—Used to recover or upgrade NAM software images
- Bootloader image in flash memory—Used to specify whether to boot the NAM application image or the helper image

Types of NAM Software Upgrades

NAM software upgrades are available in two forms:

- Patches—Incremental updates to software releases that are installed with the **patch** NAM CLI command. Patches are available only for the NAM application image.
- Images—Full image releases that are installed from the helper image. Full image upgrades are typically used to update the NAM application image, but if necessary and recommended by technical support, you can also use the helper image to upgrade the bootloader image or helper image.

Prerequisites

- Download the NAM software image from Cisco.com, and copy the image to an FTP server.
- Before performing this task, access the NAM console by completing Step 1 through Step 5 in the "Opening and Closing a NAM Console Session from the Router" section on page 282.

Perform one of the following tasks in this section, depending on whether you are adding a patch to your NAM application or are performing a full software image upgrade:

- Upgrading the NAM Software—Patch, page 305
- Upgrading the NAM Software—Full Image, page 306

Upgrading the NAM Software—Patch

Perform this task to add a patch to your NAM application image. This task is performed from the NAM CLI.

SUMMARY STEPS

1. **patch** *ftp://user:passwd@host/full-path/filename*
   or
   patch *ftp://user@host/full-path/filename*
2. **show patches**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**patch** *ftp://user:password@host/full-path/filename*
	or
	patch *ftp://user@host/full-path/filename*
	Example:
	`root@nam1.cisco.com# patch ftp://person:mypwd@examplehost/dir/subdir/nam-app.3-2.cryptoK9.patch.1-0.bin`
	Example:
	`root@nam1.cisco.com# patch ftp://person@examplehost/dir/subdir/nam-app.3-2.cryptoK9.patch.1-0.bin`
	`Proceeding with installation. Please do not interrupt.`
	`If installation is interrupted, please try again.`
	`Downloading nam-app.3-2.cryptoK9.patch.1-0.bin. Please wait...`
	`Password for person@examplehost: <mypwd>`
		Downloads and installs a software patch.
		• Use the first option, which includes the password, if the FTP server does not allow anonymous users.
		• If you use the second option, enter your password when prompted.
		• Remember to perform this task in the NAM CLI.

Step 2	**show patches** **Example:** `root@nam1.cisco.com# show patches`	Displays all installed patches. • Verify that your patch was successfully installed.

Upgrading the NAM Software—Full Image

Perform this task to upgrade one of your NAM software images to a new release. This task is performed from the NAM CLI.

SUMMARY STEPS

1. **reboot**
2. **y**
3. When prompted, enter *** to change the boot configuration.
4. **boot flash**
5. When prompted to select from the helper menu, enter **1**.
6. **ftp://***ip-address***/***path***/***nam-image-file*
7. **y**
8. **r**
9. **y**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**`reboot`**
	Example:
	`root@nam1.cisco.com# reboot`
		Shuts down and restarts the NAM.
		• Remember to perform this task in the NAM CLI.

Step 2	**`y`**
	Example:
	`Reboot the NAM? (Y/N) [N]: y`
		Confirms that you want to reboot the NAM.
		• After you confirm the reboot, the NAM displays a series of messages as it stops processes, shuts down, and then restarts.

Step 3	When prompted, enter *** to change the boot configuration. **Example:** `Please enter '***' to change boot configuration: ***`	Interrupts the boot loader. • Enter *** immediately after the prompt appears. • If you do not enter the *** in time to interrupt the boot loader, then return to Step 1 and try again.

Step 4	**`boot flash`**
	Example:
	`ServicesEngine boot-loader> boot flash`
		Loads the NAM helper image.
		• This command is entered in the boot loader CLI, which is separate from the NAM CLI and Cisco IOS CLI.

Step 5	When prompted to select from the helper menu, enter **1** or **2**.
	Example:
	`Selection [12345678rh]: 1`
	Example:
	`Selection [12345678rh]: 2`
		Selects the menu option to download the NAM software image onto the NM-NAM internal memory.
		• Option 1 preserves all configuration and report data while installing the NAM software image.
		• Option 2 reformats the NM-NAM hard drive, deleting all report data and NAM software configurations, except the basic IP configuration. Although useful for recovering a corrupted hard drive, Option 2 should be used with caution or when recommended by technical support.
		• The helper menu also has an option (7) to change the file transfer method from the default FTP method. Before performing Step 5, you may enter 7 to select the TFTP transfer method. Because many TFTP servers have problems transferring files as large as the NAM application image, we recommend that you use the default FTP method.

Step 6	**ftp://***ip-address***/***path***/***nam-image-file*
	Example:
	`Download NAM application image via ftp and write to HDD`
	`URL of application image []:`
	`ftp://172.20.98.136/dir1/dir2/nam-image.bin.gz`
		Specifies the FTP location and filename of the NAM software image.

	Command or Action	Purpose
Step 7	**y** **Example:** `Do you want to proceed installing it? [y/N] y`	Confirms that you want to install the specified NAM software image.
Step 8	**r** **Example:** `Selection [12345678rh]:r`	Selects the menu option to exit the helper and reset the NAM.

Step 9	**y**
	Example:
	`About to exit and reset Services Engine.`
	`Are you sure? [y/N] y`
		Confirms that you want to exit the helper and reset the NAM.
		• This time, ignore the prompt to enter ***.

Examples

This section provides the following examples:

- Upgrading the NAM Software—Patch: Example, page 308
- Upgrading the NAM Software—Full Image: Example, page 309

Upgrading the NAM Software—Patch: Example

```
Router> enable
Password: <password>
Router#
Router# service-module analysis-Module 1/0 session
Trying 172.20.104.86, 2033 ... Open

Cisco Network Analysis Module (NM-NAM)

nam1.cisco.com login: root
Password: <password>
Terminal type:vt100

Cisco Network Analysis Module (NM-NAM) Console, 3.2(0.10)
Copyright (c) 1999-2003 by cisco Systems, Inc.

WARNING! Default password has not been changed!

root@nam1.cisco.com# patch
ftp://person@examplehost/dir/subdir/nam-app.3-2.cryptoK9.patch.1-0.bin

Proceeding with installation. Please do not interrupt.
If installation is interrupted, please try again.

Downloading nam-app.3-2.cryptoK9.patch.1-0.bin. Please wait...
Password for person@examplehost: <mypwd>
ftp://person@examplehost/dir/subdir/nam-app.3-2.cryptoK9.patch.1-0.bin
(1K)
/usr/local/nam/patch/wor  [########################]       1K |  104.43K/s
1894 bytes transferred in 0.02 sec (102.35k/sec)

Verifying nam-app.3-2.cryptoK9.patch.1-0.bin. Please wait...
Patch nam-app.3-2.cryptoK9.patch.1-0.bin verified.
```

```
Applying /usr/local/nam/patch/workdir/nam-app.3-2.cryptoK9.patch.1-0.bin.
Please wait...
############################################ [100%]
############################################ [100%]

Patch applied successfully.
root@nam1.cisco.com# show patches

Tue Aug 31 21:04:28 2004 Patch:nam-app.3-2.strong-crypto-patchK9-1-0
Description:Strong Crypto Patch for NAM.

root@nam1.cisco.com#
```

Upgrading the NAM Software—Full Image: Example

```
Router> enable
Password: <password>
Router#
Router# service-module analysis-Module 1/0 session
Trying 172.20.104.86, 2033 ... Open

Cisco Network Analysis Module (NM-NAM)

nam1.cisco.com login: root
Password: <password>
Terminal type:vt100

Cisco Network Analysis Module (NM-NAM) Console, 3.2(0.10)
Copyright (c) 1999-2003 by cisco Systems, Inc.

WARNING! Default password has not been changed!

root@nam1.cisco.com#
root@nam1.cisco.com# reboot
Reboot the NAM? (Y/N) [N]: y

System reboot in process...
.
<debug output omitted>
.
Booting from flash..., please wait.

[BOOT-ASM]
7

Please enter '***' to change boot configuration: ***

 ServicesEngine Bootloader Version :1.0.6-NAM

ServicesEngine boot-loader>
ServicesEngine boot-loader> boot flash
.
<debug output omitted>
.
===============================================================================
Cisco Systems, Inc.
Services engine helper utility for NM-NAM
Version 1.1(1) [200311111641]

-----
```

```
Main menu
1 - Download application image and write to HDD
2 - Download application image and reformat HDD
3 - Download bootloader and write to flash
4 - Download helper and write to flash
5 - Display software versions
6 - Reset application image CLI passwords to default
7 - Change file transfer method (currently ftp/http)
8 - Show upgrade log
9 - Send Ping
r - Exit and reset Services Engine
h - Exit and shutdown Services Engine

Selection [123456789rh]: 1


-----
Download NAM application image via ftp and write to HDD
URL of application image []: ftp://172.20.98.136/dir1/dir2/nam-image.bin.gz
Getting c6svc-nam.mainline-DAILY_20030825.bin.gz from 171.69.17.19 via ftp.
ftp://172.20.98.136/dir1/dir2/nam-image.bin.gz
(46389K)
-                         [########################]   46389K | 7421.38K/s
47502347 bytes transferred in 6.25 sec (7421.14k/sec)
upgrade.bin size:48241545
File transfer successful.
Checking upgrade.bin
Do you want to proceed installing it? [y/N] y
.
<debug output omitted>
.
Application image upgrade complete. You can boot the image now.
==============================================================================
Cisco Systems, Inc.
Services engine helper utility for NM-NAM
Version 1.1(1) [200311111641]

-----
Main menu
1 - Download application image and write to HDD
2 - Download application image and reformat HDD
3 - Download bootloader and write to flash
4 - Download helper and write to flash
5 - Display software versions
6 - Reset application image CLI passwords to default
7 - Change file transfer method (currently ftp/http)
8 - Show upgrade log
9 - Send Ping
r - Exit and reset Services Engine
h - Exit and shutdown Services Engine

Selection [123456789rh]: r
About to exit and reset Services Engine.
Are you sure? [y/N] y
```

Troubleshooting Tips

If you have trouble opening a NAM console session from the router, make sure that the NAM console line is clear by entering the **service-module analysis-module** *slot*/**0 session clear** command in privileged EXEC mode.

Configuration Examples for the Network Analysis Module (NM-NAM)

This section provides the following configuration examples:

- NAM Management Interface Is Internal and Analysis-Module Interface Is Assigned an IP Address: Example, page 311
- NAM Management Interface Is Internal and Analysis-Module Interface Is IP Unnumbered: Example, page 313
- NAM Management Interface Is External and Analysis-Module Interface Is IP Unnumbered: Example, page 315

NAM Management Interface Is Internal and Analysis-Module Interface Is Assigned an IP Address: Example

In this configuration example:

- The internal NAM interface is used for management traffic.
- IP addresses from the same routable subnet are assigned to the Analysis-Module interface and the NAM system.
- A static route to the NAM through the Analysis-Module interface is configured.
- The internal NAM interface is used to monitor WAN traffic on interface Serial 0/0, and the external NAM interface is used to monitor LAN traffic on interface Fast Ethernet 0/0.
- The NM-NAM is installed in router slot 2.

Figure 17 shows the topology used in the example, and the following sections show the router and NAM configurations:

- Router Configuration (Cisco IOS Software), page 312
- NAM Configuration (NAM Software), page 313

Figure 17 NAM Management Interface Is Internal and Analysis-Module Interface Is Assigned an IP Address

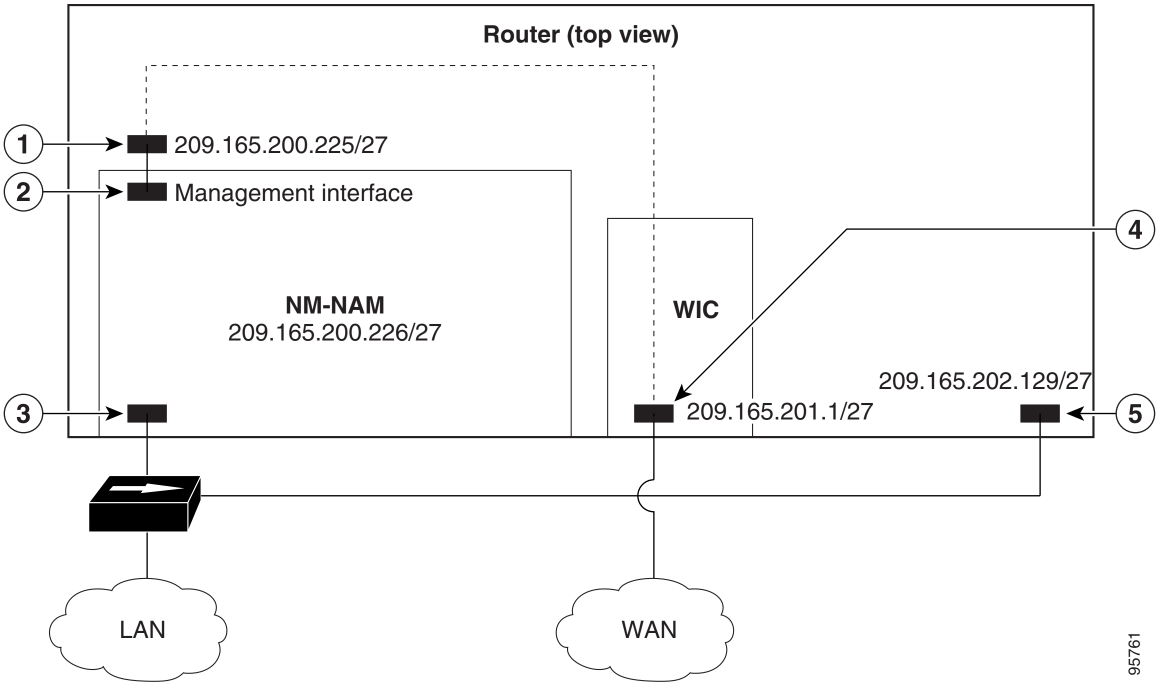


Figure 17 Callout	Interface	Location
1	Analysis-Module interface	Router internal
2	Internal NAM interface (**management**)	NM-NAM internal
3	External NAM interface	NM-NAM faceplate
4	Serial interface	WAN interface card (WIC)
5	Fast Ethernet interface	Router rear panel

Router Configuration (Cisco IOS Software)

```
!
ip cef
!
ip route 209.165.200.226 255.255.255.224 analysis-module 2/0
!
interface FastEthernet0/0
 ip address 209.165.202.129 255.255.255.224
 ip route-cache flow
 speed auto
 full-duplex
 no mop enabled
 no shutdown
!
interface Serial 0/0
 encapsulation ppp
 ip address 209.165.201.1 255.255.255.224
 analysis-module monitoring
 no shutdown
```

```
!
interface analysis-module 2/0
 ip address 209.165.200.225 255.255.255.224
 hold-queue 60 out
 no shutdown
!
```

NAM Configuration (NAM Software)

```
!
ip address 209.165.200.226 255.255.255.224
!
ip host "nam1"
!
ip domain "cisco.com"
!
ip gateway 209.165.200.225
!
ip broadcast 10.255.255.255
!
ip nameserver 172.16.201.29
!
ip interface internal
!
ip http server enable
!
exsession on
!
```

NAM Management Interface Is Internal and Analysis-Module Interface Is IP Unnumbered: Example

In this configuration example:

- The internal NAM interface is used for management traffic.
- IP addresses from the same routable subnet are assigned to the Analysis-Module interface and the NAM system.
- To conserve IP address space, the Analysis-Module interface is configured as IP unnumbered to borrow the IP address of the Fast Ethernet interface.
- A static route to the NAM through the Analysis-Module interface is configured.
- The internal NAM interface is used to monitor WAN traffic on interface Serial 0/0, and the external NAM interface is used to monitor LAN traffic on interface Fast Ethernet 0/0.
- The NM-NAM is installed in router slot 2.

Figure 18 shows the topology used in the example, and the following sections show the router and NAM configurations:

- Router Configuration (Cisco IOS Software), page 314
- NAM Configuration (NAM Software), page 315

Figure 18 Sample Topology: NAM Management Interface Is Internal and Analysis-Module Interface Is IP Unnumbered

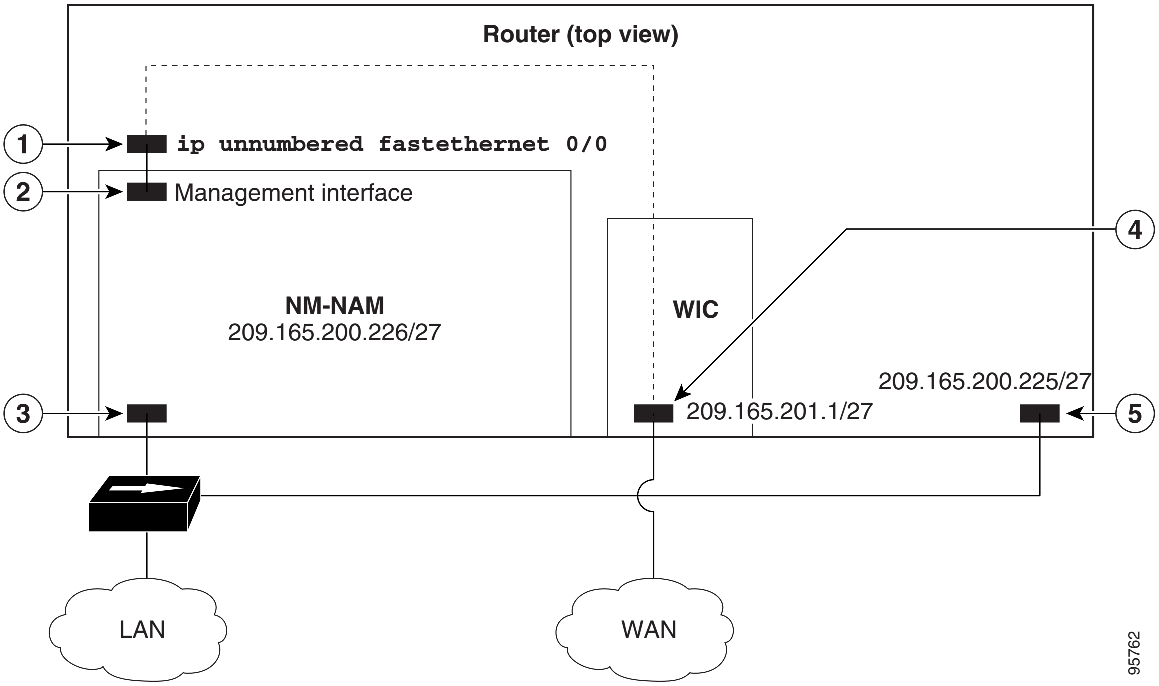


Figure 18 Callout	Interface	Location
1	Analysis-Module interface	Router internal
2	Internal NAM interface (**management**)	NM-NAM internal
3	External NAM interface	NM-NAM faceplate
4	Serial interface	WAN interface card (WIC)
5	Fast Ethernet interface	Router rear panel

Router Configuration (Cisco IOS Software)

```
!
ip cef
!
ip route 209.165.200.226 255.255.255.224 analysis-module 2/0
!
interface FastEthernet0/0
 ip address 209.165.200.225 255.255.255.224
 ip route-cache flow
 speed auto
 full-duplex
 no mop enabled
 no shutdown
!
interface Serial 0/0
 encapsulation ppp
 ip address 209.165.201.1 255.255.255.224
 analysis-module monitoring
 no shutdown
```

```
!
interface analysis-module 2/0
 ip unnumbered FastEthernet0/0
 no shutdown
 hold-queue 60 out
!
```

NAM Configuration (NAM Software)

```
!
ip address 209.165.200.226 255.255.255.224
!
ip host "nam1"
!
ip domain "cisco.com"
!
ip gateway 209.165.200.225
!
ip broadcast 10.255.255.255
!
ip nameserver 172.16.201.29
!
ip interface internal
!
ip http server enable
!
exsession on
!
```

NAM Management Interface Is External and Analysis-Module Interface Is IP Unnumbered: Example

In this configuration example:

- The external NAM interface is used for management traffic.
- The Analysis-Module interface is configured as IP unnumbered to borrow the IP address of the loopback interface.
- The borrowed loopback interface IP address is not routable.
- The NAM system is configured with an IP address from the LAN subnet that is connected to the external NAM interface.
- The internal NAM interface is used to monitor WAN traffic on interface Serial 0/0, and the external NAM interface is used to monitor LAN traffic on interface Fast Ethernet 0/0.
- The NM-NAM is installed in router slot 3.

Figure 19 shows the topology used in the example, and the following sections show the router and NAM configurations:

- Router Configuration (Cisco IOS Software), page 316
- NAM Configuration (NAM software), page 317

Figure 19 Sample Topology: NAM Management Interface Is External and Analysis-Module Interface Is IP Unnumbered

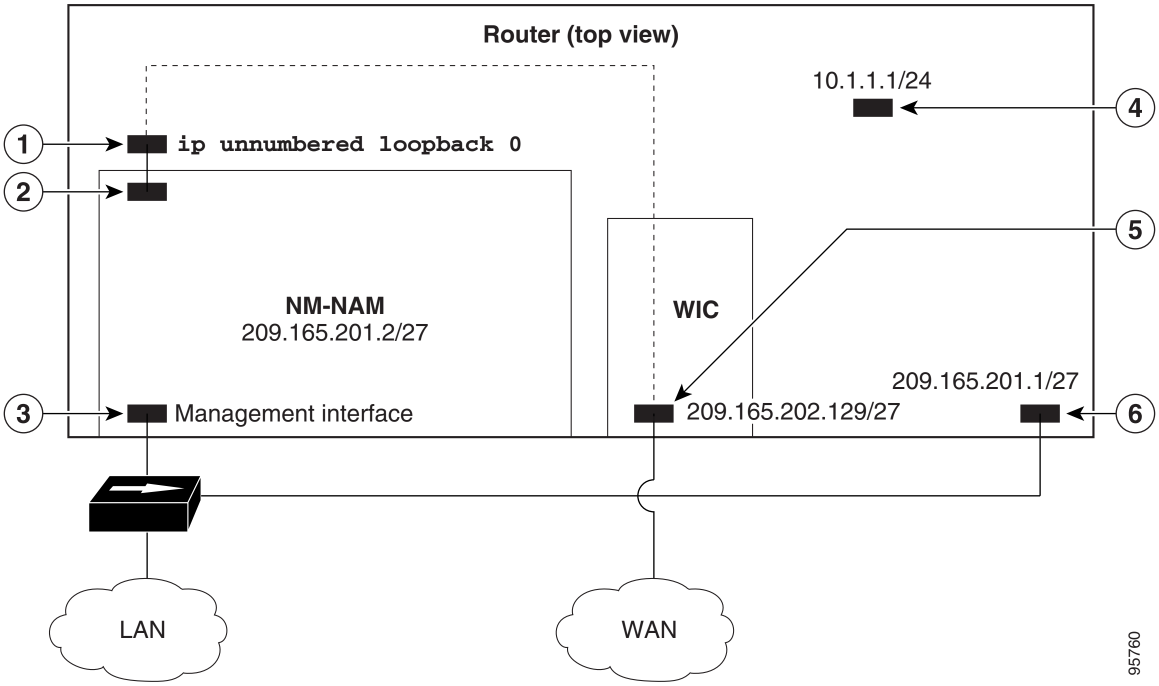


Figure 19 Callout	Interface	Location
1	Analysis-Module interface	Router internal
2	Internal NAM interface	NM-NAM internal
3	External NAM interface (**management**)	NM-NAM faceplate
4	Loopback interface	Router internal
5	Serial interface	WAN interface card (WIC)
6	Fast Ethernet interface	Router rear panel

Router Configuration (Cisco IOS Software)

```
!
ip cef
!
interface loopback 0
 ip address 10.1.1.1 255.255.255.0
!
interface FastEthernet0/0
 ip address 209.165.201.1 255.255.255.224
 ip route-cache flow
 speed auto
 full-duplex
 no mop enabled
 no shutdown
```

```
!
interface Serial 0/0
 encapsulation ppp
 ip address 209.165.202.129 255.255.255.224
 analysis-module monitoring
 no shutdown
!
interface analysis-module 3/0
 ip unnumbered loopback 0
 hold-queue 60 out
 no shutdown
!
```

NAM Configuration (NAM software)

```
!
ip address 209.165.201.2 255.255.255.224
!
ip host "nam1"
!
ip domain "cisco.com"
!
ip gateway 209.165.201.1
!
ip broadcast 10.255.255.255
!
ip nameserver 209.165.201.29
!
ip interface external
!
ip http server enable
!
exsession on
!
```

Additional References

The following sections provide references related to the Network Analysis Module (NM-NAM) feature.

Related Documents

Related Topic	Document Title
Compatibility matrixes for NAM software releases, Cisco IOS releases, and platforms Links to software downloads, product documentation, and technical documentation, including NAM software release notes, user guide, and command reference	Cisco Network Analysis Module (NAM)
Installing and cabling network modules	*Cisco Network Modules Hardware Installation Guide*
Safety and compliance	*Cisco Network Modules and Interface Cards Regulatory Compliance and Safety Information*
Cisco IOS interface commands: complete command syntax, command mode, command history, defaults, usage guidelines, and examples	*Cisco IOS Interface and Hardware Component Command Reference*

Related Topic	Document Title
Router documentation	Modular Access Routers
IP unnumbered interfaces	*Understanding and Configuring the ip unnumbered Command*
Authentication, authorization, and accounting (AAA)	*Cisco IOS Security Configuration Guide*

Standards

Standards	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	—

MIBs

MIBs	MIBs Link
Router MIBs: - CISCO-ENTITY-VENDORTYPE-OID-MIB Network Analysis Module (NAM) MIBs: - ART-MIB - DSMON-MIB - HC-RMON-MIB - MIB-II - RMON-MIB - RMON2-MIB - SMON-MIB	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

RFCs	Title
RFC 2021	*Remote Network Monitoring Management Information Base Version 2 using SMIv2*
RFC 2074	*Remote Network Monitoring MIB Protocol Identifiers*
RFC 2613	*Remote Network Monitoring MIB Extensions for Switch Networks Version 1.0*
RFC 2819	*Remote Network Monitoring Management Information Base*
RFC 3273	*Remote Network Monitoring Management Information Base for High Capacity Networks*
RFC 3287	*Remote Monitoring MIB Extensions for Differentiated Services*

Technical Assistance

Description	Link
Technical Assistance Center (TAC) home page, containing 30,000 pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/public/support/tac/home.shtml

Command Reference

The following new commands are pertinent to this feature. To see the command pages for these commands and other commands used with this feature, go to the *Cisco IOS Master Commands List*, Release 12.4, at http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124mindx/124index.htm.

- **analysis-module monitoring**
- **interface analysis-module**
- **service-module analysis-module reload**
- **service-module analysis-module reset**
- **service-module analysis-module session**
- **service-module analysis-module shutdown**
- **service-module analysis-module status**
- **show controllers analysis-module**
- **show interfaces analysis-module**

Glossary

AAA—authentication, authorization, and accounting. Pronounced “triple a.”

access list—A list kept by routers to control access to or from the router for a number of services (for example, to prevent packets with a certain IP address from leaving a particular interface on the router).

CEF—Cisco Express Forwarding.

DSMON—Differentiated Services Monitoring.

flooding—Traffic passing technique used by switches and bridges in which traffic received on an interface is sent out all the interfaces of that device except the interface on which the information was received originally.

GRE—generic routing encapsulation. Tunneling protocol developed by Cisco that can encapsulate a wide variety of protocol packet types inside IP tunnels, creating a virtual point-to-point link to Cisco routers at remote points over an IP internetwork. By connecting multiprotocol subnetworks in a single-protocol backbone environment, IP tunneling using GRE allows network expansion across a single-protocol backbone environment.

GUI—graphical user interface. A user environment that uses pictorial as well as textual representations of the input and the output of applications and the hierarchical or other data structure in which information is stored. Such conventions as buttons, icons, and windows are typical, and many actions are performed using a pointing device (such as a mouse). Microsoft Windows and the Apple Macintosh are prominent examples of platforms using a GUI.

IP multicast—Routing technique that allows IP traffic to be propagated from one source to a number of destinations or from many sources to many destinations. Rather than sending one packet to each destination, one packet is sent to a multicast group identified by a single IP destination group address.

MIB—Management Information Base. Database of network management information that is used and maintained by a network management protocol, such as SNMP or Common Management Information Protocol (CMIP). The value of a MIB object can be changed or retrieved using SNMP or CMIP commands, usually through a GUI network management system. MIB objects are organized in a tree structure that includes public (standard) and private (proprietary) branches.

NAT—Network Address Translation. Mechanism for reducing the need for globally unique IP addresses. NAT allows an organization with addresses that are not globally unique to connect to the Internet by translating those addresses into globally routable address space. Also known as *Network Address Translator.*

NetFlow—A feature of some routers that allows them to categorize incoming packets into flows. Because packets in a flow often can be treated in the same way, this classification can be used to bypass some of the work of the router and accelerate its switching operation.

PCI—Peripheral Component Interconnect. An industry local bus standard.

QoS—quality of service. Cisco IOS QoS technology lets complex networks control and predictably service a variety of networked applications and traffic types.

RMON—remote monitoring. MIB agent specification described in RFC 1271 that defines functions for the remote monitoring of networked devices. The RMON specification provides numerous monitoring, problem detection, and reporting capabilities.

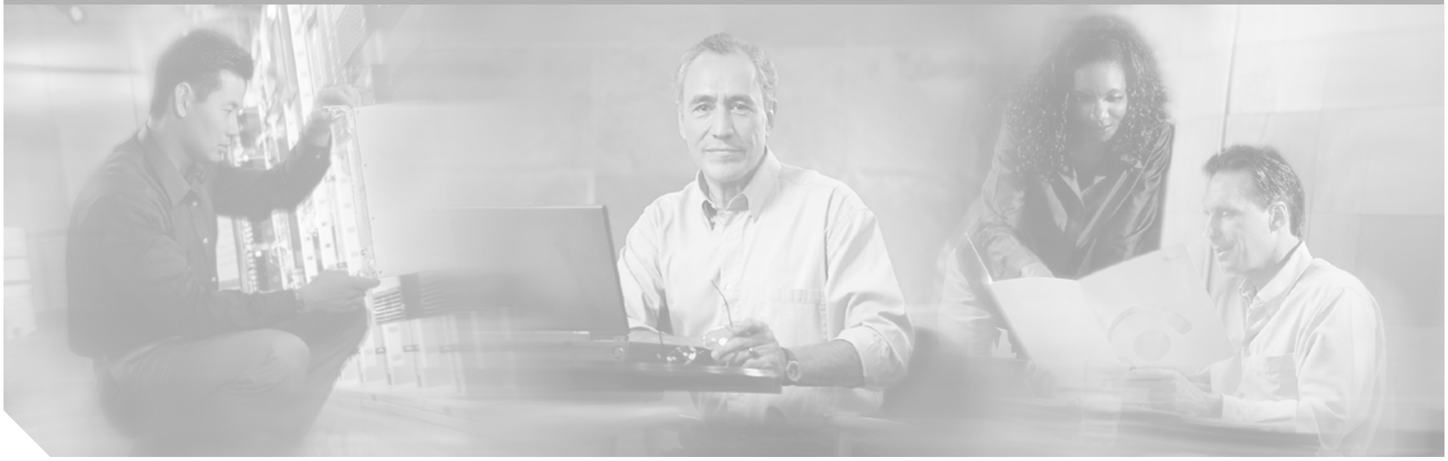
SNMP—Simple Network Management Protocol. Network management protocol used almost exclusively in TCP/IP networks. SNMP provides a means to monitor and control network devices, and to manage configurations, statistics collection, performance, and security. SNMPv2c supports centralized and distributed network management strategies and includes improvements in the Structure of Management Information (SMI), protocol operations, management architecture, and security. SNMPv3 provides secure access to devices by a combination of authenticating and encrypting packets over the network.

SSH—Secure Shell Protocol. A protocol that provides a secure remote connection to a router through a Transmission Control Protocol (TCP) application.

UDP—User Datagram Protocol. Connectionless transport layer protocol in the TCP/IP protocol stack. UDP is a simple protocol that exchanges datagrams without acknowledgments or guaranteed delivery, requiring that error processing and retransmission be handled by other protocols. UDP is defined in RFC 768.

VoIP—Voice over IP. The capability to carry normal telephony-style voice over an IP-based Internet with POTS-like functionality, reliability, and voice quality. VoIP enables a router to carry voice traffic (for example, telephone calls and faxes) over an IP network. In VoIP, the digital signal processor (DSP) segments the voice signal into frames, which then are coupled in groups of two and stored in voice packets. These voice packets are transported using IP in compliance with ITU-T specification H.323.

Note Refer to *Internetworking Terms and Acronyms* for terms not included in this glossary.



Part 5: Configuring HTTP Services

HTTP 1.1 Web Server and Client

The HTTP 1.1 Web Server and Client feature provides a consistent interface for users and applications by implementing support for HTTP 1.1 in Cisco IOS software-based devices. Prior to this release, Cisco software supported an implementation of HTTP 1.0. The integrated HTTP server API supports server application interfaces. When combined with the HTTPS feature, the HTTP 1.1 Web Server and Client provides a complete, secure solution for HTTP services to and from Cisco devices.

Feature Specifications for the HTTP 1.1 Web Server and Client

Feature History	
Release	**Modification**
11.2	The HTTP 1.0 Web Server and Cisco Web browser user interface were introduced.
12.2(15)T	The HTTP 1.1 Web Server and HTTP 1.1 Web Client were introduced.
Supported Platforms	
The HTTP 1.1 Web Server and Client are supported on all Cisco IOS-based platforms. See Cisco Feature Navigator for details.	

Finding Support Information for Platforms and Cisco IOS Software Images

Use Cisco Feature Navigator to find information about platform support and Cisco IOS software image support. Access Cisco Feature Navigator at http://www.cisco.com/go/fn. You must have an account on Cisco.com. If you do not have an account or have forgotten your username or password, click **Cancel** at the login dialog box and follow the instructions that appear.

Contents

Information About the HTTP 1.1 Web Server and Client

This feature updates the Cisco implementation of the Hypertext Transfer Protocol (HTTP) from 1.0 to 1.1. The HTTP server allows features and applications, such as the Cisco Web browser user interface, to be run on your routing device.

The Cisco implementation of HTTP 1.1 is backward-compatible with previous Cisco IOS releases. If you are currently using configurations that enable the HTTP server, no configuration changes are needed, as all defaults remain the same.

The process of enabling and configuring the HTTP server also remains the same as in previous releases. Support for Server Side Includes (SSI) and HTML forms has not changed. Additional configuration options, in the form of the **ip http timeout-policy** command and the **ip http max-connections** command have been added. These options allow configurable resource limits for the HTTP server. If you do not use these optional commands, the default policies are used.

Remote applications may require that you enable the HTTP server before using them. Applications that use the HTTP server include:

- the Cisco web browser user interface, which uses the Cisco IOS Homepage Server, HTTP-based EXEC Server, and HTTP IOS File System (IFS) Server
- the VPN Device Manager (VDM) application, which uses the VDM Server and the XML Session Manager (XSM)
- the QoS Device Manager (QDM) application, which uses the QDM Server
- the IP Phone and Cisco IOS Telephony Service applications, which uses the ITS Local Directory Search and IOS Telephony Server (ITS)

No Cisco applications make use of the HTTP Client in Cisco IOS Release 12.2(15)T.

About HTTP Server General Access Policies

The new **ip http timeout-policy** command allows you to specify general access characteristics for the server by configuring a value for idle time, connection life, and request maximum. By adjusting these values you can configure a general policy; for example, if you want to maximize throughput for HTTP connections, you should configure a policy that minimizes connection overhead. You can do this by specifying large values for the **life** and **request** options so that each connection stays open longer and more requests are processed for each connection.

Another example would be to configure a policy that minimizes the response time for new connections. You can do this by specifying small values for the **life** and **request** options so that the connections are quickly released to serve new clients.

A throughput policy would be better for HTTP sessions with dedicated management applications, as it would allow the application to send more requests before the connection is closed, while a response time policy would be better for interactive HTTP sessions, as it would allow more people to connect to the server at the same time without having to wait for connections to become available.

In general, you should configure these options as appropriate for your environment. The value for the **idle** option should be balanced so that it is large enough not to cause an unwanted request or response timeout on the connection, but small enough that it does not hold a connection open longer than necessary.

Access security policies for the HTTP server are configured using the **ip http authentication** command, which allows only selective users to access the server, and the **ip http access-class** command, which allows only selective IP hosts to access the server.

How to Configure the HTTP 1.1 Web Server

To enable the HTTP server and configure optional server characteristics, perform the following steps. The HTTP server is disabled by default.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip http server**
4. **ip http authentication** (optional)
5. **ip http port** (optional)
6. **ip http path** (optional)
7. **ip http access-class** (optional)
8. **ip http max-connections** (optional)
9. **ip http timeout-policy** (optional)

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 http server`**
	Example:
	`Router(config)# ip http server`
		Enables the HTTP 1.1 server, including the Cisco web browser user interface.
		Note If you are enabling the secure HTTP (HTTPS) server using the **ip http secure-server** command, you should disable the standard HTTP server using the **no ip http server** command. This is required to ensure only secure connections to the server.

	Command or Action	Purpose

Step 4	**ip http authentication** {**aaa** | **enable** | **local** | **tacacs**}
	Example:
	`Router(config)# ip http authentication aaa`
		(Optional) Specifies the authentication method to be used for login when a client connects to the HTTP server. The methods for authentication are:
		aaa—Indicates that the authentication method used for the AAA login service (specified by by the **aaa authentication login default** command) should be used for authentication.
		enable—Indicates that the "enable" password should be used for authentication. (This is the default method.)
		local —Indicates that the login user name, password and privilege level access combination specified in the local system configuration (by the **username** global configuration command) should be used for authentication and authorization.
		tacacs—Indicates that the TACACS (or XTACACS) server should be used for authentication.

Step 5	**ip http port** *port-number* **Example:** `Router(config)# ip http port 8080`	(Optional) Specifies the server port that should be used for HTTP communication (for example, for the Cisco Web browser user interface).
Step 6	**ip http path** *URL* **Example:** `Router(config)# ip http path slot1:`	(Optional) Sets the base HTTP path for HTML files. The base path is used to specify the location of the HTTP server files (HTML files) on the local system. Generally, the HTML files are located in system Flash memory.
Step 7	**ip http access-class** *access-list-number* **Example:** `Router(config)# ip http access-class 20`	(Optional) Specifies the access list that should be used to allow access to the HTTP server.

	Command or Action	Purpose

Step 8	**`ip http max-connections`** *`value`*
	Example:
	`Router(config)# ip http max-connections 10`
		(Optional) Sets the maximum number of concurrent connections to the HTTP sever that will be allowed. The default value is 5.

Step 9	**`ip http timeout-policy idle`** *`seconds`* **`life`** *`seconds`* **`requests`** *`value`*
	Example:
	`Router(config)#` **`ip http timeout-policy idle 30 life 120 requests 100`**
		(Optional) Sets the characteristics that determine how long a connection to the HTTP server should remain open. The characteristics are:
		idle—The maximum number of seconds the connection will be kept open if no data is received or response data can not be sent out on the connection. Note that a new value may not take effect on any already existing connections. If the server is too busy or the limit on the **life** time or the number of **requests** is reached, the connection may be closed sooner. The default value is 180 seconds (3 minutes).
		life—The maximum number of seconds the connection will be kept open, from the time the connection is established. Note that the new value may not take effect on any already existing connections. If the server is too busy or the limit on the idle time or the number of requests is reached, it may close the connection sooner. Also, since the server will not close the connection while actively processing a request, the connection may remain open longer than the specified **life** time if processing is occurring when the life maximum is reached. In this case, the connection will be closed when processing finishes. The default value is 180 seconds (3 minutes). The maximum value is 86400 seconds (24 hours).
		requests—The maximum limit on the number of requests processed on a persistent connection before it is closed. Note that the new value may not take effect on any already existing connections. If the server is too busy or the limit on the idle time or the life time is reached, the connection may be closed before the maximum number of requests are processed. The default value is 1. The maximum value is 86400.

How to Configure the HTTP Client

The standard HTTP 1.1 client and the secure HTTP client are always enabled. No commands exist to disable the HTTP client. For information about configuring optional characteristics for the secure HTTP (HTTPS) client, see the "HTTPS - HTTP Server and Client with SSL 3.0" 12.2(15)T feature guide document.

To configure optional characteristics of the HTTP client, use any of the following optional commands.

1. **ip http client cache**
2. ip http client connection
3. ip http client password
4. ip http client proxy-server

5. ip http client response
6. ip http client source-interface
7. ip http client username

```
Router(config)#ip http client ?
  cache              HTTP client cache
  connection         Configure HTTP Client connection
  password           Specify password for HTTP(S) file system client connections
  proxy-server       Specify proxy server name for HTTP file system client
                     connections
  response           How long HTTP Client waits for a response from the server
                     for a request message before giving up
  source-interface   Specify interface for source address in all HTTP(S) client
                     connections
  username           Specify username for HTTP(S) file system client connections
```

DETAILED STEPS

	Command or Action	Purpose

Step 1	`ip http client cache ager interval <0-60>`
	
	`ip http client cache memory {file <kilobytes> | pool <kilobytes> }`
		`C3660-1(config)#ip http client cache ?`
		`  ager    Cache Ager Interval Time`
		`  memory  Maximum memory allowed for HTTP Client`
		`Cache`
		
		`C3660-1(config)#ip http client cache ager ?`
		`  interval  Interval Time`
		
		`C3660-1(config)#ip http client cache ager interval`
		`?`
		`  <0-60>  Interval in Minutes<0-60>, default is 5`
		
		`C3660-1(config)#ip http client cache ager interval`
		`5 ?`
		`  <cr>`
		
		`C3660-1(config)#ip http client cache memory ?`
		`  file  maximum file size allowed for caching`
		`  pool  maximum memory pool allowed for http cache`
		
		`C3660-1(config)#ip http client cache memory file ?`
		`  <1-10>  size of cache memory file in`
		`kbytes<1-10>, default is 2`
		
		`C3660-1(config)#ip http client cache memory file 2`
		`?`
		`  <cr>`
		
		`C3660-1(config)#ip http client cache memory pool ?`
		`  <0-100>  size of cache memory pool in kbytes`
		`<0-100>, default is 100`
		
		`C3660-1(config)#ip http client cache memory pool`
		`100 ?`
		`  <cr>`
		
		`C3660-1(config)#ip http client cache ?`
		`  ager    Cache Ager Interval Time`
		`  memory  Maximum memory allowed for HTTP Client`
		`Cache`
		
		•

Step 2	`ip http client connection {retry <1-5> | idle timeout <1-60> | persistent | timeout <1-60>}`	

Step 3	`ip http server`
	
	Example:
	`Router(config)# ip http server`
		Enables the HTTP 1.1 server, including the Cisco web browser user interface.
		
		Note If you are enabling the secure HTTP (HTTPS) server using the **ip http secure-server** command, you should disable the standard HTTP server using the **no ip http server** command. This is required to ensure only secure connections to the server.

	Command or Action	Purpose

Step 4	`ip http authentication {aaa | enable | local | tacacs}`
	Example:
	`Router(config)# ip http authentication aaa`
		(Optional) Specifies the authentication method to be used for login when a client connects to the HTTP server. The methods for authentication are:
		aaa—Indicates that the authentication method used for the AAA login service (specified by by the **aaa authentication login default** command) should be used for authentication.
		enable—Indicates that the “enable” password should be used for authentication. (This is the default method.)
		local —Indicates that the login user name, password and privilege level access combination specified in the local system configuration (by the **username** global configuration command) should be used for authentication and authorization.
		tacacs—Indicates that the TACACS (or XTACACS) server should be used for authentication.

Step 5	`ip http port port-number`
	Example:
	`Router(config)# ip http port 8080`
		(Optional) Specifies the server port that should be used for HTTP communication (for example, for the Cisco Web browser user interface).

Step 6	`ip http path URL`
	Example:
	`Router(config)# ip http path slot1:`
		(Optional) Sets the base HTTP path for HTML files. The base path is used to specify the location of the HTTP server files (HTML files) on the local system. Generally, the HTML files are located in system Flash memory.

Step 7	`ip http access-class access-list-number`
	Example:
	`Router(config)# ip http access-class 20`
		(Optional) Specifies the access list that should be used to allow access to the HTTP server.

	Command or Action	Purpose
Step 8	**ip http max-connections** *value* **Example:** Router(config)# ip http max-connections 10	(Optional) Sets the maximum number of concurrent connections to the HTTP sever that will be allowed. The default value is 5.
Step 9	**ip http timeout-policy idle** *seconds* **life** *seconds* **requests** *value* **Example:** Router(config)# **ip http timeout-policy idle 30 life 120 requests 100**	(Optional) Sets the characteristics that determine how long a connection to the HTTP server should remain open. The characteristics are: **idle**—The maximum number of seconds the connection will be kept open if no data is received or response data can not be sent out on the connection. Note that a new value may not take effect on any already existing connections. If the server is too busy or the limit on the **life** time or the number of **requests** is reached, the connection may be closed sooner. The default value is 180 seconds (3 minutes). **life**—The maximum number of seconds the connection will be kept open, from the time the connection is established. Note that the new value may not take effect on any already existing connections. If the server is too busy or the limit on the idle time or the number of requests is reached, it may close the connection sooner. Also, since the server will not close the connection while actively processing a request, the connection may remain open longer than the specified **life** time if processing is occurring when the life maximum is reached. In this case, the connection will be closed when processing finishes. The default value is 180 seconds (3 minutes). The maximum value is 86400 seconds (24 hours). **requests**—The maximum limit on the number of requests processed on a persistent connection before it is closed. Note that the new value may not take effect on any already existing connections. If the server is too busy or the limit on the idle time or the life time is reached, the connection may be closed before the maximum number of requests are processed. The default value is 1. The maximum value is 86400.

Configuration Examples for the HTTP 1.1 Web Server

The following example shows a typical configuration that enables the server and sets some of the characteristics:

```
Router(config)# ip http server
Router(config)# ip http authentication aaa
Router(config)# ip http path flash:
Router(config)# ip http access-class 10
Router(config)# ip http max-connections 10
```

In the following example, a Throughput timeout policy is applied. This configuration would allow each connection to be idle a maximum of 30 seconds (approximately). Each connection will remain open (be "alive") until either the HTTP server has been busy processing requests for approximately 2 minutes (120 seconds) or until approximately100 requests have been processed.

```
Router(config)# ip http timeout-policy idle 30 life 120 requests 100
```

In the following example, a Response Time timeout policy is applied. This configuration would allow each connection to be idle a maximum of 30 seconds (approximately). Each connection will be closed as soon as the first request has been processed.

```
Router(config)# ip http timeout-policy idle 30 life 30 requests 1
```

Verifying HTTP Connectivity

To verify remote connectivity to the HTTP server, enter the system IP address in a Web browser, followed by a colon and the appropriate port number (80 is the default port number).

For example, if the system IP address is 209.165.202.129 and the port number is 8080, enter **http://209.165.202.129:8080** as the URL in a Web browser.

If HTTP authentication is configured, a login dialog box will appear. Enter the appropriate user name and password. If the default login authentication method of "enable" is configured, you may leave the username field blank, and use the "enable" password to log in.

The system home page should appear in your browser.

Where to Go Next

For information about secure HTTP connections using Secure Socket Layer (SSL) 3.0, refer to the "HTTPS - HTTP with SSL 3.0" 12.2(15)T feature document listed below.

Additional References

For additional information related to the HTTP 1.1 Web Server and Client, refer to the following references:

Related Documents

Related Topic	Document Title
HTTPS	"HTTPS - HTTP with SSL 3.0," 12.2(15)T feature document: http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122newft/122t/122t15/ftsslsht.htm
HTTPS	"Firewall Support of HTTPS Authentication Proxy," 12.2(15)T feature document

Standards

No specific standards are supported by this feature. Note that HTTP 1.1, as defined in RFC 2616, is currently classified as a "Standards Track" document by the IETF.

MIBs

MIBs	MIBs Link
• No specific MIBs are supported for this feature.	To obtain lists of supported MIBs by platform and Cisco IOS release, and to download MIB modules, go to the Cisco MIB website on Cisco.com at the following URL: http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml

To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL:

http://tools.cisco.com/ITDIT/MIBS/servlet/index

If Cisco MIB Locator does not support the MIB information that you need, you can also obtain a list of supported MIBs and download MIBs from the Cisco MIBs page at the following URL:

http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml

To access Cisco MIB Locator, you must have an account on Cisco.com. If you have forgotten or lost your account information, send a blank e-mail to cco-locksmith@cisco.com. An automatic check will verify that your e-mail address is registered with Cisco.com. If the check is successful, account details with a new random password will be e-mailed to you. Qualified users can establish an account on Cisco.com by following the directions found at this URL:

http://www.cisco.com/register

RFCs

RFCs[1]	Title
RFC 2616	"Hypertext Transfer Protocol -- HTTP/1.1"

[1] Not all supported RFCs are listed.

The Cisco implementation of the HTTP version 1.1 supports a subset of elements defined in RFC 2616. The following is a list of supported RFC 2616 headers:

- Allow (Only GET, HEAD, and POST methods are supported)
- Authorization, WWW-Authenticate - Basic authentication only
- Cache-control
- Chunked Transfer Encoding
- Connection close
- Content-Encoding
- Content-Language
- Content-Length
- Content-Type
- Date, Expires
- Location

Technical Assistance

Description	Link
Technical Assistance Center (TAC) home page, containing 30,000 pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/public/support/tac/home.shtml

Command Reference

The following new and modified commands are pertinent to this feature. To see the command pages for these commands and other commands used with this feature, go to the *Cisco IOS Master Commands List*, Release 12.4, at http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124mindx/124index.htm.

- **debug ip http all**
- **ip http access-class**
- **ip http max-connections**
- **ip http path**
- **ip http port**

- **ip http server**
- **ip http timeout-policy**
- **show ip http server**

HTTPS - HTTP Server and Client with SSL 3.0

This feature provides Secure Socket Layer (SSL) version 3.0 support for the HTTP 1.1 server and HTTP 1.1 client within Cisco IOS software. SSL provides server authentication, encryption, and message integrity to allow secure HTTP communications. SSL also provides HTTP client authentication. HTTP over SSL is abbreviated as HTTPS.

Specifications for the HTTPS - HTTP Server and Client with SSL 3.0 Feature

Feature History	
Release	**Modification**
12.2(15)T	This feature was introduced.
Supported Platforms	
This feature is supported only in Cisco IOS software images that support SSL. Specifically, SSL is supported in "IPSec 56" and "IPSec 3DES" images (contains "k8" or "k9" in the image name) in Cisco IOS Release 12.2(15)T.	

Finding Support Information for Platforms and Cisco IOS Software Images

Use Cisco Feature Navigator to find information about platform support and Cisco IOS software image support. Access Cisco Feature Navigator at http://www.cisco.com/go/fn. You must have an account on Cisco.com. If you do not have an account or have forgotten your username or password, click **Cancel** at the login dialog box and follow the instructions that appear.

Contents

Prerequisites for HTTPS - HTTP Server and Client with SSL 3.0

If you want to enable secure HTTP connections (encryption) without a configured certificate authority trustpoint, you must first ensure that each device has the key (such as an RSA public key or a shared key) of the other device. In most cases an RSA key-pair will be generated automatically. The RSA key-pair is used for creating a self-signed certificate (which is also generated automatically).

Restrictions for HTTPS - HTTP Server and Client with SSL 3.0

This feature is available only in Cisco IOS software images that support SSL. In this release, SSL is supported in "IPSec 56" (contains "k8" in the image name) and "IPSec 3DES" images (contains "k9" in the image name). "IPSec 56" images provide up to 64-bit encryption, "IPSec 3 DES" images provide greater than 64-bit encryption. The following CipherSuites are supported in IPSec DES images:

- SSL_RSA_WITH_RC4_128_MD5 —RSA key exchange (RSA Public Key Cryptography) with RC4 128-Bit encryption and MD5 for message digest
- SSL_RSA_WITH_RC4_128_SHA —RSA key exchange with RC4 128-Bit encryption and SHA for message digest
- SSL_RSA_WITH_3DES_EDE_CBC_SHA—RSA key exchange with 3DES and DES-EDE3-CBC for message encryption and SHA for message digest
- SSL_RSA_WITH_DES_CBC_SHA—RSA key exchange with DES-CBC for message encryption and SHA for message digest

For IPSec 56 images, only the SSL_RSA_WITH_DES_CBC_SHA CipherSuite is supported. For further details on these CipherSuites, see "The SSL Protocol Version 3.0" Internet-Draft document (see the Related Documents section).

For this feature RSA (in conjunction with the specified encryption and digest algorithm combinations above) is used for both key generation and authentication on SSL connections. This usage is independent of whether a CA trustpoint is configured or not.

Information About HTTPS - HTTP Server and Client with SSL 3.0

To configure the HTTPS - HTTP with SSL 3.0 feature, you should understand the following concepts:

- The Secure HTTP Server and Secure HTTP Client, page 340
- Certificate Authority Trustpoints, page 341
- CipherSuites, page 341

The Secure HTTP Server and Secure HTTP Client

A secure HTTP connection means that data sent to and received from an HTTP server are encrypted before being sent out over the internet. HTTP with SSL encryption provides a secure connection to allow such functions as configuring a router from a web browser. Cisco's implementation of the secure HTTP server and secure HTTP client uses an implementation of the Secure Socket Layer (SSL) version 3.0. Application layer encryption provides an alternative to older methods such as having to set up a tunnel to the HTTP server for remote management. HTTP over SSL is abbreviated as HTTPS; the URL of a secure connection will begin with https:// instead of http://.

The Cisco IOS HTTP secure server's primary role is to listen for HTTPS requests on a designated port (the default HTTPS port is 443) and pass the request to the HTTP 1.1 web server. The HTTP 1.1 server processes requests and passes responses (served pages) back to the HTTP secure server, which, in turn, responds to the original request.

The Cisco IOS HTTP secure client's primary role is to respond to Cisco IOS application requests for HTTPS User Agent services, perform HTTPS User Agent services on the application's behalf, and pass the response back to the application.

Certificate Authority Trustpoints

Certificate authorities (CAs) are responsible for managing certificate requests and issuing certificates to participating IPSec network devices. These services provide centralized security key and certificate management for the participating devices. Specific CA servers are referred to as "trustpoints."

The HTTPS server provides a secure connection by providing a certified X.509v3 certificate to the client when a connection attempt is made. The certified X.509v3 certificate is obtained from a specified CA trustpoint. The client (usually a web browser), in turn, has a public key that allows it to authenticate the certificate.

Configuring a CA trustpoint is highly recommended for secure HTTP connections. However, if a CA trustpoint is not configured for the routing device running the HTTPS server, the server will certify itself and generate the needed RSA key pair. Because a self-certified (self-signed) certificate does not provide adequate security, the connecting client will generate a notification that the certificate is self-certified, and the user will have the opportunity to accept or reject the connection. This option is available for internal network topologies (such as testing).

This feature also provides an optional command (**ip http secure-client-auth**) that, when enabled, has the HTTPS server request an X.509v3 certificate from the client. Authenticating the client provides more security than server authentication by itself.

For additional information on Certificate Authorities, see the "Configuring Certification Authority Interoperability" chapter in the *Cisco IOS Security Configuration Guide, Release 12.2*.

CipherSuites

A CipherSuite specifies the encryption algorithm and digest algorithm to use on a SSL connection. Web browsers will offer a list of supported CipherSuites when connecting to the HTTPS server, and the client and server will negotiate the best encryption algorithm to use from those that are supported by both. For example, Netscape Communicator 4.76 supports U.S. security with RSA Public Key Cryptography, MD2, MD5, RC2-CBC, RC4, DES-CBC, and DES-EDE3-CBC.

For the best possible encryption, you should use a browser that supports 128-bit encryption, such as Microsoft Internet Explorer version 5.5 (or later), or Netscape Communicator version 4.76 (or later). The SSL_RSA_WITH_DES_CBC_SHA CipherSuite provides less security than the other CipherSuites, as it does not offer 128-bit encryption.

In terms of router processing load (speed), the following list ranks the CipherSuites from fastest to slowest (slightly more processing time is required for the more secure and more complex CipherSuites):

1. SSL_RSA_WITH_DES_CBC_SHA
2. SSL_RSA_WITH_RC4_128_MD5
3. SSL_RSA_WITH_RC4_128_SHA
4. SSL_RSA_WITH_3DES_EDE_CBC_SHA

How to Configure the Secure HTTP Server and Client

- Declaring a Certificate Authority Trustpoint, page 342
- Configuring the Secure HTTP Server, page 345
- Configuring HTTP Server Options, page 348
- Configuring the Secure HTTP Client, page 350

Declaring a Certificate Authority Trustpoint

Configuring a CA trustpoint is highly recommended for secure HTTP connections. The certified X.509v3 certificate for the secure HTTP server (or client) is obtained from the specified CA trustpoint. If you do not declare a CA trustpoint, then a self-signed certificate will be used for secure HTTP connections. The self-signed certificate is generated automatically.

SUMMARY STEPS

1. **hostname**
2. **ip domain-name**
3. **crypto key generate rsa** (optional)
4. **crypto ca trustpoint**
5. **enrollment url**
6. **enrollement http-proxy** (optional)
7. **crl** {**query** | **optional** | **best-effort**}
8. **primary**
9. **exit**
10. crypto ca auth
11. crypto ca enroll
12.

DETAILED STEPS

	Command or Action	Purpose

Step 1	**hostname** *name*
	Example:
	`(config)# hostname Router`
	`Router(config)#`
		Specifies the host name of the router.
		• This step is only needed if you have not previously configured a host-name for your router. The host name is required because a fully qualified domain name is needed for security keys and certificates.

Step 2	**ip domain-name** *name* **Example:** `Router(config)# ip domain-name myrouter.example.com`	Specifies the IP domain name of the router. • This step is only needed if you have not previously configured an IP domain name for your router. The domain name is required because a fully qualified domain name is needed for security keys and certificates.

Step 3	**crypto key generate rsa** [**usage-keys**]
	Example:
	`Router(config)# crypto key generate rsa`
	`The name for the keys will be: myrouter.example.com`
	`How many bits in the modulus[512]?`
	`Generating RSA keys.... [OK].`
		(Optional) Generates an RSA key pair.
		• RSA key pairs are used to sign and encrypt IKE key management messages and are required before you can obtain a certificate for your router.
		• RSA key pairs are generated automatically. This command can be used to regenerate the keys, if needed.

Step 4	**crypto ca trustpoint** *name* **Example:** `Router(config)# crypto ca trustpoint TP1`	Specifies a local configuration name for the CA trustpoint and enters CA TrustPoint configuration mode. **Note** The **crypto ca identity** command was replaced by the **crypto ca trustpoint** command in Cisco IOS Release 12.2(8)T.

Step 5	**enrollment url** *URL*
	Example:
	`Router(ca-trustpoint)# enrollment url`
	`http://TP1.domain.com`
		URL of the CA where your router should send certificate requests.
		• If you are using Simple Certificate Enrollment Protocol (SCEP) for enrollment, the URL argument must be in the form **http://***CA-name*, where *CA-name* is the host Domain Name System (DNS) name or IP address of the CA trustpoint.

Step 6	**enrollment http-proxy** *host-name port-number*
	Example:
	`Router(ca-trustpoint)# enrollment http-proxy domain2.com`
	`8080`
		(Optional) Configures the router to obtain certificates from the CA through an HTTP proxy server.

	Command or Action	Purpose

Step 7	**crl** {**query** *url* | **optional** | **best-effort**}
	Example:
	`Router(ca-trustpoint)# crl query ldap://example.domain.com`
		Configures the router to request a certificate revocation list (CRL), make CRL checking optional, or perform CRL checking on a “best-effort” basis.
		• CRLs ensure that the certificate of the peer has not been revoked.
		• The **crl optional** command configures the router to accept certificates even if the appropriate CRL can not be downloaded.
		• Use the **crl query url** command to specify the Lightweight Directory Access Protocol (LDAP) URL of the CA server; for example, **ldap://another_server**.

Step 8	**primary** **Example:** `Router(ca-trustpoint)# primary`	(Optional) Specifies that this trustpoint should be used as the primary (default) trustpoint for CA requests. • Use this command if more than one CA trustpoint will be configured on this router.
Step 9	**exit** **Example:** `Router(ca-trustpoint)# exit`	Exits CA TrustPoint Configuration Mode and returns the CLI to global configuration mode.
Step 10	**crypto ca authenticate** *name* **Example:** `Router(config)# crypto ca authenticate TP1`	Authenticates the CA by getting the public key of the CA. • Use the same name that you used when declaring the CA in the **crypto ca trustpoint** command.
Step 11	**crypto ca enrollment** *name* **Example:** `Router(config)# crypto ca enrollment TP1`	Obtains the certificate from the specified CA trustpoint. • This command requests a signed certificate from the CA for each RSA key pair.
Step 12	**copy running-config startup-config** or **copy system:running-config nvram:startup-config** **Example:** `Router(config)# do copy running-config startup-config`	Saves the configuration to NVRAM. • This command is required to save the certificates into NVRAM. If not used, the certificates would be lost at router reload. • The **do** command prefix allows you to execute EXEC mode commands in global configuration mode.

Configuring the Secure HTTP Server

Prerequisites

If a certificate authority is to be used for certification, you should declare the CA trustpoint on the routing device before enabling the secure HTTP server.

SUMMARY STEPS

1. **show ip http server status**
2. **configure terminal**
3. **ip http secure-server**
4. **ip http secure-port**
5. **ip http secure-ciphersuite**
6. **ip http secure-client-auth**
7. **ip http secure-trustpoint**
8. **end**
9. **show ip http server secure status**

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router# **show ip http server status** **Example:** Router# show ip http server status HTTP server status: Disabled HTTP server port: 80 HTTP server authentication method: enable HTTP server access class: 0 HTTP server base path: Maximum number of concurrent server connections allowed: 5 Server idle time-out: 600 seconds Server life time-out: 600 seconds Maximum number of requests allowed on a connection: 1 HTTP secure server capability: Present HTTP secure server status: Disabled HTTP secure server port: 443 HTTP secure server ciphersuite: 3des-ede-cbc-sha des-cbc-sha rc4-128-md5 rc4-12a HTTP secure server client authentication: Disabled HTTP secure server trustpoint:	(Optional) Displays the status of the HTTP server. • If you are unsure whether the secure HTTP server is supported in the software image you are running, issue this command and look for the line “HTTP secure server capability: {Present | Not present}”. • This command shows you status of standard HTTP server (enabled or disabled).
Step 2	**configure terminal** **Example:** Router# configure terminal	Enters global configuration mode.
Step 3	**no ip http server** **Example:** Router(config)# no ip http server	Disables the standard HTTP server. **Note** When enabling the secure HTTP (HTTPS) server you should always disable the standard HTTP server to prevent insecure connections to the same services. This is a precautionary step (typically, the HTTP server is disabled by default).
Step 4	**ip http secure-server** **Example:** Router(config)# ip http secure-server	Enables the HTTPS server.
Step 5	**ip http secure-port** *port-number* **Example:** Router(config)# ip http secure-port 1025	(Optional) Specifies the port number that should be used for the HTTPS server. The default port number is 443. Valid options are 443 or any number in the range 1025 to 65535.

	Command or Action	Purpose

Step 6	**ip http secure-ciphersuite** {[**3des-ede-cbc-sha**] [**rc4-128-md5**] [**rc4-128-sha**] [**des-cbc-sha**]}
	Example:
	`Router(config)# ip http secure-ciphersuite rc4-128-sha rc4-128-md5`
		(Optional) Specifies the CipherSuites (encryption algorithms) that should be used for encryption over the HTTPS connection.
		• This command allows you to restrict the list of CipherSuites that the sever offers the connecting clients. For example, you may want to allow only the most secure CipherSuite to be used.
		• Unless you have a reason to specify the CipherSuites that should be used, or you are unfamiliar with the details of these CipherSuites, you should leave this command unconfigured and let the server and client negotiate the CipherSuite that they both support (this is the default).

Step 7	**ip http secure-client-auth** **Example:** `Router(config)# ip http secure-client-auth`	(Optional) Configures the HTTP server to request an X.509v3 certificate from the client in order to authenticate the client during the connection process. • In the default connection and authentication process, the client requests a certificate from the HTTP server, but the server does not attempt to authenticate the client. Authenticating the client provides more security than server authentication by itself, but not all clients may be configured for CA authentication.
Step 8	**ip http secure-trustpoint** *name* **Example:** `Router(config)# ip http secure-trustpoint trustpoint_01`	Specifies the CA trustpoint that should be used for to obtain a X.509v3 security certificate and to authenticate the connecting client's certificate. • Use of this command assumes you have already declared a CA trustpoint using the **crypto ca trustpoint** command and associated sub-mode commands. • Use the same trustpoint name that you used in the associated **crypto ca trustpoint** command.

	Command or Action	Purpose

Step 9	**end**
	Example:
	`Router(config)# end`
	`Router#`
		Ends your current configuration session and returns you to privileged EXEC mode.

Step 10	**show ip http server secure status**
	Example:
	`Router# show ip http server secure status`
	`HTTP secure server status: Enabled`
	`HTTP secure server port: 1025`
	`HTTP secure server ciphersuite: rc4-128-md5`
	`rc4-128-sha`
	`HTTP secure server client authentication: Disabled`
	`HTTP secure server trustpoint: CA_trust_local`
		Displays the status of the HTTP secure server configuration.

Verifying a Secure HTTP Connection

To connect to the router running the HTTPS server with a web browser, enter **https://***URL*, where the the URL is the IP address or host name of the router. If a port other than the default port is configured (using the **ip http secure-port** command), you must also specify the port number after the URL. For example:

```
https://209.165.202.129:1026
```

or

```
https://host.domain.com:1026
```

Generally, you can verify that you have a secure connection to an HTTP server by looking for an image of a padlock at the bottom of your browser window. Also note that secure HTTP connections have a URL that starts with "https:" instead of "http:".

Configuring HTTP Server Options

The configuration of the standard HTTP server applies to the secure HTTP server as well. The following optional commands are standard HTTP server commands that apply to both the standard HTTP server and the secure HTTP server.

SUMMARY STEPS

1. **ip http path**
2. **ip http access-class**
3. **ip http max-connections**
4. **ip http timeout-policy**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**ip http path** *path-name* **Example:** `Router(config)# ip http path slot1:`	(Optional) Sets the base HTTP path for HTML files. • The base path is used to specify the location of the HTTP server files (HTML files) on the local system. Generally, the HTML files are located in system Flash memory.
Step 2	**ip http access-class** *access-list-number* **Example:** `Router(config)# ip http access-class 20`	(Optional) Specifies the access list that should be used to allow access to the HTTP server.
Step 3	**ip http max-connections** *value* **Example:** `Router(config)# ip http max-connections 10`	(Optional) Sets the maximum number of concurrent connections to the HTTP sever that will be allowed. The default value is 5.
Step 4	**ip http timeout-policy idle** *seconds* **life** *seconds* **requests** *value* **Example:** `Router(config)# ip http timeout-policy idle 30 life 120 requests 100`	(Optional) Sets the characteristics that determine how long a connection to the HTTP server should remain open. The characteristics are: **idle**—The maximum number of seconds the connection will be kept open if no data is received or response data can not be sent out on the connection. Note that a new value may not take effect on any already existing connections. If the server is too busy or the limit on the **life** time or the number of **requests** is reached, the connection may be closed sooner. The default value is 180 seconds (3 minutes). **life**—The maximum number of seconds the connection will be kept open, from the time the connection is established. Note that the new value may not take effect on any already existing connections. If the server is too busy or the limit on the idle time or the number of requests is reached, it may close the connection sooner. Also, since the server will not close the connection while actively processing a request, the connection may remain open longer than the specified **life** time if processing is occurring when the life maximum is reached. In this case, the connection will be closed when processing finishes. The default value is 180 seconds (3 minutes). The maximum value is 86400 seconds (24 hours). **requests**—The maximum limit on the number of requests processed on a persistent connection before it is closed. Note that the new value may not take effect on any already existing connections. If the server is too busy or the limit on the idle time or the life time is reached, the connection may be closed before the maximum number of requests are processed. The default value is 1. The maximum value is 86400.

Configuring the Secure HTTP Client

Prerequisites

The standard HTTP client and the secure HTTP client are always enabled.

A certificate authority is required for secure HTTP client certification; the following steps assume that you have previously declared a CA trustpoint on the routing device. If a CA trustpoint is not configured, and the remote HTTPS server requires client authentication, connections to the secure HTTP client will fail.

SUMMARY STEPS

1. **ip http client secure-trustpoint**
2. **ip http client secure-ciphersuite**
3. **end**
4. **show ip http client secure status**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**ip http client secure-trustpoint** *name* **Example:** `Router(config)# ip http client secure-trustpoint trustpoint_01`	(Optional) Specifies the CA trustpoint that should be used if the remote HTTP server requests client authentication. • Use of this command assumes you have already declared a CA trustpoint using the **crypto ca trustpoint** command and associated sub-mode commands. • Use the same trustpoint name that you used in the associated **crypto ca trustpoint** command. • This command is optional if client authentication is not needed, or if a primary trustpoint has been configured. If the **ip http client secure-trustpoint** command is not used, the router will use the primary trustpoint, as specified by the **primary** CA TrustPoint configuration mode command.
Step 2	**ip http client secure-ciphersuite** {[**3des-ede-cbc-sha**] [**rc4-128-md5**] [**rc4-128-sha**] [**des-cbc-sha**]} **Example:** `Router(config)# ip http client secure-ciphersuite rc4-128-sha rc4-128-md5`	(Optional) Specifies the CipherSuites (encryption algorithms) that should be used for encryption over the HTTPS connection. • This command allows you to restrict the list of CipherSuites that the client offers when connecting to a secure HTTP server. For example, you may want to allow only the most secure CipherSuite(s) to be used. • Unless you have a reason to specify the CipherSuites that should be used, or you are unfamiliar with the details of these CipherSuites, you should leave this command unconfigured and let the server and client negotiate the CipherSuite that they both support (this is the default).

Step 3	**end**
	
	Example:
	`Router(config)# end`
	`Router#`
		Ends your current configuration session and returns you to privileged EXEC mode.

Step 4	**show ip http client secure status**
	
	Example:
	`Router> show ip http client secure status`
	`HTTP secure client ciphersuite: 3des-ede-cbc-sha des-cbc-sha rc4-128-md5 rc4-12a`
	`HTTP secure client trustpoint:`
		Displays the status of the HTTP secure server configuration.

Configuration Examples for the Secure HTTP Server and Client

The following example shows a configuration session in which the secure HTTP server is enabled, the port for the secure HTTP server is configured as 1025, and the remote CA trustpoint server “CA_trust_local” will be used for certification.

```
Router# show ip http server status
HTTP server status: Disabled
HTTP server port: 80
HTTP server authentication method: enable
HTTP server access class: 0
HTTP server base path:
Maximum number of concurrent server connections allowed: 5
Server idle time-out: 600 seconds
Server life time-out: 600 seconds
Maximum number of requests allowed on a connection: 1
HTTP secure server capability: Present
HTTP secure server status: Disabled
HTTP secure server port: 443
HTTP secure server ciphersuite: 3des-ede-cbc-sha des-cbc-sha rc4-128-md5 rc4-12a
HTTP secure server client authentication: Disabled
HTTP secure server trustpoint:

Router# config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# ip http secure-server
Router(config)# ip http client secure-trustpoint CA_trust_local
Router(config)# ip http secure-port 1024
Invalid secure port value.

Router(config)# ip http secure-port 1025
Router(config)# ip http secure-ciphersuite rc4-128-sha rc4-128-md5
Router(config)# end
Router# show ip http server secure status
HTTP secure server status: Enabled
HTTP secure server port: 1025
HTTP secure server ciphersuite: rc4-128-md5 rc4-128-sha
HTTP secure server client authentication: Disabled
HTTP secure server trustpoint: CA_trust_local
```

In the following example, the CA trustpoint CA_trust_local is specified, and the HTTPS client is configured to use this trustpoint for client authentication requests:

```
Router# config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# crypto ca trustpoint CA_trust_local
Router(ca-trustpoint)# enrollment url http://CA_trust1.domain.com
Router(ca-trustpoint)# crl query ldap://example.domain.com
Router(ca-trustpoint)# primary
Router(ca-trustpoint)# exit
Router(config)# ip http client secure-trustpoint CA_trust_local
Router(config)# end
Router# copy running-config startup-config
```

Additional References

For additional information related to the HTTPS - HTTP Server and Client with SSL 3.0 feature, refer to the following documents:

Related Documents

Related Topic	Document Title
SSL 3.0	*The SSL Protocol Version 3.0* This document is available from various sources online. Currently, the document “draft-freier-ssl-version3-02.txt” is available at http://wp.netscape.com/eng/ssl3/draft302.txt
Standard Cisco Web Client	*HTTP 1.1 Web Client*, Release 12.2(15)T feature document
Standard Cisco Web Server	*HTTP 1.1 Web Server*, Release 12.2(15)T feature document http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122newft/122t/122t15/fthttp1s.htm
Certification Authority Interoperability	*Configuring Certification Authority Interoperability*, Release 12.2 Mainline document http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122cgcr/fsecur_c/fipsenc/scfinter.htm *Certificate Autoenrollment*, Release 12.2(8)T feature document http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122newft/122t/122t8/ftautoen.htm *Certificate Enrollment Enhancements*, Release 12.2(8)T feature document http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122newft/122t/122t8/ftenrol2.htm *Trustpoint CLI*, Release 12.2(8)T feature document http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122newft/122t/122t8/fttrust.htm *Source Interface Selection for Outgoing Traffic with Certificate Authority*, Release 12.2(15)T feature document http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122newft/122t/122t15/ft_asish.htm

Related Standards

No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.

Related MIBs

MIBs	MIBs Link
No new or modified MIBs are supported by this feature, and support for existing MIBs has not been modified by this feature.	To obtain lists of supported MIBs by platform and Cisco IOS release, and to download MIB modules, go to the Cisco MIB website on Cisco.com at the following URL: http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml

Related RFCs

RFCs[1]	Description
RFC 2616	Cisco's implementation of HTTP is based on RFC 2616, "Hypertext Transfer Protocol -- HTTP/1.1"

[1] Full support for listed RFCs is not claimed.

Technical Assistance

Description	Link
Technical Assistance Center (TAC) home page, containing 30,000 pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/public/support/tac/home.shtml

Command Reference

The following new commands are pertinent to this feature. To see the command pages for these commands and other commands used with this feature, go to the *Cisco IOS Master Commands List*, Release 12.4, at http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124mindx/124index.htm.

- **debug ip http ssl error**
- **ip http client secure-ciphersuite**
- **ip http client secure-trustpoint**
- **ip http secure-ciphersuite**
- **ip http secure-client-auth**
- **ip http secure-port**
- **ip http secure-server**
- **ip http secure-trustpoint**
- **show ip http client secure status**
- **show ip http server secure status**

Glossary

RSA—RSA is a widely used Internet encryption and authentication system that uses public and private keys for encryption and decryption. The abbreviation RSA comes from the first letter of the last names of the three original developers. The RSA algorithm is included in many applications, such as the web browsers from Microsoft and Netscape. The RSA encryption system is owned by RSA Security.

SHA—The Secure Hash Algorithm. SHA was developed by NIST and is specified in the Secure Hash Standard (SHS, FIPS 180). Often used as an alternative to MD5 (Message Digest 5) algorithm.

signatures, digital— In the context of SSL, “signing” means to encrypt with a private key. In digital signing, one-way hash functions are used as input for a signing algorithm. In RSA signing, a 36-byte structure of two hashes (one SHA and one MD5) is signed (encrypted with the private key).

SSL 3.0—Secure Socket Layer version 3.0. SSL is a security protocol that provides communications privacy over the Internet. The protocol allows client and server applications to communicate in a way that is designed to prevent eavesdropping, tampering, or message forgery. SSL uses a program layer located between the Internet’s Hypertext Transfer Protocol (HTTP) and Transmission Control Protocol (TCP) layers. SSL is included as part of most web server products and as part of most Internet browsers. The SSL 3.0 specification can be found at .*http://home.netscape.com/eng/ssl3/*

Note Refer to the *Internetworking Terms and Acronyms* document for terms not included in this glossary.

HTTP Inspection Engine

The HTTP Inspection Engine feature allows users to configure their Cisco IOS Firewall to detect and prohibit HTTP connections—such as tunneling over port 80, unauthorized request methods, and non-HTTP compliant file transfers—that are not authorized within the scope of the security policy configuration. Tunneling unauthorized protocols through port 80 and over HTTP exposes a network to significant security risks.

The Cisco IOS Firewall can now be configured with a security policy that adheres to the following tasks:

- Allowing specific traffic targeted for port 80 to traverse the firewall. The traffic is inspected for protocol conformance and for the types of HTTP commands that are allowed or disallowed.
- Denying specific traffic targeted for port 80 that does not comply to HTTP traffic standards. The firewall is enabled to drop the packet, reset the connection, and send a syslog message, as appropriate.

Feature History for HTTP Inspection Engine

Release	Modification
12.3(14)T	This feature was introduced.

Finding Support Information for Platforms and Cisco IOS Software Images

Use Cisco Feature Navigator to find information about platform support and Cisco IOS software image support. Access Cisco Feature Navigator at http://www.cisco.com/go/fn. You must have an account on Cisco.com. If you do not have an account or have forgotten your username or password, click **Cancel** at the login dialog box and follow the instructions that appear.

Contents

Restrictions for HTTP Inspection Engine

The Cisco 831 router with 48M RAM does not have enough memory to support this feature.

Information About HTTP Inspection Engine

Before configuring an application firewall to detect and police specific traffic targeted for port 80, you should understand the following concepts:

- What Is a Security Policy?, page 358
- Cisco IOS HTTP Application Policy Overview, page 358

What Is a Security Policy?

The application firewall uses a security policy, which consists of a collection of static signatures, to detect security violations. A static signature is a collection of parameters that specify protocol conditions that must be met before an action is taken. (For example, a signature may specify that an HTTP data stream containing the POST method must reset the connection.) These protocol conditions and reactions are defined by the end user via the command-line interface (CLI) to form a security policy.

Cisco IOS HTTP Application Policy Overview

HTTP uses port 80 to transport Internet web services, which are commonly used on the network and rarely challenged with regards to their legitimacy and conformance to standards. Because port 80 traffic is typically allowed through the network without being challenged, many application developers are leveraging HTTP traffic as an alternative transport protocol in which to enable their application to travel through or even bypass the firewall.

Most firewalls provide only packet filtering capabilities that simply permit or deny port 80 traffic without inspecting the data stream; the Cisco IOS application firewall for HTTP performs packet inspection as follows:

- Detects HTTP connections that are not authorized within the scope of the security policy configuration.
- Detects users who are tunneling applications through port 80.

If the packet is not in compliance with the HTTP protocol, it will be dropped, the connection will be reset, and a syslog message will be generated, as appropriate.

How to Define and Apply an HTTP Application Policy to a Firewall for Inspection

This section contains the following procedures:

- Defining an HTTP Application Policy, page 359
- Applying an HTTP Application Policy to a Firewall for Inspection, page 363

Defining an HTTP Application Policy

Use this task to create an HTTP application firewall policy.

Restrictions

Although application firewall policies are defined in global configuration mode, only one global policy for a given protocol is allowed per interface.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **appfw policy-name** *policy-name*
4. **application** *protocol*
5. **strict-http action** {**reset** | **allow**} [**alarm**]
6. **content-length** {**min** *bytes* **max** *bytes* | **min** *bytes* | **max** *bytes*} **action** {**reset** | **allow**} [**alarm**]
7. **content-type-verification** [**match-req-resp**] **action** {**reset** | **allow**} [**alarm**]
8. **max-header-length** {**request** *bytes* **response** *bytes*} **action** {**reset** | **allow**} [**alarm**]
9. **max-uri-length** *bytes* **action** {**reset** | **allow**} [**alarm**]
10. **request-method** {**rfc** *rfc-method* | **extension** *extension-method*} **action** {**reset** | **allow**} [**alarm**]
11. **port-misuse** {**p2p** | **tunneling** | **im** | **default**} **action** {**reset** | **allow**} [**alarm**
12. **transfer-encoding type** {**chunked** | **compress** | **deflate** | **gzip** | **identity** | **default**} **action** {**reset** | **allow**} [**alarm**]
13. **timeout** *seconds*
14. **audit-trail** {**on** | **off**}
15. **exit**
16. **exit**

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	**appfw policy-name** *policy-name* **Example:** `Router(config)# appfw policy-name mypolicy`	Defines an application firewall policy and puts the router in application firewall policy configuration mode.
Step 4	**application** *protocol* **Example:** `Router(cfg-appfw-policy)# application http`	Allows you to configure inspection parameters for a given protocol. Currently, only HTTP traffic can be inspected. - *protocol* —Specify the **http** keyword. This command puts you in appfw-policy-*protocol* configuration mode, where "*protocol*" is dependent upon the specified protocol. Because only HTTP can be specified, the configuration mode is appfw-policy-http.
Step 5	**strict-http action** {**reset** | **allow**} [**alarm**] **Example:** `Router(cfg-appfw-policy-http)# strict-http action allow alarm`	(Optional) Allows HTTP messages to pass through the firewall or resets the TCP connection when HTTP noncompliant traffic is detected.
Step 6	**content-length** {**min** *bytes* **max** *bytes* | **min** *bytes* | **max** *bytes*} **action** {**reset** | **allow**} [**alarm**] **Example:** `Router(cfg-appfw-policy-http)# content-length max 1 action allow alarm`	(Optional) Permits or denies HTTP traffic through the firewall on the basis of message size. - **min** | **max** *bytes*—Minimum or maximum content length, in bytes, allowed per message. Number of bytes range: 0 to 65535.
Step 7	**content-type-verification** [**match-req-resp**] **action** {**reset** | **allow**} [**alarm**] **Example:** `Router(cfg-appfw-policy-http)# content-type-verification match-req-resp action allow alarm`	(Optional) Permits or denies HTTP traffic through the firewall on the basis of content message type.
Step 8	**max-header-length** {**request** *bytes* **response** *bytes*} **action** {**reset** | **allow**} [**alarm**] **Example:** `Router(cfg-appfw-policy-http)# max-header-length request 1 response 1 action allow alarm`	(Optional) Permits or denies HTTP traffic on the basis of the message header length. - *bytes*—Number of bytes ranging from 0 to 65535.

	Command or Action	Purpose
Step 9	**max-uri-length** *bytes* **action** {**reset** | **allow**} [**alarm**] **Example:** `Router(cfg-appfw-policy-http)# max-uri-length 1 action allow alarm`	(Optional) Permits or denies HTTP traffic on the basis of the URI length in the request message.
Step 10	**request method** {**rfc** *rfc-method* | **extension** *extension-method*} **action** {**reset** | **allow**} [**alarm**] **Example:** `Router(cfg-appfw-policy-http)# request-method rfc default action allow alarm`	(Optional) Permits or denies HTTP traffic according to either the request methods or the extension methods. • **rfc**—Specifies that the supported methods of RFC 2616, *Hypertext Transfer Protocol—HTTP/1.1*, are to be used for traffic inspection. • *rfc-method*—Any one of the following RFC 2616 methods can be specified: **connect**, **default, delete**, **get**, **head**, **options**, **post**, **put**, **trace**. • **extension**—Specifies that the extension methods are to be used for traffic inspection. • *extension-method*—Any one of the following extension methods can be specified: **copy**, **default, edit**, **getattribute**, **getproperties**, **index**, **lock**, **mkdir**, **move**, **revadd**, **revlabel**, **revlog**, **save**, **setattribute**, **startrev**, **stoprev**, **unedit**, **unlock**.
Step 11	**port-misuse** {**p2p** | **tunneling** | **im** | **default**} **action** {**reset** | **allow**} [**alarm**] **Example:** `Router(cfg-appfw-policy-http)# port-misuse default action allow alarm`	(Optional) Permits or denies HTTP traffic through the firewall on the basis of specified applications in the HTTP message. • **p2p**—Peer-to-peer protocol applications subject to inspection: Kazaa and Gnutella. • **tunneling**—Tunneling applications subject to inspection: HTTPPort/HTTPHost, GNU Httptunnel, GotoMyPC, Firethru, Http-tunnel.com Client • **im**—Instant messaging protocol applications subject to inspection: Yahoo Messenger. • **default**—All applications are subject to inspection.

	Command or Action	Purpose
Step 12	**transfer-encoding type** {**chunked** | **compress** | **deflate** | **gzip** | **identity** | **default**} **action** {**reset** | **allow**} [**alarm**] **Example:** `Router(cfg-appfw-policy-http)# transfer-encoding type default action allow alarm`	(Optional) Permits or denies HTTP traffic according to the specified transfer-encoding of the message. • **chunked**—Encoding format (specified in RFC 2616, *Hypertext Transfer Protocol—HTTP/1*) in which the body of the message is transferred in a series of chunks; each chunk contains its own size indicator. • **compress**—Encoding format produced by the UNIX "compress" utility. • **deflate**—"ZLIB" format defined in RFC 1950, *ZLIB Compressed Data Format Specification version 3.3*, combined with the "deflate" compression mechanism described in RFC 1951, *DEFLATE Compressed Data Format Specification version 1.3*. • **gzip**—Encoding format produced by the "gzip" (GNU zip) program. • **identity**—Default encoding, which indicates that no encoding has been performed. • **default**—All of the transfer encoding types.
Step 13	**timeout** *seconds* **Example:** `Router(cfg-appfw-policy-http)# timeout 60`	(Optional) Overrides the global TCP idle timeout value for HTTP traffic. **Note** If this command is not issued, the default value specified via the **ip inspect tcp idle-time** command will be used.

Step 14	**audit-trail** {**on** | **off**}
	Example:
	`Router(cfg-appfw-policy-http)# audit-trail on`
		(Optional) Turns audit trail messages on or off.
		Note If this command is not issued, the default value specified via the **ip inspect audit-trail** command will be used.

Step 15	**exit** **Example:** `Router(cfg-appfw-policy-http)# exit`	Exits cfg-appfw-policy-http configuration mode.
Step 16	**exit** **Example:** `Router(cfg-appfw-policy)# exit`	Exits cfg-appfw-policy configuration mode.

What to Do Next

After you have successfully defined an application policy for HTTP traffic inspection, you must apply the policy to an inspection rule. Thereafter, the inspection rule must be applied to an interface. For information on completing this task, see the section "Applying an HTTP Application Policy to a Firewall for Inspection."

Applying an HTTP Application Policy to a Firewall for Inspection

Use this task to apply an HTTP application policy to an inspection rule, followed by applying the inspection rule to an interface.

Note An application policy can coexist with other inspection protocols (for example, an HTTP policy and an FTP policy can coexist).

Prerequisites

You must have already defined an application policy (as shown in the section "Defining an HTTP Application Policy").

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip inspect name** *inspection-name* **appfw** *policy-name*
4. **ip inspect name** *inspection-name* **http** [**alert** {**on** | **off**}] [**audit-trail** {**on** | **off**}] [**timeout** *seconds*]
5. **interface** *type number*
6. **ip inspect** *inspection-name* {**in** | **out**}
7. **exit**
8. **exit**
9. **show appfw configuration** [*name*]

   or

   show ip inspect {**name** *inspection-name* | **config** | **interfaces** | **session** [**detail**] | **statistics** | **all**}

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 inspect name`** *`inspection-name`* **`appfw`** *`policy-name`*
	Example:
	`Router(config)# ip inspect name firewall appfw mypolicy`
		Defines a set of inspection rules for the application policy.
		• *policy-name*—Must match the policy name specified via the **appfw policy-name** command.

	Command or Action	Purpose
Step 4	**ip inspect name** *inspection-name* **http** [**alert** {**on** | **off**}] [**audit-trail** {**on** | **off**}] [**timeout** *seconds*] **Example:** `Router(config)# ip inspect name firewall http`	Defines a set of inspection rules that is to be applied to all HTTP traffic. • The *inspection-name* argument must match the *inspection-name* argument specified in Step 3.
Step 5	**interface** *type number* **Example:** `Router#(config)# interface FastEthernet0/0`	Configures an interface type and enters interface configuration mode.

Step 6	**ip inspect** *inspection-name* {**in** | **out**}
	Example:
	`Router#(config-if)# ip inspect firewall in`
		Applies the inspection rules (defined in Step 3 and Step 4) to all traffic entering the specified interface.
		• The *inspection-name* argument must match the inspection name defined via the **ip inspect name** command.

Step 7	**exit** **Example:** `Router#(config-if)# exit`	Exits interface configuration mode.
Step 8	**exit** **Example:** `Router(config)# exit`	Exits global configuration mode.

Step 9	**show appfw configuration** [*name*]
	Example:
	`Router# show appfw configuration`
	or
	show ip inspect {**name** *inspection-name* | **config** | **interfaces** | **session** [**detail**] | **statistics** | **all**}
	Example:
	`Router# show ip inspect config`
		(Optional) Displays application firewall policy configuration information.
		(Optional) Displays firewall-related configuration information.

Troubleshooting Tips

To help troubleshoot the application firewall configuration, issue the following application-firewall specific debug command: **debug appfw** {**application** *protocol* | **function-trace** | **object-creation** | **object-deletion** | **events** | **timers** | **detailed**}.

The following sample configuration shows how to configure an HTTP policy with application firewall debugging enabled:

```
Router(config)# appfw policy-name myPolicyAPPFW  FUNC:appfw_policy_find
APPFW  FUNC:appfw_policy_find -- Policy myPolicy is not found
APPFW  FUNC:appfw_policy_alloc
APPFW  FUNC:appfw_policy_alloc -- policy_alloc 0x65727278
APPFW  FUNC:appfw_policy_alloc -- Policy 0x65727278 is set to valid
APPFW  FUNC:appfw_policy_alloc -- Policy myPolicy has been created
APPFW  FUNC:appfw_policy_command -- memlock policy 0x65727278

! Debugging sample for application (HTTP) creation

Router(cfg-appfw-policy)# application httpAPPFW  FUNC:appfw_http_command
APPFW  FUNC:appfw_http_appl_find
APPFW  FUNC:appfw_http_appl_find -- Application not found
APPFW  FUNC:appfw_http_appl_alloc
APPFW  FUNC:appfw_http_appl_alloc -- appl_http 0x64D7A25C
APPFW  FUNC:appfw_http_appl_alloc -- Application HTTP parser structure 64D7A25C created

! Debugging sample for HTTP-specific application inspection
Router(cfg-appfw-policy-http)#
Router(cfg-appfw-policy-http)# strict-http action reset alarm
APPFW  FUNC:appfw_http_subcommand
APPFW  FUNC:appfw_http_subcommand -- strict-http cmd turned on

Router# debug appfw detailed

APPFW Detailed Debug debugging is on
fw7-7206a#debug appfw object-creation
APPFW Object Creations debugging is on
fw7-7206a#debug appfw object-deletion
APPFW Object Deletions debugging is on
```

Configuration Examples for Setting Up an HTTP Inspection Engine

This section contains the following configuration example:

- Setting Up and Verifying an HTTP Inspection Engine: Example, page 365

Setting Up and Verifying an HTTP Inspection Engine: Example

The following example show how to define the HTTP application firewall policy "mypolicy." This policy includes all supported HTTP policy rules. This example also includes sample output from the **show appfw configuration** and **show ip inspect config** commands, which allow you to verify the configured setting for the application policy.

```
! Define the HTTP policy.
appfw policy-name mypolicy
 application http
  strict-http action allow alarm
  content-length maximum 1 action allow alarm
  content-type-verification match-req-rsp action allow alarm
  max-header-length request 1 response 1 action allow alarm
  max-uri-length 1 action allow alarm
  port-misuse default action allow alarm
  request-method rfc put action allow alarm
  transfer-encoding type default action allow alarm
!
!
! Apply the policy to an inspection rule.
ip inspect name firewall appfw mypolicy
ip inspect name firewall http
```

```
!
!
! Apply the inspection rule to all HTTP traffic entering the FastEthernet0/0 interface.
interface FastEthernet0/0
 ip inspect firewall in
!
!
! Issue the show appfw configuration command and the show ip inspect config command after
the inspection rule "mypolicy" is applied to all incoming HTTP traffic on the
FastEthernet0/0 interface.
!
Router# show appfw configuration

Application Firewall Rule configuration
  Application Policy name mypolicy
    Application http
      strict-http action allow alarm
      content-length minimum 0 maximum 1 action allow alarm
      content-type-verification match-req-rsp action allow alarm
      max-header-length request length 1 response length 1 action allow alarm
      max-uri-length 1 action allow alarm
      port-misuse default action allow alarm
      request-method rfc put action allow alarm
      transfer-encoding default action allow alarm

Router# show ip inspect config

Session audit trail is disabled
Session alert is enabled
one-minute (sampling period) thresholds are [400:500] connections
max-incomplete sessions thresholds are [400:500]
max-incomplete tcp connections per host is 50. Block-time 0 minute.
tcp synwait-time is 30 sec -- tcp finwait-time is 5 sec
tcp idle-time is 3600 sec -- udp idle-time is 30 sec
dns-timeout is 5 sec
Inspection Rule Configuration
Inspection name firewall
http alert is on audit-trail is off timeout 3600
```

Additional References

The following sections provide references related to the HTTP Inspection Engine feature.

Related Documents

Related Topic	Document Title
Firewall commands: complete command syntax, command mode, defaults, usage guidelines, and examples	*Cisco IOS Security Command Reference*, Release 12.3T

Standards

Standards	Title
No new or modified standards are supported by this feature.	—

MIBs

MIBs	MIBs Link
No new or modified MIBs are supported by this feature.	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

RFCs	Title
RFC 2616	*Hypertext Transfer Protocol -- HTTP/1.1*

Technical Assistance

Description	Link
Technical Assistance Center (TAC) home page, containing 30,000 pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/public/support/tac/home.shtml

Command Reference

The following new and modified commands are pertinent to this feature. To see the command pages for these commands and other commands used with this feature, go to the *Cisco IOS Master Commands List*, Release 12.4, at http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124mindx/124index.htm.

New Commands

- **appfw policy-name**
- **application**
- **audit-trail**
- **content-length**
- **content-type-verification**

- **debug appfw**
- **max-header-length**
- **max-uri-length**
- **port-misuse**
- **request-method**
- **show appfw**
- **strict-http**
- **timeout**
- **transfer-encoding type**

Modified Command

- **ip inspect name**

Selective Enabling of Applications Using an HTTP or HTTPS Server

HTTP Server - Enabling of Applications

The Selective Enabling of Applications Using an HTTP or HTTPS Server feature eliminates a potential security vulnerability by providing a facility to enable selected HTTP and HTTP over Secure Socket Layer (HTTPS) services on both the Cisco IOS HTTP and HTTPS server infrastructure. This feature also provides the capability to view the current state of the HTTP and HTTPS services, including which services are enabled or disabled.

Feature History for the Selective Enabling of Applications Using an HTTP or HTTPS Server Feature

Release	Modification
12.3(14)T	This feature was introduced.

Finding Support Information for Platforms and Cisco IOS Software Images

Use Cisco Feature Navigator to find information about platform support and Cisco IOS software image support. Access Cisco Feature Navigator at http://www.cisco.com/go/fn. You must have an account on Cisco.com. If you do not have an account or have forgotten your username or password, click **Cancel** at the login dialog box and follow the instructions that appear.

Contents

Information About Selective Enabling of Applications Using an HTTP or HTTPS Server

To use the Selective Enabling of Applications Using an HTTP or HTTPS Server feature, you should understand the following concept:

- Selective Enabling of Applications Within the HTTP and HTTPS Infrastructure, page 370

Selective Enabling of Applications Within the HTTP and HTTPS Infrastructure

The Selective Enabling of Applications Using an HTTP or HTTPS Server feature eliminates a potential security vulnerability by providing a facility to enable selected HTTP and HTTPS services on both the Cisco IOS HTTP and HTTPS server infrastructure. This feature also provides the capability to view the current state of the HTTP and HTTPS services, including which services are enabled or disabled.

Prior to this feature, HTTP or HTTPS applications running on a router or a switch, were either all enabled or all disabled when the HTTP server or HTTPS server was enabled or disabled, respectively (using the **ip http server** and **ip http secure-server** commands). In the situation where all HTTP or HTTPS applications were enabled, remote end-users were given potential access to services that could allow them to pose a potential security threat to service providers.

With this new feature, the Cisco IOS HTTP and HTTPS infrastructure provides a way to enable only selected HTTP and HTTPS applications to run on a router or a switch, thereby bypassing a potential security vulnerability. Selected HTTP and HTTPS applications can be enabled using the new **ip http active-session-modules** and **ip http secure-active-session-modules** configuration commands, respectively.

Note The maximum number of sessions that can be registered with the Cisco IOS HTTP or HTTPS server is 32.

How to Enable Selected Applications Using an HTTP or HTTPS Server

This section contains the following procedures:

- Enabling Selected HTTP Applications, page 370
- Enabling Selected HTTPS Applications, page 371

Enabling Selected HTTP Applications

Perform this task to selectively enable the HTTP applications that will service incoming HTTP requests from remote clients.

SUMMARY STEPS

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

3. **ip http session-module-list** *listname prefix1* [*prefix2,..., prefixn*]
4. **ip http active-session-modules** {*listname* | **none** | **all**}
5. **end**
6. **show ip http server session-module**

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 http session-module-list`** *`listname prefix1`* `[`*`prefix2,...,prefixn`*`]`
	Example:
	`Router(config)# ip http session-module-list list1 SCEP,HOME_PAGE`
		Defines a list of HTTP or HTTPS application names.

Step 4	**`ip http active-session-modules`** `{`*`listname`* `|` **`none`** `|` **`all`**`}`
	Example:
	`Router(config)# ip http active-session-modules list1`
		Selectively enables HTTP applications that will service incoming HTTP requests from remote clients.
		• The *listname* argument enables only those HTTP services configured in the list identified by the **ip http session-module-list** command to serve HTTP requests.
		• The keyword **none** disables all HTTP services from serving HTTP requests.
		• The keyword **all** enables all HTTP services to serve HTTP requests.

Step 5	**`end`**
	Example:
	`Router(config)# end`
		Ends your configuration session and returns the CLI to Privileged Exec mode.

Step 6	**`show ip http server session-module`**
	Example:
	`Router# show ip http server session-module`
		(Optional) Displays information about all HTTP and HTTPS services available on the router or switch, including their current state of service, such as whether they are enabled or disabled.

Enabling Selected HTTPS Applications

Perform this task to selectively enable the HTTPS applications that will service incoming HTTPS requests from remote clients.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip http session-module-list** *listname prefix1* [*prefix2*,..., *prefixn*]
4. **ip http secure-active-session-modules** {*listname* | **none** | **all**}
5. **end**
6. **show ip http server session-module**

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 http session-module-list** *listname prefix1* [*prefix2*,...,*prefixn*] **Example:** `Router(config)# ip http session-module-list list1 SCEP,HOME_PAGE`	Defines a list of HTTP or HTTPS application names.

Step 4	**ip http secure-active-session-modules** {*listname* | **none** | **all**}
	Example:
	`Router(config)# ip http secure-active-session-modules list1`
		Selectively enables HTTPS applications that will service incoming HTTPS requests from remote clients.
		• The *listname* argument enables only those HTTPS services configured in the list identified by the **ip http session-module-list** command to serve HTTPS requests.
		• The keyword **none** disables all HTTPS services from serving HTTPS requests.
		• The keyword **all** enables all HTTPS services to serve HTTPS requests.

Step 5	**end**
	Example:
	`Router(config)# end`
		Ends your configuration session and returns the CLI to Privileged Exec mode.

Step 6	**show ip http server session-module** **Example:** `Router# show ip http server session-module`	(Optional) Displays information about all HTTP and HTTPS services available on the router or switch, including their current state of service, such as whether they are enabled or disabled.

Configuration Examples for Selective Enabling of Applications Using an HTTP or HTTPS Server

This section provides the following configuration example:

- Enabling Selected HTTP and HTTPS Applications: Example, page 373

Enabling Selected HTTP and HTTPS Applications: Example

The following configuration sample shows a configuration with different set of services available for HTTP and HTTPS requests. In this example, all HTTP applications are enabled for providing services to remote clients, but for HTTPS services, only the HTTPS applications defined in list1 (Simple Certificate Enrollment Protocol [SCEP] and HOME_PAGE) are enabled.

```
ip http session-module-list list1 SCEP,HOME_PAGE
ip http active-session-modules all
ip http server
ip http secure-server
ip http secure-active-session-modules list1
```

Additional References

The following sections provide references related to the Selective Enabling of Applications Using an HTTP or HTTPS Server feature.

Related Documents

Related Topic	Document Title
Additional HTTP configuration information	"Using the Cisco Web Browser User Interface" chapter in the section "Cisco IOS User Interfaces" in the *Cisco IOS Configuration Fundamentals and Network Management Configuration Guide*, Release 12.3T
Additional HTTPS configuration information	*HTTPS - HTTP Server and Client with SSL 3.0*, Cisco IOS Release 12.2(15)T feature module.
Additional HTTP and HTTPS commands	*Cisco IOS Configuration Fundamentals and Network Management Command Reference*, Release 12.3T

Standards

Standards	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	—

MIBs

MIBs	MIBs Link
None	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

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

Technical Assistance

Description	Link
Technical Assistance Center (TAC) home page, containing 30,000 pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/public/support/tac/home.shtml

Command Reference

The following new and modified commands are pertinent to this feature. To see the command pages for these commands and other commands used with this feature, go to the *Cisco IOS Master Commands List*, Release 12.4, at http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124mindx/124index.htm.

- **ip http active-session-modules**
- **ip http secure-active-session-modules**
- **ip http session-module-list**
- **show ip http server**

HTTP Client API for Tcl IVR

The HTTP Client API for Tcl IVR feature provides support for Tcl IVR applications to retrieve data from or post data to an HTTP server. Also introduced with this feature is a new command-line interface structure for configuring voice applications and support for additional Tcl 8.3.4 commands.

Feature History for HTTP Client API for Tcl IVR

Release	Modification
12.3(14)T	This feature was introduced.

Finding Support Information for Platforms and Cisco IOS Software Images

Use Cisco Feature Navigator to find information about platform support and Cisco IOS software image support. Access Cisco Feature Navigator at http://www.cisco.com/go/fn. You must have an account on Cisco.com. If you do not have an account or have forgotten your username or password, click **Cancel** at the login dialog box and follow the instructions that appear.

Contents

Prerequisites for HTTP Client API for Tcl IVR and New Cisco Voice Application Command-Line Interface Structure

- Familiarity with Tcl IVR, VoiceXML, and Cisco IOS commands.
- Required hardware:
  - Cisco 3600 series
  - Cisco AS5300
  - Cisco AS5350

  - Cisco AS5400
  - Cisco AS5800
  - Cisco AS58550
- Required software:
  - Cisco IOS Release 12.3(14)T or later
  - Tcl 8.3.4
  - VoiceXML 2.0

Restrictions for HTTP Client API for Tcl IVR and New Cisco Voice Application Command-Line Interface Structure

If Cisco IOS configuration commands are used within the Tcl scripts, submode commands must be entered as quoted arguments on the same line as the configuration command.

Information About HTTP Client API for Tcl IVR and New Cisco Voice Application Command-Line Interface Structure

HTTP API for Tcl IVR 2.0

An HTTP application programming interface to the IOS HTTP client is provided. The HTTP package is accessed using the **package require httpios 1.0** Tcl command. Additional commands are provided to configure HTTP. See the *Tcl IVR API Version 2.0 Programming Guide* for more information.

Newly-Supported Tcl 8.3.4 Commands

The following Tcl 8.3.4 commands are now supported:

- **cd**
- **close**
- **eof**
- **fconfigure**
- **file**
- **fileevent**
- **flush**
- **glob**

- **namespace**
- **open**
- **package**
- **pwd**
- **read**
- **seek**

The following command is modified:

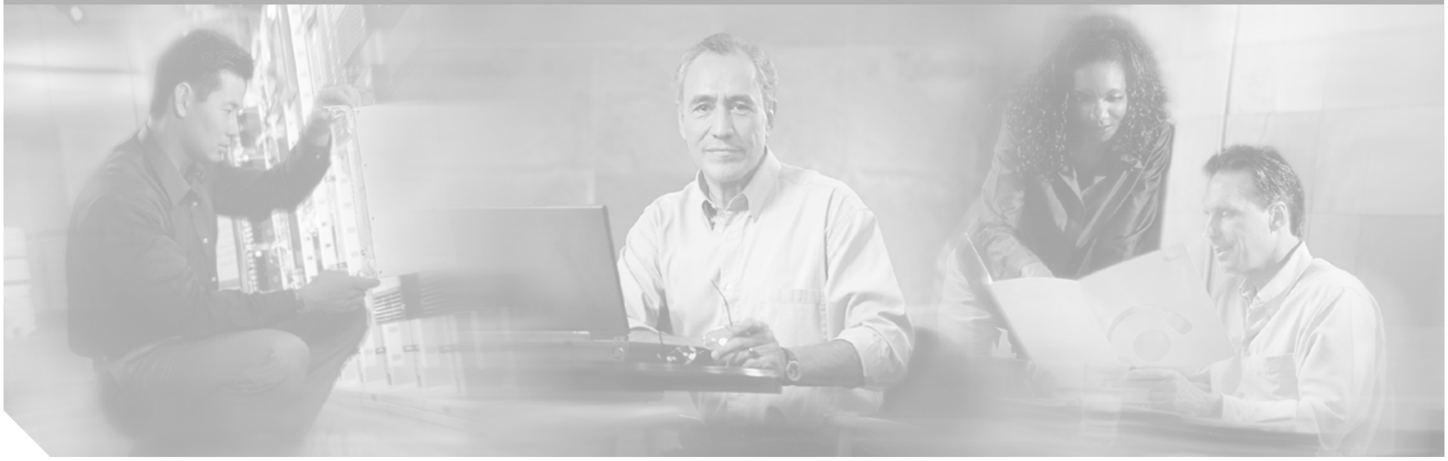
- **puts**

See the *Tcl IVR API Version 2.0 Programming Guide* for more information.

New Cisco Voice Application Command-Line Interface Structure

The **call application voice** command structure for configuring Tcl and IVR applications has been restructured to provide easier configuration of application parameters than the earlier CLI structure.

For more information, see the "Cisco IOS Release 12.3(14)T and Later Voice Application Command-Line Interface Structure Changes" section in Configuring Basic Functionality for Tcl IVR and VoiceXML Applications in the *Cisco IOS Tcl IVR and VoiceXML Application Guide*.



Part 6: CNS Configuration

CNS Configuration Agent

Feature History

Release	Modification
12.2(2)T	This feature was introduced.
12.0(18)ST	This feature was integrated into Cisco IOS Release 12.0(18)ST.
12.0(22)S	This feature was integrated into Cisco IOS Release 12.0(22)S.

This feature module describes the CNS Configuration Agent feature. It includes the following sections:

Feature Overview

Cisco Networking Services (CNS) is a foundation technology for linking users to network services. CNS Software Developers Kit (SDK) accomplishes this linking by making applications network-aware and increasing the intelligence of the network elements. CNS SDK provides building blocks to a range of customers in market segments such as enterprise, service provider, independent software vendors, and system integrators.

The CNS Configuration Agent feature supports routing devices by providing the following:

- Initial configurations
- Incremental (partial) configurations
- Synchronized configuration updates

Initial Configuration

When a routing device first comes up, it connects to the configuration server component of CNS Configuration Agent by establishing a TCP connection through the use of **cns config initial**, a standard command-line interface (CLI) command. The device issues a request and identifies itself by providing a unique configuration ID to the configuration server.

When the CNS web server receives a request for a configuration file, it invokes the Java Servlet and executes the corresponding embedded code. The embedded code directs the CNS web server to access the directory server and file system to read the configuration reference for this device (configuration ID) and template. The Configuration Agent prepares an instantiated configuration file by substituting all the parameter values specified in the template with valid values for this device. The configuration server forwards the configuration file to the CNS web server for transmission to the routing device.

The CNS Configuration Agent feature accepts the configuration file from the CNS web server, performs XML parsing, checks syntax (optional), and loads the configuration file. The routing device reports the status of the configuration load as an event to which a network monitoring or workflow application can subscribe.

Incremental Configuration

Once the network is up and running, new services can be added using the CNS Configuration Agent. Incremental (partial) configurations can be sent to routing devices. The actual configuration can be sent as an event payload by way of the Event Gateway (push operation) or as a signal event that triggers the device to initiate a pull operation.

The routing device can check the syntax of the configuration before applying it. If the syntax is correct, the routing device applies the incremental configuration and publishes an event that signals success to the configuration server. If the device fails to apply the incremental configuration, it publishes an event that indicates an error status.

Once the routing device has applied the incremental configuration, it can write it to NVRAM, or wait until signaled to do so.

Synchronized Configuration

When a routing device receives a configuration, it has the option to defer application of the configuration upon receipt of a write-signal event. The CNS Configuration Agent feature allows the device configuration to be synchronized with other dependent network activities.

Benefits

- Provides an automatic mechanism for delivering configuration files to routing devices.
- Enables dynamic creation of configuration files using information from a directory repository.
- Employs an open scalable architecture.
- Supports event-based provisioning interface for partial configurations.

Related Documents

- Cisco IOS Release 12.2(2)T/12.0(18)ST/12.0(22)S “CNS Event Agent” feature module document:

http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122newft/122t/122t2/ftcns_ea.htm

- Data Sheet: “Cisco Networking Services 1.0”

http://www.cisco.com/warp/public/cc/pd/nemnsw/nesv/prodlit/cns12_ds.htm

- CSN Product Literature

http://www.cisco.com/warp/customer/cc/pd/nemnsw/nesv/prodlit/index.shtml

Supported Platforms

12.2(2)T and later

The CNS Configuration Agent feature is supported on the following platforms:

- Cisco 800 series
- Cisco 1400 series
- Cisco 1600 series
- Cisco 1700 series
- Cisco 2500 series
- Cisco 2600 series
- Cisco 3600 series
- Cisco 3800 series
- Cisco 4500
- Cisco 7100 series
- Cisco 7200 series
- Cisco 7500 series

12.0(18)ST

The CNS Configuration Agent feature is supported on all platforms using 12.0(18)ST or later, including:

- Cisco 7200 series
- Cisco 10000 series
- Cisco 10700
- Cisco 12000 series (‘gsr’ images)
- Cisco 15300 series

12.0(22)S

The CNS Configuration Agent feature is supported on all platforms using 12.0(22)S or later, including:

- Cisco 7200 series
- Cisco 7500/RSP series
- Cisco 10000 series
- Cisco 10720
- Cisco 12000 series

Supported Standards, MIBs, and RFCs

Standards

None

MIBs

None

For descriptions of supported MIBs and how to use MIBs, see the Cisco MIB web site on CCO at http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml.

RFCs

None

Configuration Tasks

To configure the CNS Configuration Agent on your routing device, use any of the following commands as needed:

Command	Purpose
`Router(config)# cns config initial`	Downloads an initial configuration to the router when it boots up.
`Router(config)# cns event`	Establishes a TCP connection with the Event Gateway. This is required for the router to request or receive incremental updates.
`Router(config)# cns config partial`	Enables the partial Configuration Agent. This is required for the router to request or receive updates.

Command Reference

The following new commands are pertinent to this feature. To see the command pages for these commands and other commands used with this feature, go to the *Cisco IOS Master Commands List*, Release 12.4, at http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124mindx/124index.htm.

- **cns config cancel**
- **cns config initial**
- **cns config partial**
- **cns config retrieve**
- **debug cns config**
- **debug cns xml-parser**
- **show cns config**

CNS Event Agent

Feature History

Release	Modification
12.2(2)T	This feature was introduced.
12.0(18)ST	This feature was integrated into Cisco IOS Release 12.0(18)ST.
12.0(22)S	This feature was integrated into Cisco IOS Release 12.0(22)S.

This feature module describes the CNS Event Agent feature. This feature module includes the following sections:

Feature Overview

Cisco Networking Services (CNS) is a foundation technology for linking users to network services. CNS Software Developers Kit (SDK) accomplishes this linking by making applications network-aware and increasing the intelligence of the network elements. CNS SDK provides building blocks to a range of customers in market segments such as enterprise, service provider, independent software vendors, and system integrators.

The CNS Event Agent is part of the Cisco IOS infrastructure that allows Cisco IOS applications to publish and subscribe to events on a CNS Event Bus. CNS Event Agent works in conjunction with the CNS Configuration Agent feature.

Benefits

- Enables the full set of CNS Configuration Services.
- Opens up Cisco IOS applications to allow interoperability with third-party services that may exist on the CNS Event Bus.

Supported Platforms

CNS Event Agent is supported on the following platforms in Cisco IOS Release 12.2(2)T:

- Cisco 800 series
- Cisco 1400 series
- Cisco 1600 series
- Cisco 1700 series
- Cisco 2500 series
- Cisco 2600 series
- Cisco 3600 series (Cisco 3620, 3640, and 3660 platforms)
- Cisco 3800 series
- Cisco 4500
- Cisco 7100 series
- Cisco 7200 series
- Cisco 7500 series
- Cisco AS5300 series*
- Cisco AS5400*
- Cisco AS5800*

**Software images for Access Server platforms have not been released for version 12.2(2)T, but this feature is supported in any release based on 12.2 T that includes software images for Access Servers.*

CNS Event Agent is supported on the following platforms in Cisco IOS Release 12.0(18)ST (12.0.18-ST):

- Cisco 7500 series (RSP7000/7500)
- Cisco 7200 series
- Cisco 10000 series
- Cisco 10700 series
- Cisco 12000 series

CNS Event Agent is supported on the following platforms in Cisco IOS Release 12.0(22)S

- Cisco 7200 series
- Cisco 7500/RSP series
- Cisco 10000 series
- Cisco 10720
- Cisco 12000 series

Supported Standards, MIBs, and RFCs

Standards

None

MIBs

None

For descriptions of supported MIBs and how to use MIBs, see the Cisco MIB web site on CCO at http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml.

RFCs

None

Configuration Tasks

To configure the CNS Event Agent, use the following commands beginning in global configuration mode:

	Command	Purpose
Step 1	`Router (config)# cns event`	Configures the Event Gateway for CNS.
Step 2	`Router# show cns event`	Displays information about the CNS Event Agent.

Command Reference

The following new commands are pertinent to this feature. To see the command pages for these commands and other commands used with this feature, go to the *Cisco IOS Master Commands List*, Release 12.4, at http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124mindx/124index.htm.

- **cns event**
- **debug cns event**
- **show cns event**

CNS Flow-Through Provisioning

Feature History

Release	Modification
12.2(2)T	This feature was introduced on all platforms.
12.2(2)XB	This feature was implemented on Cisco IAD2420 series IADs.
12.2(8)T	This feature was implemented on Cisco 2600 series and Cisco 3600 series routers.

This document describes the CNS Flow-Through Provisioning feature in Cisco IOS Release 12.2(8)T. It includes the following sections:

- Feature Overview, page 389
- Supported Platforms, page 395
- Supported Standards, MIBs, and RFCs, page 396
- Prerequisites, page 396
- Configuration Tasks, page 397
- Configuration Examples, page 400
- Command Reference, page 405
- Glossary, page 406

Feature Overview

Note In Cisco IOS releases 12.3(8)T and 12.3(9), significant enhancements were made to this feature. See the CNS Zero Touch and CNS Frame Relay Zero Touch features for more details.

Cisco Networking Services (CNS) Flow-Through Provisioning provides the infrastructure for automated configuration of large numbers of network devices. Based on CNS event and config agents, it eliminates the need for an onsite technician to initialize the device. The result is an automated workflow from initial subscriber-order entry through Cisco manufacturing and shipping to final device provisioning and subscriber billing. This focuses on a root problem of today's service-provider and other similar business models: use of human labor in activating service.

To achieve such automation, CNS Flow-Through Provisioning relies on standardized configuration templates that you create. However, the use of such templates requires a known fixed hardware configuration, uniform for all subscribers. There is no way to achieve this without manually prestaging each line card or module within each chassis. While the inventory within a chassis is known at time of manufacture, controlling which line cards or modules are in which slots thereafter is labor-intensive and error-prone.

To overcome these difficulties, CNS Flow-Through Provisioning defines a new set of Cisco IOS commands—the **cns** commands. When a remote router is first powered on, these commands do the following:

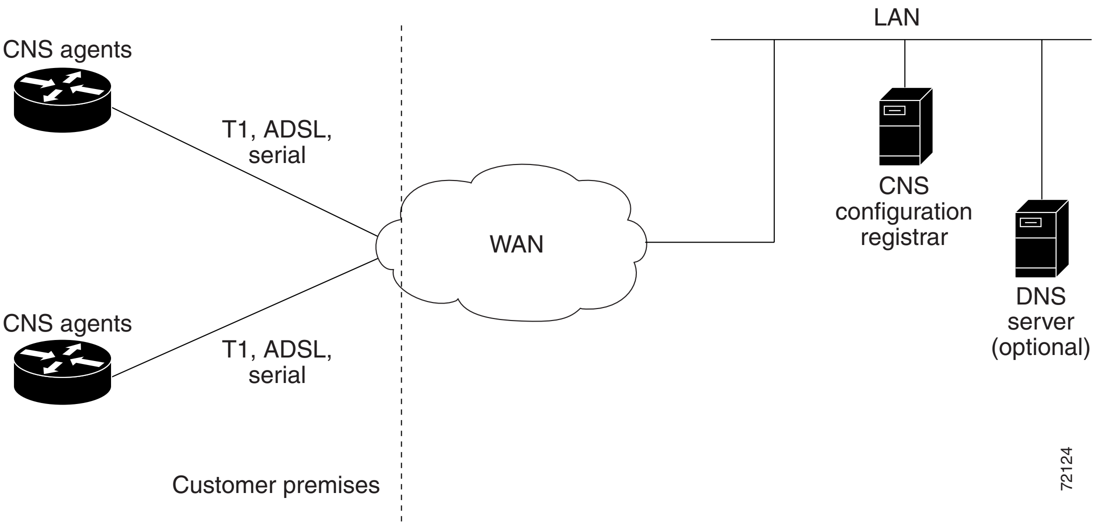
1. To each router interface in turn, applies a preset temporary bootstrap configuration that pings the CNS configuration engine, until a ping is successful and the connecting interface thus determined.
2. Connects, by way of software called a CNS agent, to a CNS configuration engine housed in a Cisco IE2100 device.
3. Passes to the CNS configuration engine a device-unique ID, along with a human-readable description of the router's line-card or module inventory by product number and location, in XML format.

In turn, the configuration engine does the following:

1. Locates in an LDAP directory, based on the device IDs, a predefined configuration template for the main chassis and subconfiguration template for each line card or module.
2. Substitutes actual slot numbers from the chassis inventory for the template's slot-number parameters, thus resolving the templates into subscriber-specific configurations that match the true line-card or module slot configuration.
3. Downloads this initial configuration to the target router. The CNS agent directly applies the configuration to the router.

Figure 20 shows the CNS Flow-Through Provisioning architecture.

Figure 20 CNS Flow-Through Provisioning Architecture



Configurations

CNS Flow-Through Provisioning involves three different types of configuration on the remote router:

- Bootstrap configuration

  You specify the preset bootstrap configuration on which this solution depends as part of your order from Cisco using Cisco Configuration Express, an existing service integrated with the Cisco.com order-entry tool. You specify a general-subscriber nonspecific bootstrap configuration that provides connectivity to the CNS configuration engine. Cisco then applies this configuration to all the devices of that order in a totally automated manufacturing step. This configuration runs automatically on power-on.

- Initial configuration

  The CNS configuration engine downloads an initial configuration, once only, to replace the temporary bootstrap configuration. You can either save or not save it in the router's nonvolatile NVRAM memory:

  - If you save the configuration, the bootstrap configuration is overwritten.
  - If you do not save the configuration, the download procedure repeats each time that the router powers off and then back on. This enables the router to update to the current Cisco IOS configuration without intervention.

- Incremental (partial) configuration

  On subsequent reboot, incremental or partial configurations are performed to update the configuration without the network having to shut down. Such configurations can be delivered either in a push operation that you initiate or a pull operation on request from the router.

Unique IDs

Key to this solution is the capability to associate, with each device, a simple, manageable, and unique ID that is compatible with your systems for order entry, billing, provisioning, and shipping and can also link your order-entry system to the Cisco order-fulfillment system. Such an ID must have the following characteristics:

- Be available from manufacturing as part of order fulfillment
- Be recordable on the shipping carton and chassis
- Be available to the device's Cisco IOS software
- Be modifiable after the device is first powered up
- Be representative of both a specific chassis and a specific entry point into your network

To define such an ID, CNS Flow-Through Provisioning equips the CNS agent with a new set of commands—the **cns** commands—with which you specify how configurations should be done and, in particular, how the system defines unique IDs. You enable the Cisco IOS software to auto-discover the unique ID according to directions that you specify and information that you provide, such as chassis serial number, MAC address, IP address, and several other possibilities. The **cns** commands are part of the bootstrap configuration of the manufactured device, specified to Cisco Configuration Express at time of order.

Within this scope, Configuration Express and the **cns** commands also allow you to define custom asset tags to your own specifications, which are serialized during manufacture and automatically substituted into the unit's bootstrap configuration.

Cisco appends tags to the carton for all the various types of IDs supported by the **cns** commands, so that these values can be bar-code read at shipping time and fed back into your systems. Alternatively, these IDs are also available through a direct XML-software interface between your system and the Cisco order-status engine, eliminating the need for bar-code reading. The CNS agent also provides a feedback mechanism whereby the remote device can receive XML events or commands to modify the device's ID, in turn causing that same device to broadcast an event indicating the old/new IDs.

Management Point

On most networks, a small percentage of individual remote routers get configured locally. This can potentially be a serious problem, not only causing loss of synchronization across your network but also opening your system to the possibility that an automatic reconfiguration might conflict with an existing configuration and cause a router to become unusable or even to lose contact with the network.

To address this problem, you can designate a management point in your network, typically on the Cisco IE2100 CNS configuration engine, and configure it to keep track of the configurations on all remote routers.

To enable this solution, configure the CNS agent to publish an event on the CNS event bus whenever any change occurs to the running configuration. This event indicates exactly what has changed (old/new), eliminating the need for the management point to perform a highly unscalable set of operations such as Telnetting into the device, applying a script, reading back the entire running configuration, and determining the difference between old and new configurations. Additionally, you can arrange for SNMP notification traps of configuration changes occurring through the SNMP MIB set.

Point-to-Point Event Bus

Today's business environment requires that you be able to ensure your customers a level of service not less than what they are actually paying for. Toward this end, you activate service-assurance applications that broadcast small poll/queries to the entire network while expecting large responses from a typically small subset of devices according to the criteria of the query.

For these queries to be scalable, it is necessary for the replying device to bypass the normal broadcast properties of the event bus and instead reply on a direct point-to-point channel. While all devices need the benefit of the broadcasted poll so that they can all be aware of the query to which they may need to reply, the devices do not need to be aware of each others' replies. Massive copying and retransmission of device query replies, as part of the unnecessary reply broadcast, is a serious scalability restriction.

To address this scalability problem, the CNS event bus has a point-to-point connection feature that communicates directly back to the poller station.

Benefits

Automated Configuration

CNS Flow-Through Provisioning simplifies installation by moving configuration requirements to the CNS configuration engine and allowing the Cisco IOS configuration to update automatically. The registrar uses popular industry standards and technologies such as XML, ADSI/Active Directory, HTTP/Web Server, ASP, and Publish-Subscribe Event Bus. The CNS configuration agent enables the CNS configuration engine to configure remote routers in a plug-and-play manner.

Unique IP Addresses and Host Name

CNS Flow-Through Provisioning uses DNS reverse lookup to retrieve the host name by passing the IP address, then assigns the IP address and optionally the host name to the remote router. Both IP address and host name are thus guaranteed to be unique.

Reduced Technical Personnel Requirements

CNS Flow-Through Provisioning permits remote routers to be installed by a person with limited or no technical experience. Because configuration occurs automatically on connection to the network, a network engineer or technician is not required for installation.

Rapid Deployment

Because a person with limited or no technical experience can install a remote router immediately without any knowledge or use of Cisco IOS software, the router can be sent directly to its final premises and be brought up without technician deployment.

Direct Shipping

Routers can be shipped directly to the remote end-user site, eliminating warehousing and manual handling. Configuration occurs automatically on connection to the network.

Remote Updates

CNS Flow-Through Provisioning automatically handles configuration updates, service additions, and deletions. The CNS configuration engine performs a push operation to send the information to the remote router.

Security

Event traffic to and from the remote router is opaque to unauthorized listeners or intruders to your network. CNS agents leverage the latest security features in Cisco IOS software.

Restrictions

Remote Router

- The remote router must run a Cisco IOS image that supports CNS configuration agent and CNS event agent. These include the following:
  - Cisco IOS Release 12.0(18)ST or later release
  - Cisco IOS Release 12.2(4)T or later release
- Ports must be prepared on the remote router for connection to the network.

CNS Configuration Engine

- The CNS configuration engine must be Cisco Intelligence Engine 2100 series running software version 1.3.
- The configuration engine must have access to an information database of attributes for building a configuration. This database can reside on the Cisco IE2100 itself.
- Configuration templates must be prepared on the CNS configuration engine before installation of the remote router.
- The user of CNS Flow-Through Provisioning and the CNS configuration engine must be familiar with designing network topologies, designing configuration templates, and using the CNS configuration engine.

Remote Routers

- You must ensure that the remote router is configured using Cisco Configuration Express.

Related Features and Technologies

Simple Network-Enabled Auto-Provisioning for Cisco IAD2420 Series IADs

CNS Flow-Through Provisioning expands on Simple Network-Enabled Auto-Provisioning.

Cisco Intelligence Engine 2100 Series

CNS Flow-Through Provisioning requires the CNS IE2100 series product.

Related Documents

CNS Agents

- *CNS Configuration Agent,* Cisco IOS Release 12.2(2)T, available online at http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122newft/122t/122t2/ftcns
- *CNS Event Agent,* Cisco IOS Release 12.2(2)T, available online at http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122newft/122t/122t2/ftcns

CNS Configuration Engine

- *Cisco Intelligence Engine 2100 Configuration Registrar Manual,* Cisco Release 1.1 or higher, available online at http://www.cisco.com/univercd/cc/td/doc/product/rtrmgmt/ie2100/cnfg_reg/

IP and ATM Configuration

- *Cisco IOS IP Configuration Guide*, Cisco IOS Release 12.2, available online at http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122cgcr/fipr_c/index.htm
- The section on configuring ATM in *Cisco IOS Wide-Area Networking Configuration Guide*, Cisco IOS Release 12.2, available online at http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122cgcr/fwan_c/index.htm

IAD and Router Hardware and Software

- Cisco IAD2420 series hardware and software documents, available online at http://www.cisco.com/univercd/cc/td/doc/product/access/iad/iad2420/index.htm
- Cisco 2600 series hardware and software documents, available online at http://www.cisco.com/univercd/cc/td/doc/product/access/acs_mod/cis2600/hw_inst/index.htm
- Cisco 3600 series hardware and software documents, available online at http://www.cisco.com/univercd/cc/td/doc/product/access/acs_mod/cis3600/hw_inst/index.htm

Cisco Configuration Express

- Information on Cisco Configuration Express, available online at http://www.cisco.com/warp/public/779/servpro/operate/ce/

CNS Flow-Through Provisioning on Cisco IAD2420 Series IADs

- *Simple Network-Enabled Auto-Provision for Cisco IAD2420 Series IADs*, Cisco IOS Release 12.2(2)XB, available online at http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122newft/122limit/122x/122xb/122xb_2/

Cisco IOS Software

- Cisco IOS Release 12.2 documentation for your router, available online at http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122cgcr/index.htm

Router Platform Documentation

- Configuration guides for your router, available online starting from http://www.cisco.com/univercd/cc/td/doc/product/access/acs_mod/index.htm

Supported Platforms

- Cisco 1700 series routers
- Cisco 2600 series routers
- Cisco 3600 series routers
- Cisco 7200 series routers
- Cisco 12000 series routers

Determining Platform Support Through Cisco Feature Navigator

Cisco IOS software is packaged in feature sets that support specific platforms. To get updated information regarding platform support for this feature, access Cisco Feature Navigator. Cisco Feature Navigator dynamically updates the list of supported platforms as new platform support is added for the feature.

Cisco Feature Navigator is a web-based tool that enables you to determine which Cisco IOS software images support a specific set of features and which features are supported in a specific Cisco IOS image. You can search by feature or release. Under the release section, you can compare releases side by side to display both the features unique to each software release and the features in common.

To access Cisco Feature Navigator, you must have an account on Cisco.com. If you have forgotten or lost your account information, send a blank e-mail to cco-locksmith@cisco.com. An automatic check will verify that your e-mail address is registered with Cisco.com. If the check is successful, account details with a new random password will be e-mailed to you. Qualified users can establish an account on Cisco.com by following the directions at http://www.cisco.com/register/.

Cisco Feature Navigator is updated regularly when major Cisco IOS software releases and technology releases occur. For the most current information, go to the Cisco Feature Navigator home page at the following URL:
http://www.cisco.com/go/fn/

Availability of Cisco IOS Software Images

Platform support for particular Cisco IOS software releases is dependent on the availability of the software images for those platforms. Software images for some platforms may be deferred, delayed, or changed without prior notice. For updated information about platform support and availability of software images for each Cisco IOS software release, refer to the online release notes or, if supported, Cisco Feature Navigator.

Supported Standards, MIBs, and RFCs

Standards

No new or modified standards are supported by this feature.

MIBs

No new or modified MIBs are supported by this feature.

Note CNS Flow-Through Provisioning provides two access mechanisms for accessing MIBs: a nongranular mechanism using SNMP encapsulation and a granular mechanism using XML encapsulation. These mechanisms enable you to access the MIBS currently available in the remote router. The MIBS currently available depend on the router platform and Cisco IOS release.

To obtain lists of supported MIBs by platform and Cisco IOS release, and to download MIB modules, go to the Cisco MIB website on Cisco.com at the following URL:
http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml

RFCs

No new or modified RFCs are supported by this feature.

Prerequisites

Do the following before using CNS Flow-Through Provisioning:

- Configure the remote router to support the CNS configuration agent and the CNS event agent. For more information, see the CNS agent documentation listed in the "Related Documents" section on page 394.
- Configure a transport protocol on the remote router that is compatible with the remote router's external interface. Table 20 lists the supported transport protocols that can be used depending on the router interface.
- Create the configuration template in the CNS configuration-engine provisioning database. (This is best done by a senior network designer.)

Table 20 Router Interface and Transport Protocols Required by CNS Flow-Through Provisioning

	Transport Protocol		
Router Interface	**SLARP**	**ATM InARP**	**PPP (IPCP)**
T1	Yes	Yes	Yes
ADSL	No	Yes	Yes
Serial	Yes	No	Yes

Configuration Tasks

The CNS Flow-Through Provisioning feature allows the remote router to be connected and configured automatically. Cisco Configuration Express loads a minimal set of Cisco IOS configuration commands for the router in the startup-configuration file in the NVRAM, either at the manufacturer or at your premises. The router is ready to be installed on premises with no further configuration.

If you wish to change the configuration or install a custom configuration, see the following sections for configuration tasks. Each task in the list is identified as either required or optional.

- Configuring the CNS Configuration Agent (required)
- Configuring the CNS Event Agent (required)
- Configuring the Remote Router (optional)
- Verifying CNS Flow-Through Provisioning (optional)

Configuring the CNS Configuration Agent (required)

The CNS configuration engine uses templates to build a configuration file. Each parameter in the template must have a directory-customized schema attribute associated.

Tip For additional information on using the CNS configuration engine, refer to *Configuration Registrar Administration*, available online at http://www.cisco.com/univercd/cc/td/doc/product/rtrmgmt/ie2100/cnfg_reg/rel_1_0/crmanual/

To create a template in the CNS configuration engine through the Edit Template graphical user interface (GUI), follow these steps:

Step 1 Associate each remote router object in the CNS configuration engine with one specific template (you may apply one template to multiple router objects).

Step 2 Enter the value in the Edit Parameter GUI of the CNS configuration engine. (The template is not interactive.) If no value is assigned for an attribute, the attribute value in the configuration file is empty.

Configuring the CNS Event Agent (required)

For an event to be initiated between the remote router and the CNS configuration engine, the CNS event agent must configure a connection. To configure the CNS event agent to do so, use the following command in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# cns event {hostname	ip-address} [encrypt] [port-number] [backup] [init-retry retry-count] [keepalive seconds retry-count] [source ip-address] [force-fmt1]]`	Configures the CNS event gateway, which provides CNS event services to Cisco IOS clients. **Note** The **encrypt** keyword is not yet supported.

Configuring the Remote Router (optional)

Your remote router arrives from the factory with a bootstrap configuration. Upon initial power-on, the router automatically pulls from the CNS configuration engine a full initial configuration, although you can optionally arrange for this manually as well. After initial configuration, you can optionally arrange for periodic incremental (partial) configurations for synchronization purposes.

Initial Configuration

Initial configuration of the remote router occurs automatically when the router is initialized on the network. Optionally, you can perform this configuration manually.

CNS Flow-Through Provisioning assigns the remote router a unique IP address or host name. After resolving the IP address (using SLARP, ATM InARP, or PPP protocols), the system optionally uses DNS reverse lookup to assign a host name to the router and invokes the CNS agent to download the initial configuration from the CNS configuration engine.

To manually perform an initial configuration, use the following commands in global configuration mode:

	Command	Purpose
Step 1	Router(config)# **cns config connect-intf** *interface-prefix* [**ping-interval** *seconds*] [**retries** *number*]	Specifies the interface for connecting to the CNS configuration engine.
Step 2	Router(config-cns-conn-if)# **config-cli ...** or Router(config-cns-conn-if)# **line-cli**	**config-cli** followed by commands that, used as is, configure the interface. Or **line-cli** followed by a command to configure modem lines to enable dialout and, after that, commands to configure the modem dialout line.
Step 3	Router(config-cns-conn-if)# **exit**	Returns to global configuration mode.
Step 4	Router(config)# **hostname** *name*	Specifies, to the CNS configuration engine, the host name for the remote router.
Step 5	Router(config)# **ip route** *network-number*	Establishes a static route to the CNS configuration engine, whose IP address is *network-number.*
Step 6	Router(config)# **cns id** *interface num* {**dns-reverse** | **ipaddress** | **mac-address**} [**event**] or Router(config)# **cns id** {**hardware-serial** | **hostname** | **string** *string*} [**event**]	Sets the unique event-id or config-id router ID. The ID defaults to the remote router's host name.
Step 7	Router(config)# **cns config initial** {*hostname* | *ip-address*} [**encrypt**] [*port-number*] [**event**] [**no-persist**] [**page** *page*] [**source** *ip-address*] [**syntax-check**]	Starts the CNS configuration agent, connects to the CNS configuration engine, and initiates an initial configuration. You can use this command only before the system boots for the first time. **Note** The **encrypt** keyword is not yet supported. **Caution** If you write the new configuration to NVRAM by omitting the **no-persist** keyword, the original bootstrap configuration is overwritten.

	Command	Purpose
Step 8	`Router(config)# cns mib-access encapsulation {snmp | xml [size bytes]}`	Specifies whether CNS should use granular (XML) or nongranular (SNMP) encapsulation to access MIBs.
Step 9	`Router(config)# cns notifications encapsulation {snmp | xml}`	Specifies whether CNS notifications should be sent using nongranular (SNMP) or granular (XML) encapsulation.
Step 10	`Router(config)# cns inventory [config | event]`	Enables the CNS inventory agent—that is, sends an inventory of the router's line cards and modules to the CNS configuration agent.

Configuring the Remote Router with a Full Configuration—Example

The following example shows initial configuration on a remote router. The remote router's host name is the unique ID. The CNS configuration engine IP address is 172.28.129.22.

```
Router(config)# cns config connect-intf serial ping-interval 1 retries 1
Router(config-cns-conn-if)# config-cli ip address negotiated
Router(config-cns-conn-if)# config-cli encapsulation ppp
Router(config-cns-conn-if)# config-cli ip directed-broadcast
Router(config-cns-conn-if)# config-cli no keepalive
Router(config-cns-conn-if)# config-cli no shutdown
Router(config-cns-conn-if)# exit
Router(config)# hostname RemoteRouter
RemoteRouter(config)# ip route 172.28.129.22 255.255.255.0 10.11.11.1
RemoteRouter(config)# cns id Ethernet 0 ipaddress
RemoteRouter(config)# cns config initial 10.1.1.1 no-persist
RemoteRouter(config)# cns mib-access encapsulation xml
RemoteRouter(config)# cns notifications encapsulation xml
RemoteRouter(config)# cns inventory config
```

Incremental Configuration

Incremental or partial configuration allows the remote router to be incrementally configured after its initial configuration. You must perform these configurations manually through the CNS configuration engine. The registrar allows you to change the configuration templates, edit parameters, and submit the new configuration to the router without a software or hardware restart.

To perform an incremental (partial) configuration, configure the CNS event agent—see the "Configuring the CNS Event Agent (required)" section on page 397—and then use the following command in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# cns config partial {hostname | ip-address} [encrypt] [port-number] [source ip-address]`	Starts the CNS configuration agent, which provides CNS configuration services to Cisco IOS clients. **Note** The **encrypt** keyword is not yet supported.

Configuring the Remote Router with an Incremental Configuration—Example

The following example shows incremental (partial) configuration on a remote router. The CNS configuration engine IP address is 172.28.129.22 and the port number is 80.

```
Router(config)# cns config partial 172.28.129.22 80
```

Verifying CNS Flow-Through Provisioning (optional)

Command	Purpose
`Router# show cns config connections`	Displays the status of the CNS event agent connection.
`Router# show cns config outstanding`	Displays information about incremental (partial) CNS configurations that have started but not yet completed.
`Router# show cns config stats`	Displays statistics about the CNS configuration agent.
`Router# show cns event connections`	Displays the status of the event agent connection.
`Router# show cns event stats`	Displays statistics about the event agent connection.
`Router# show cns event subject`	Displays a list of subjects about the event agent connection.

Troubleshooting Tips

Command	Purpose
`Router# debug cns config`	Displays information on CNS configurations.
`Router# debug cns event`	Displays information on CNS events.
`Router# debug cns management`	Displays information on CNS management.
`Router# debug cns xml-parser`	Displays information on the XML parser.
`Router# cns config cancel`	Cancels an incremental (partial) CNS configuration.
`Router(config)# cns config notify`	Detects CNS configuration changes and send an event containing the previous and current configurations.

Configuration Examples

This section provides the following configuration examples:

- Cisco Configuration Express File Using T1 over HDLC Protocol Example
- T1 Configuration Template Example
- Voice Configuration Template Example
- Remote Router Example
- Serial-Interface Configuration Example

Cisco Configuration Express File Using T1 over HDLC Protocol Example

The following example shows use of the Cisco Configuration Express file to configure the remote router before delivery to its final premises. In the example, 172.28.129.22 is the IP address of the CNS configuration engine.

```
!cns configure and event agents
cns config initial 172.28.129.22 no-persist
       cns event 172.28.129.22

    !T1 configuration
    controller t1 0
      framing esf
      linecode b8zs
      channel-group 0 timeslots 1-24 speed 64

    cns id s0:0 ipaddress

    !Assign IP addr to s0:0
    interface s0:0
    ip address slarp retry 2

    !IP static route
    ip route 0.0.0.0 0.0.0.0 s0:0
      end
```

T1 Configuration Template Example

The following example shows use of the T1 configuration template to build the configuration for use on T1.

```
hostname ${LDAP://this:attrName=IOShostname}
enable password ${LDAP://this:attrName=IOSpassword}
controller T1 0
clock source ${LDAP://this:attrName=IOST1-clocksource}
linecode ${LDAP://this:attrName=IOST1-line}
framing ${LDAP://this:attrName=IOST1-framing}
channel-group ${LDAP://this:attrName=IOST1-channel-group} timeslots
${LDAP://this:attrName=IOST1-timeslots} speed ${LDAP://this:attrName=IOST1-speed}
```

Voice Configuration Template Example

The following example shows use of the voice configuration template to build the configuration for using voice.

```
voice-port 1/1
codec ${LDAP://this:attrName=IOSvoice-port1}
dial-peer voice 1 pots
application ${LDAP://this:attrName=IOSdial-peer1}
port 1/1
```

Remote Router Example

The following example shows a remote router configuration.

```
Current configuration: 1659 bytes
!
```

```
version 12.2
no service pad
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname tira-24V
!
!
network-clock base-rate 64k
ip subnet-zero
ip cef
!
ip audit notify log
ip audit po max-events 100
!
class-map match-any voice
match access-group 100
!
!
policy-map qos
class voice
priority percent 70
voice service voip
h323
!
no voice confirmation-tone
voice-card 0
!
!
controller T1 0
framing sf
linecode ami
!
controller T1 1
mode cas
framing esf
linecode b8zs
ds0-group 0 timeslots 1 type e&m-immediate-start
ds0-group 1 timeslots 2 type e&m-immediate-start
!
!
interface Ethernet0
ip address 10.1.1.2 255.255.0.0
!
interface Serial0
bandwidth 1536
ip address 10.11.11.1 255.255.255.0
no ip mroute-cache
load-interval 30
clockrate 148000
!
ip classless
ip route 223.255.254.254 255.255.255.0 1.3.0.1
!
no ip http server
ip pim bidir-enable
!
access-list 100 permit udp any range 16384 32767 any
access-list 100 permit tcp any any eq 1720
call rsvp-sync
!
voice-port 1:0
timeouts wait-release 3
```

```
!
voice-port 1:1
timeouts wait-release 3
!
!
mgcp profile default
!
dial-peer cor custom
!
dial-peer voice 1000 pots
destination-pattern 1000
port 1:0
forward-digits 0
!
dial-peer voice 1001 pots
destination-pattern 1001
no digit-strip
port 1:1
forward-digits 0
!
dial-peer voice 2000 voip
destination-pattern 2000
session target ipv4:10.11.11.2
codec g711ulaw
!
dial-peer voice 2001 voip
destination-pattern 2001
session target ipv4:10.11.11.2
signal-type ext-signal
codec g711ulaw
!
!
line con 0
line aux 0
line 2 3
line vty 0 4
```

Serial-Interface Configuration Example

The following example shows configuration of a serial interface to connect to and download a configuration from a Cisco IE2100 CNS configuration engine. The IE2100 IP address is 10.1.1.1. The gateway IP address to reach the 10.1.1.0 network is 10.11.11.1. The CNS default ID is the host name, so that **cns id** command is not needed. However, the **hostname** command is key to retrieving the configuration file on the CNS configuration engine.

This configuration auto-tries every serial interface on the remote router in turn, applies the **config-cli** commands to that interface, and tries to ping the address in the **cns config initial** cli. When it succeeds, it performs a normal initial configuration.

```
Initial basic configuration (serial interface) PPP
cns config connect-intf serial ping-interval 1 retries 1
config-cli ip address negotiated
config-cli encapsulation ppp
config-cli ip directed-broadcast
config-cli no keepalive
config-cli no shutdown
exit
hostname 26ML
ip route 10.1.1.1 255.255.255.0 10.11.11.1
cns config initial 10.1.1.1 no-persist
cns inventory config
Initial basic configuration (serial interface) HDLC
cns config connect-intf serial ping-interval 1 retries 1
config-cli ip address slarp retry 1
config-cli no shutdown
exit
hostname tira-36V
ip route 10.1.1.1 255.255.255.0 10.11.11.1
cns config initial 10.1.1.1 no-persist
cns inventory config
Incremental configuration (serial interface)
cns config partial 10.1.1.1
cns event 10.1.1.1
```

Command Reference

The following new and modified commands are pertinent to this feature. To see the command pages for these commands and other commands used with this feature, go to the *Cisco IOS Master Commands List*, Release 12.4, at http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124mindx/124index.htm.

New Commands

- **cns config cancel**
- **cns config connect-intf**
- **cns config notify**
- **cns inventory**
- **cns mib-access encapsulation**
- **cns notifications encapsulation**
- **config-cli**
- **debug cns config**
- **debug cns event**
- **debug cns management**
- **debug cns xml-parser**
- **line-cli**
- **show cns config connections**
- **show cns config outstanding**
- **show cns config stats**
- **show cns event connections**
- **show cns event stats**
- **show cns event subject**

Modified Commands

- **cns config initial**
- **cns config partial**
- **cns event**
- **cns id**

Glossary

ADSI—Microsoft's Active Directory Services Interface.

ADSL—asymmetric digital subscriber line. Available through several telecommunications carriers to accommodate the need for increased bandwidth for Internet access and telecommuting applications.

ARP—Address Resolution Protocol.

ASP—Microsoft's Active Server Pages technology.

ATM InARP—ATM Inverse Address Resolution Protocol.

CLEC—competitive local-exchange carrier. A company that builds and operates communication networks in metropolitan, urban, and remote areas and provides its customers with an alternative to the local telephone company.

CLI—command-line interface.

CNS—Cisco Networking Services.

CSU—channel service unit.

codec—code/decoder. An algorithm that transforms analog signals into digital signals and digital signals into analog signals.

CPE—customer-premises equipment. Devices such as channel service units (CSUs) and data service units (DSUs), modems, and ISDN terminal adapters, required to provide an electromagnetic termination for wide-area network circuits before connecting to the router or access server. This equipment was historically provided by the telephone company, but is now typically provided by the customer in North American markets.

DNS—Domain Name System.

DSU—data service unit.

HDLC—High-Level Data Link Control.

HTTP—Hypertext Transport Protocol.

IAD—integrated access device. A CPE device used to combine services from various sources onto a common platform for transmission on a common transport span. Typically, an IAD combines various voice and data services such as circuit-based services such as traditional plain old telephone service (POTS) and packet-switched services such as Frame Relay or ATM.

LDAP—Lightweight Directory Access Protocol.

NVRAM—Nonvolatile random-access memory.

PPP/IPCP—Point-to-Point Protocol / IP Control Protocol.

POTS—plain old telephone service.

PVC—permanent virtual circuit.

SLARP—Serial Line ARP.

XML—eXtensible Markup Language.

CNS Image Agent

The CNS Image Agent feature is an infrastructure in Cisco IOS software to enable automated installation and activation of Cisco IOS images on Cisco IOS networking devices.

Feature Specifications for the CNS Image Agent

Feature History	
Release	**Modification**
12.3(1)	This feature was introduced.
Supported Platforms	
For platforms supported in Cisco IOS Release 12.3(1), consult Cisco Feature Navigator.	

Finding Support Information for Platforms and Cisco IOS Software Images

Use Cisco Feature Navigator to find information about platform support and Cisco IOS software image support. Access Cisco Feature Navigator at http://www.cisco.com/go/fn. You must have an account on Cisco.com. If you do not have an account or have forgotten your username or password, click **Cancel** at the login dialog box and follow the instructions that appear.

Contents

Prerequisites for the CNS Image Agent

- Determine where to store the Cisco IOS images on a file server to make the image available to many other networking devices. If the CNS Event Bus is to be used to store and distribute the images, the CNS event agent must be configured.
- Set up a file server to enable the networking devices to download the new images. Protocols such as TFTP, HTTP, HTTPS, and rcp can be used.
- Determine how to handle error messages generated by CNS image agent operations. Error messages can be sent to the CNS Event Bus or an HTTP or HTTPS URL.

Restrictions for the CNS Image Agent

During automated image loading operations you must try to prevent the Cisco IOS device from losing connectivity with the file server that is providing the image. Image reloading is subject to memory issues and connection issues. Boot options must also be configured to allow the Cisco IOS device to boot another image if the first image reload fails. For more details refer to the “File Management” section of the Release 12.2 *Cisco IOS Configuration Fundamentals Configuration Guide*.

Information About the CNS Image Agent

To configure the CNS image agent, you need to understand the following concepts:

- CNS, page 408
- CNS Image Agent, page 408

CNS

CNS is a foundation technology for linking users to networking services. Existing CNS features include CNS configuration and event agents and a flow-through provisioning structure. The configuration and event agents use a CNS Configuration Engine to provide methods for automating initial Cisco IOS device configurations, incremental configurations, and synchronized configuration updates, and it reports the status of the configuration load as an event to which a network monitoring or workflow application can subscribe. The CNS flow-through provisioning uses the CNS configuration and event agents to provide an automated workflow, eliminating the need for an on-site technician.

CNS Image Agent

Administrators maintaining large networks of Cisco IOS devices need an automated mechanism to load image files onto large numbers of remote devices. Existing network management applications are useful to determine which images to run and how to manage images received from the Cisco online software center. Other image distribution solutions do not scale to cover thousands of devices and cannot distribute images to devices behind a firewall or using Network Address Translation (NAT). The CNS image agent enables the managed device to initiate a network connection and request an image download allowing devices using NAT, or behind firewalls, to access the image server.

The CNS image agent can be configured to use the CNS Event Bus. To use the CNS Event Bus, the CNS event agent must be enabled and connected to the CNS event gateway in the CNS Configuration Engine. The CNS image agent can also use an HTTP server that understands the CNS image agent protocol. Deployment of CNS image agent operations can use both the CNS Event Bus and an HTTP server.

How to Configure the CNS Image Agent

This section contains the following procedures:

- Configuring the CNS Image Agent Using the CLI, page 409 (optional)
- Configuring the CNS Image Agent to Use the CNS Event Bus, page 411 (optional)
- Polling the Server Using the CLI, page 413 (optional)
- Polling the Server Using Command Scheduler, page 414 (optional)

Configuring the CNS Image Agent Using the CLI

Use this task to configure CNS image agent parameters using command-line interface (CLI) commands.

CNS Image Agent ID

CNS uses a unique identifier to identify an image agent associated with that Cisco IOS device. Using the same process as CNS event and configuration agents, the configuration of the **cns id** command determines whether an IP address or MAC address of a specified interface, the hardware serial hardware number of the device, an arbitrary text string, or the host name of the device is used as the image ID. By default, the system uses the host name of the device.

The CNS image ID is sent in the content of the messages sent by the image agent and allows an application to know the unique image ID of the Cisco IOS device that generated the message. A password can be configured and associated with the image ID in the image agent messages.

Prerequisites

- To configure the CNS image agent to use HTTP or HTTPS to communicate with an image server, you need to know the URL for the image server and the URL to which status messages can be sent.
- If you are using HTTPS to communicate with the image server, you must set up security certificates to allow the server to be authenticated by the image agent when the connection is established.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **cns id** *type number* {**dns-reverse** | **ipaddress** | **mac-address**} [**event**] [**image**]
   or
   cns id {**hardware-serial** | **hostname** | **string** *text*} [**event**] [**image**]
4. **cns image** [**server** *server-url* [**status s***tatus-url*]]
5. **cns image password** *image-password*

6. **cns image retry** *seconds*
7. **exit**

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	**cns id** *type number* {**dns-reverse** | **ipaddress** | **mac-address**} [**event**] [**image**]
	or
	cns id {**hardware-serial** | **hostname** | **string** *text*} [**event**] [**image**]
	Example:
	`Router(config)# cns id fastethernet 0/1 ipaddress image`
	or
	Example:
	`Router(config)# cns id hardware-serial image`
		Specifies a unique CNS ID and interface type and number from which to retrieve the unique ID.
		or
		Specifies a unique CNS ID assigned from the hardware serial number, device host name, or an arbitrary text string.
		The following information applies to either version of the syntax.
		• Use the **event** keyword to specify an event agent ID.
		• Use the **image** keyword to specify an image agent ID.
		• If no keywords are used, the configuration agent ID is configured.

Step 4	**cns image** [**server** *server-url*] **status** *status-url* **Example:** `Router(config)# cns image server https://10.21.2.3/cns/imgsvr status https://10.21.2.3/cns/status/`	Enables CNS image agent services and specifies the URL of the image distribution server. • Use the optional **status** keyword and *status-url* argument to specify the URL of a web server to which error messages are written. • If the **status** keyword and *status-url* argument are not specified, status messages are sent as events on the CNS Event Bus. To view the status messages on the CNS Event Bus, the CNS event agent must be configured.
Step 5	**cns image password** *password* **Example:** `Router(config)# cns image password abctext`	(Optional) Specifies a password for CNS image agent services. • If a password is configured, the password is included with the image ID in CNS image agent messages sent out by the image agent. The receiver of these messages can use this information to authenticate the sending device.

	Command or Action	Purpose

Step 6	`cns image retry seconds`
	Example:
	`Router(config)# cns image retry 240`
		(Optional) Specifies an image upgrade retry interval in seconds.
		• The default interval is 60 seconds.

Step 7	`exit`
	Example:
	`Router(config)# exit`
		Exits global configuration mode, and returns the router to privileged EXEC mode.

What to Do Next

Proceed to the "Polling the Server Using the CLI" section to connect to the web server and download an image.

If any of the commands in the task fail, proceed to the "Troubleshooting CNS Image Agent Operation" section to try to determine the problem.

Configuring the CNS Image Agent to Use the CNS Event Bus

Use this task to configure CNS image agent parameters to use the CNS Event Bus. When the CNS image agent and event agent are both enabled, the CNS Event Bus is listened to by the software. For more details on the CNS event agent and CNS Event Bus refer to the *CNS Event Agent* feature document in Cisco IOS Release 12.2(2)T and *CNS Flow-Through Provisioning* feature document in Cisco IOS Release 12.2(8)T.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **cns event** {*hostname* | *ip-address*} [*port-number*] [**encrypt**] [**backup**] [**failover-time** *seconds*] [**keepalive** *seconds retry-count*] [**source** *ip-address*] [**force-fmt1**]
4. **cns id** *type number* {**dns-reverse** | **ipaddress** | **mac-address**} [**event**] [**image**]
   or
   cns id {**hardware-serial** | **hostname** | **string** *text*} [**event**] [**image**]
5. **cns image** [**server** *server-url* [**status** *status-url*]]
6. **cns image password** *image-password*
7. **exit**

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	**cns event** {*hostname* | *ip-address*} [*port-number*] [**encrypt**] [**backup**] [**failover-time** *seconds*] [**keepalive** *seconds retry-count*] [**source** *ip-address*] [**force-fmt1**] **Example:** `Router(config)# cns event 10.20.2.4`	Configures the CNS event gateway, which provides CNS event services to Cisco IOS clients. • The CNS event agent must be configured before the CNS image agent can use the CNS Event Bus.

Step 4	**cns id** *type number* {**dns-reverse** | **ipaddress** | **mac-address**} [**event**] [**image**]
	or
	cns id {**hardware-serial** | **hostname** | **string** *text*} [**event**] [**image**]
	Example:
	`Router(config)# cns id fastethernet 0/1 ipaddress image`
	or
	Example:
	`Router(config)# cns id hardware-serial image`
		Specifies a unique CNS ID, and interface type and number from which to retrieve the unique ID.
		or
		Specifies a unique CNS ID assigned from the hardware serial number, device host name, or an arbitrary text string.
		The following information applies to either version of the syntax.
		• Use the **event** keyword to specify an event agent ID.
		• Use the **image** keyword to specify an image agent ID.
		• If no keywords are used, the configuration agent ID is configured.

Step 5	**cns image** [**server** *server-url*] **status** *status-url* **Example:** `Router(config)# cns image`	Enables CNS image agent services. • If the **server** keyword and argument are not specified, the CNS image agent process starts and listens for events on the CNS Event Bus.

	Command or Action	Purpose
Step 6	**cns image password** *password* **Example:** `Router(config)# cns image password abctext`	(Optional) Specifies a password for CNS image agent services. • If a password is configured, the password is included with the image ID in CNS image agent messages sent out by the image agent. The receiver of these messages can use this information to authenticate the sending device.
Step 7	**exit** **Example:** `Router(config)# exit`	Exits global configuration mode, and returns the router to privileged EXEC mode.

Troubleshooting Tips

- Use the **show cns event connections** command to check that the CNS event agent is connected to the CNS event gateway.
- Use the **show cns event subject** command to check that the image agent subject names are registered. Subject names for the CNS image agent begin with cisco.mgmt.cns.image.

Polling the Server Using the CLI

Use this task to poll the image distribution server using HTTP or HTTPS.

Prerequisites

This task assumes that you have already configured the CNS image agent using the tasks in the "Configuring the CNS Image Agent Using the CLI" section.

SUMMARY STEPS

1. **enable**
2. **cns image retrieve** [**server** *server-url* [**status** *status-url*]]

DETAILED STEPS

	Command or Action	Purpose

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

Step 2	**`cns image retrieve`** `[`**`server`** *`server-url`* `[`**`status`** *`status-url`*`]]`
	Example:
	`Router# cns image retrieve https://10.19.2.3/imgsvr/ status https://10.19.2.3/imgsvr/status/`
		Contacts a Cisco CNS image distribution server and downloads a new image if a new image exists.
		• Use the optional **status** keyword and *status-url* argument to specify the URL of a web server to which status messages are written.
		• If the **server** and **status** keywords are not specified, the server and status URLs configured with the **cns image** command are used.
		Note We recommend using the **cns trusted-server** command to specify the host part of the server or status URL as a trusted server.

Troubleshooting Tips

- If the web server appears to be down, use the **ping** command to check connectivity.
- If using HTTP, use the **show ip http client all** command to display information about HTTP clients and connections.

Polling the Server Using Command Scheduler

Use this task to set up Command Scheduler policy lists of EXEC CNS commands and configure a Command Scheduler occurrence to specify the time or interval after which the CNS commands will run.

Command Scheduler Policy Lists

Policy lists consist of one or more lines of fully qualified EXEC CLI commands to be run at the same time. Create a separate policy list for commands to be run on a different schedule. No editor function is available and the policy list is run in the order in which it was configured. To delete an entry, use the **no** form of the **cli** command followed by the appropriate EXEC command. If an existing policy list name is used, new entries are added to the end of the policy list. To view entries in a policy list, use the **show running-config** command. If a policy list is only scheduled to run once, it will not be displayed by the **show running-config** command after it has run.

Policy lists can be configured after the policy list has been scheduled, but each policy list must be configured before it is scheduled to run.

Prerequisites

The EXEC CLI commands to be run by Command Scheduler must be tested on the routing device to determine if it will run without generating a prompt or allowing execution interruption by keystrokes. Initial testing is important because Command Scheduler will delete the entire policy list if any CLI syntax fails. Removing the policy list ensures that any CLI dependencies will not generate more errors.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **kron policy-list** *list-name*
4. **cli** *command*
5. **exit**
6. **kron occurrence** *occurrence-name* [**user** *user-name*] {**in** [[*numdays*:]*numhours*:]*nummin* | **at** *hours*:*min* [[*month*] *day-of-month*] [*day-of-week*]} {**oneshot** | **recurring**}
7. **policy-list** *list-name*
8. **exit**

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	**kron policy-list** *list-name* **Example:** `Router(config)# kron policy-list cns-weekly`	Specifies a name for a new or existing Command Scheduler policy list and enters kron-policy configuration mode. • If the *list-name* is new, a new policy list structure is created. • If the *list-name* exists, the existing policy list structure is accessed. The policy list is run in configured order with no editor function.

	Command or Action	Purpose
Step 4	**cli** *command* **Example:** `Router(config-kron-policy)# cli cns image retrieve server https://10.19.2.3/cnsweek/ status https://10.19.2.3/cnsstatus/week/`	Specifies the fully-qualified EXEC command and associated syntax to be added as an entry in the specified Command Scheduler policy list. • Each entry is added to the policy list in the order in which it is configured. • Repeat this step to add other EXEC CLI commands to a policy list to be executed at the same time or interval. **Note** EXEC commands that generate a prompt or can be terminated using keystrokes will cause an error.
Step 5	**exit** **Example:** `Router(config-kron-policy)# exit`	Exits kron-policy configuration mode, and returns the router to global configuration mode.

Step 6	**kron occurrence** *occurrence-name* [**user** *user*] {**in** [[*numdays*:]*numhours*:]*nummin* | **at** *hours*:*min* [[*month*] *day-of-month*] [*day-of-week*]} {**oneshot** | **recurring**}
	Example:
	`Router(config)# kron occurrence may user sales at 6:30 may 20 oneshot`
		Specifies a name and schedule for a new or existing Command Scheduler occurrence and enters kron-occurrence configuration mode.
		• If the *list-name* is new, a new occurrence list structure is created.
		• If the *list-name* exists, the existing occurrence structure is accessed. The occurrence is run in configured order with no editor function.
		• Use the **in** keyword to specify a delta time interval with a timer that starts when this command is configured.
		• Use the **at** keyword to specify a calendar date and time.

Step 7	**policy-list** *list-name* **Example:** `Router(config-kron-occurrence)# policy-list sales-may`	Specifies a Command Scheduler policy list. • Each entry is added to the occurrence list in the order in which it is configured. **Note** If the CLI commands in a policy list generate a prompt or can be terminated using keystrokes, an error will be generated and the policy list will be deleted.
Step 8	**exit** **Example:** `Router(config-kron-occurrence)# exit`	Exits kron-occurrence configuration mode, and returns the router to global configuration mode. • Repeat this step one more time to exit global configuration mode.

Troubleshooting CNS Image Agent Operation

This section explains how to troubleshoot CNS image agent issues. The **show** commands created for the CNS image agent display information that is reset to zero after a successful reload of the device. Depending on the configuration of the image distribution process, the new image may not reload immediately. When a reload is not immediate or has failed, use the CNS image agent **show** commands to determine whether the image agent has connected to the image distribution server over HTTP or whether the image agent is receiving events from an application over the CNS Event Bus.

SUMMARY STEPS

1. **enable**
2. **show cns image status**
3. **clear cns image status**
4. **show cns image connections**
5. **show cns image inventory**
6. **debug cns image** [**agent** | **all** | **connection** | **error**]

DETAILED STEPS

<table>
<tr><th></th><th>Command or Action</th><th>Purpose</th></tr>
<tr><td>Step 1</td><td><b>enable</b>
<b>Example:</b>
Router> enable</td><td>Enables higher privilege levels, such as privileged EXEC mode.
• Enter your password if prompted.</td></tr>
<tr><td>Step 2</td><td><b>show cns image status</b>
<b>Example:</b>
Router# show cns image status</td><td>(Optional) Displays information about the CNS image agent status.</td></tr>
<tr><td>Step 3</td><td><b>clear cns image status</b>
<b>Example:</b>
Router# clear cns image status</td><td>(Optional) Clears CNS image agent status statistics.</td></tr>
<tr><td>Step 4</td><td><b>show cns image connections</b>
<b>Example:</b>
Router# show cns image connections</td><td>(Optional) Displays information about CNS image management server HTTP or HTTPS connections.</td></tr>
<tr><td>Step 5</td><td><b>show cns image inventory</b>
<b>Example:</b>
Router# show cns image inventory</td><td>(Optional) Displays inventory information about the CNS image agent.
• This command displays a dump of XML that would be sent out in response to an image agent inventory request message. The XML output can be used to determine the information requested by an application.</td></tr>
<tr><td>Step 6</td><td><b>debug cns image</b> [<b>agent</b> | <b>all</b> | <b>connection</b> | <b>all</b>]
<b>Example:</b>
Router# debug cns image all</td><td>(Optional) Displays debugging messages for CNS image agent services.</td></tr>
</table>

Examples

This section provides the following output examples:

- Sample Output for the show cns image status Command
- Sample Output for the show cns image connections Command
- Sample Output for the show cns image inventory Command
- Sample Output for the debug cns image Command

Sample Output for the show cns image status Command

In the following example, status information about the CNS image agent is displayed using the **show cns image status** privileged EXEC command:

```
Router# show cns image status

Last upgrade started at 11:45:02.000 UTC Mon May 6 2003
Last upgrade ended at 11:56:04.000 UTC Mon May 6 2003 status SUCCESS

Last successful upgrade ended at 11:56:04.000 UTC Mon May 6 2003
Last failed upgrade ended at 06:32:15.000 UTC Wed Apr 16 2003
Number of failed upgrades: 2
Number of successful upgrades: 6
 messages received: 12
 receive errors: 5
Transmit Status
  TX Attempts:4
    Successes:3         Failures 2
```

Sample Output for the show cns image connections Command

In the following example, information about the status of the CNS image management HTTP connections is displayed using the **show cns image connections** privileged EXEC command:

```
Router# show cns image connections

CNS Image Agent:  HTTP connections
Connection attempts 1
never connected:0   Abrupt disconnect:0
Last successful connection at 11:45:02.000 UTC Mon May 6 2003
```

Sample Output for the show cns image inventory Command

In the following example, information about the CNS image agent inventory is displayed using the **show cns image inventory** privileged EXEC command:

```
Router> show cns image inventory

Inventory Report
<imageInventoryReport><deviceName><imageID>Router</imageID><hostName>Router</ho
IOS (tm) C2600 Software (C2600-I-M), Experimental Version 12.3(20030414:081500)]
Copyright (c) 1986-2003 by cisco Systems, Inc.
Compiled Mon 14-Apr-03 02:03 by engineer</versionString><imageFile>tftp://10.25>
.
.
.
```

Sample Output for the debug cns image Command

In the following example, debugging messages for all CNS image agent services are displayed using the **debug cns image** privileged EXEC command. The CNS image agent in this example is connecting to an image server over HTTP. After connecting, the image server asks for an inventory of the Cisco IOS device.

```
Router# debug cns image all

All cns image debug flags are on

Router# cns image retrieve

May  7 06:11:42.175: CNS Image Agent: set EXEC lock
May  7 06:11:42.175: CNS Image Agent: received message from EXEC
May  7 06:11:42.175: CNS Image Agent: set session lock 1
May  7 06:11:42.175: CNS Image Agent: attempting to send to
destination(http://10.1.36.8:8080/imgsrv/xgate):
<?xml version="1.0" encoding="UTF-8"?><cnsMessageversion="1.0">
<senderCredentials><userName>dvlpr-7200-6</userName></senderCredentials>
<messageID>dvlpr-7200-6_2</messageID><sessionControl><imageSessionStart version="1.0">
<initiatorInfo><trigger>EXEC</trigger><initiatorCredentials><userName>dvlpr-7200-6</userNa
me>
</initiatorCredentials></initiatorInfo></imageSessionStart></sessionControl></cnsMessage>
May  7 06:11:42.175: CNS Image Agent: clear EXEC lock
May  7 06:11:42.175: CNS Image Agent: HTTP message sent
url:http://10.1.36.8:8080/imgsrv/xgate

May  7 06:11:42.191: CNS Image Agent: response data alloc 4096 bytes
May  7 06:11:42.191: CNS Image Agent: HTTP req data free
May  7 06:11:42.191: CNS Image Agent: response data freed
May  7 06:11:42.191: CNS Image Agent: receive message
<?xml version="1.0" encoding="UTF-8"?>
<cnsMessage version="1.0">
        <senderCredentials>
                <userName>myImageServer.cisco.com</userName>
                <passWord>R0lGODlhcgGSALMAAAQCAEMmCZtuMFQxDS8b</passWord>
        </senderCredentials>
        <messageID>dvlpr-c2600-2-476456</messageID>
        <request>
                <replyTo>
                        <serverReply>http://10.1.36.8:8080/imgsrv/xgate</serverReply>
                </replyTo>
                <imageInventory>
                        <inventoryItemList>
                                <all/>
                        </inventoryItemList>
                </imageInventory>
        </request>
</cnsMessage>
```

Configuration Examples for the CNS Image Agent

This section contains the following configuration examples:

- Configuring the CNS Image Agent Examples, page 420
- Polling the Server Examples, page 420

Configuring the CNS Image Agent Examples

In the following example, the CNS image agent parameters are configured using the CLI. An image ID is specified to use the IP address of the FastEthernet interface 0/1, a password is configured for the CNS image agent services, the CNS image upgrade retry interval is set to four minutes, and image management and status servers are configured.

```
cns id FastEthernet0/1 ipaddress image
cns image retry 240
cns image password abctext
cns image server https://10.21.2.3/cns/imgsvr status https://10.21.2.3/cns/status/
```

In the following example, the CNS image agent is configured to use the CNS Event Bus. An image ID is specified as the hardware serial number of the networking device, the CNS event agent is enabled with a number of parameters, and the CNS image agent is enabled without any keywords or options. The CNS image agent will listen for events on the CNS Event Bus.

```
cns id hardware-serial image
cns event 10.21.9.7 11011 keepalive 240 120 failover-time 5
cns image
cns image password abctext
```

Polling the Server Examples

In the following example, the CNS image agent polls a file server using the **cns image retrieve** command. Assuming that the CNS image agent is already enabled, the file server and status server paths specified here will overwrite any existing image agent server and status configuration. The new file server will be polled and a new image, if it exists, will be downloaded to the networking device.

```
cns image retrieve server https://10.19.2.3/cns/ status https://10.19.2.3/cnsstatus/
```

In the following example, a Command Scheduler policy named cns-weekly is configured to run EXEC CLI involving CNS commands. The policy is then scheduled to run every seven days, one hour and thirty minutes.

```
kron policy-list cns-weekly
 cli cns image retrieve server https://10.1.2.3/week/ status https://10.1.2.3/status/week/
!
kron occurrence week in 7:1:30 recurring
 policy-list cns-weekly
```

Where to Go Next

One feature that can be used with the CNS image agent is the Command Scheduler process. See the "Related Documents" section for more details.

Additional References

The following sections provide references related to the CNS image agent:

- Related Documents, page 421
- Standards, page 421
- MIBs, page 421
- RFCs, page 422
- Technical Assistance, page 422

Related Documents

Related Topic	Document Title
CNS commands: complete command syntax, command mode, defaults, usage guidelines, and examples	"CNS Commands" chapter in the *Cisco IOS Configuration Fundamentals Command Reference,* Release 12.3
CNS configuration agent	"CNS Configuration Agent" feature document, Release 12.2(2)T
CNS event agent	"CNS Event Agent" feature document, Release 12.2(2)T
CNS flow-through provisioning	"CNS Flow-Through Provisioning" feature document, Release 12.2(8)T
CNS Configuration Engine	*Cisco Intelligence Engine 2100 Configuration Registrar Manual*, Release 1.1 or higher
Command Scheduler	"Command Scheduler" feature document, Release 12.3(1)

Standards

Standards	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	—

MIBs

MIBs	MIBs Link
No new or modified MIBs are supported by this feature, and support for existing MIBs has not been modified by this feature.	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

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

Technical Assistance

Description	Link
Technical Assistance Center (TAC) home page, containing 30,000 pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/public/support/tac/home.shtml

Command Reference

The following new and modified commands are pertinent to this feature. To see the command pages for these commands and other commands used with this feature, go to the *Cisco IOS Master Commands List*, Release 12.4, at http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124mindx/124index.htm.

New Commands

- **clear cns image connections**
- **clear cns image status**
- **cns image**
- **cns image password**
- **cns image retrieve**
- **cns image retry**
- **debug cns image**
- **show cns image connections**
- **show cns image inventory**
- **show cns image status**

Modified Commands

- **cns id**

CNS Frame Relay Zero Touch

Note The CNS Frame Relay Zero Touch feature provides enhancements to the CNS Flow-Through Provisioning feature introduced in Cisco IOS Release 12.2(8)T. As part of this feature enhancement, the following commands have been replaced by new commands:

- The **cns config connect-intf** command is replaced by the **cns connect** and **cns template connect** commands.
- The **config-cli** and **line-cli** commands are replace by the **cli (cns)** command.

Cisco Networking Services (CNS) technology enables deployment of customer premises equipment (CPE) routers across multiple access technologies. The CNS Frame Relay Zero Touch feature provides a CNS zero touch deployment solution over Frame Relay where the CPE router discovers its DLCI and IP address dynamically, and then contacts a CNS engine to retrieve its full configuration automatically. This capability is made possible through a single generic bootstrap configuration file common across all service provider end customers subscribing to the services. Within the CNS framework, customers who deploy Frame Relay can create this generic bootstrap configuration without device-specific or network-specific information such as the data link connection identifier (DLCI), IP address, interface type, controller type (if applicable), or the next hop interface used for the static default route.

History for the CNS Frame Relay Zero Touch Feature

Release	Modification
12.3(2)XF	This feature was introduced.
12.3(8)T	This feature was integrated into Cisco IOS Release 12.3(8)T.

Finding Support Information for Platforms and Cisco IOS Software Images

Use Cisco Feature Navigator to find information about platform support and Cisco IOS software image support. Access Cisco Feature Navigator at http://www.cisco.com/go/fn. You must have an account on Cisco.com. If you do not have an account or have forgotten your username or password, click **Cancel** at the login dialog box and follow the instructions that appear.

Contents

Information About CNS Frame Relay Zero Touch

To use the CNS Frame Relay Zero Touch feature, you should understand the following concepts:

Benefits of CNS Frame Relay Zero Touch

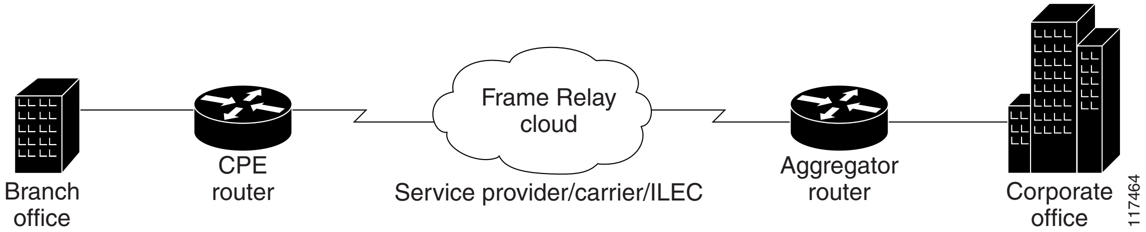
The CNS Frame Relay Zero Touch feature provides the following benefits:

- A service provider can have a single common bootstrap configuration.
- The generic bootstrap configuration does not require the IP address to be hardwired.
- The point-to-point DLCI does not need to be known in advance.
- IP directly over Frame Relay is allowed.
- Use of a channel service unit (E1 or T1 controller) is allowed.

The Zero Touch Solution for Frame Relay

Figure 21 illustrates a typical customer network architecture using Frame Relay.

Figure 21 Connectivity in a Frame Relay Customer Network



The CPE router is deployed at multiple sites. Each site connects to a Frame Relay cloud through a point-to-point permanent virtual circuit (PVC). Connectivity from the Frame Relay cloud to the corporate office is through a PVC that terminates at the corporate office. IP traffic sent to the CNS configuration engine is routed through the corporate office. The PVC is identified by its DLCI. The DLCI can vary between branch offices. In order to support zero touch deployment, the CPE router must be able to learn which DLCI to use to connect to the CNS configuration engine.

Note The CNS Frame Relay Zero Touch feature does not support switched virtual circuits (SVCs).

To support the zero touch capability, the Frame Relay functionality has been modified in the following two ways:

- A new Cisco IOS command (**ip address dynamic**) has been introduced to discover the CPE router's IP address dynamically based on the aggregator router's IP address. To configure IP over Frame Relay, the local IP address must be configured on the interface.
- The CPE router can now read Local Management Interface (LMI) messages from a Frame Relay switch and determine the list of available DLCIs.

How the Frame Relay Zero Touch Feature Works

Note As part of the CNS Frame Relay Zero Touch feature, the following commands have been replaced by new commands:

- The **cns config connect-intf** command is replaced by the **cns connect** and **cns template connect** commands.
- The **config-cli** and **line-cli** commands are replace by the **cli (cns)** command.

The CNS connect functionality is configured with a set of CNS connect templates. A CNS connect profile is created for connecting to the CNS configuration engine and to implement the CNS connect templates on a CPE router. CNS connect variables can be used as placeholders within a CNS connect template configuration. These variables, such as the active DLCI, are substituted with real values before the CNS connect templates are sent to the router's parser.

When a CPE router is placed in a Frame Relay network, it contains a generic bootstrap configuration. This configuration includes customer-specific Frame Relay configuration (including the LMI type), CNS connect templates, CNS connect profiles, and the **cns config initial** command. This command initiates the CNS connect function.

The CNS connect functionality begins by selecting the first available controller or interface specified by the CNS connect profile and then performs multiple ping iterations through all the associated active DLCIs. For each iteration, the CNS connect function attempts to ping the CNS configuration engine. If the ping is successful, the pertinent configuration information can be downloaded from the CNS configuration engine.

When iterating over the active DLCIs on a Frame Relay interface, the router must be able to automatically go through a list of active DLCIs returned by the LMI messages for that interface and select an active DLCI to use. When more than one of the active DLCIs allow IP connectivity to the CNS configuration engine, the DLCI used will be the first one tried by the CNS connect functionality. If the ping attempt is unsuccessful, the next active DLCI is tried and so on. If connectivity to the CNS configuration engine is unsuccessful for all active DLCIs, the CNS connect function removes the configuration applied to the selected controller or interface, and the CNS connect process restarts with the next available controller or interface specified by the CNS connect profile.

Note The Frame Relay zero touch solution does not support IP over PPP over Frame Relay because routing to an interface (or subinterface) that supports IP over PPP over Frame Relay is not possible.

How to Create a Generic Bootstrap Configuration for the CNS Zero Touch Solution

This section contains the following procedure:

- Creating a Generic Bootstrap Configuration, page 426

Creating a Generic Bootstrap Configuration

Perform this task to create a bootstrap configuration for the CNS zero touch solution.

Note When configuring the generic bootstrap configuration, you must configure a static default route to the interface that is being configured. For example, the **ip route 0.0.0.0 0.0.0.0 serial1.1** command configures a static default route to serial interface 1. This route directs all traffic to the specified subinterface. The Frame Relay subsystem must ensure that this routing configuration is successful.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **cns template connect** *name*
4. **cli** *config-text*
5. Repeat Step 4 as needed.
6. **exit**
7. Repeat Step 3 to Step 6 as needed.
8. **cns connect** *name* [**ping-interval** *interval-seconds*] [**retries** *number-retries*] [**timeout** *timeout-seconds*] [**sleep** *sleep-seconds*]
9. **discover** {**line** *line-type* | **controller** *controller-type* | **interface** [*interface-type*] | **dlci** [**subinterface** *subinterface-number*]}
   or
   template *name*
10. Repeat Step 9 as needed.
11. Repeat Step 8 to Step 10 as needed.
12. **cns config initial** {*ip-address* | *host-name*} [**encrypt**] [*port-number*] [**page** *page*] [**syntax-check**] [**no-persist**] [**source** *ip-address*] [**event**] [**inventory**]

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	**cns template connect** *name* **Example:** `Router(config)# cns template connect setup-frame`	Enters CNS template connect configuration mode and defines the name of a CNS connect template.
Step 4	**cli** *config-text* **Example:** `Router(config-templ-conn)# cli encapsulation frame-relay`	Specifies the command lines of a CNS connect template.
Step 5	Repeat Step 4 as needed.	—
Step 6	**exit** **Example:** `Router(config-templ-conn)# exit`	Exits CNS template connect configuration mode and completes the configuration of a CNS connect template. **Note** Entering **exit** is required. This requirement was implemented to prevent accidentally entering a command without the **cli** command.
Step 7	Repeat Step 3 to Step 6 as needed.	—
Step 8	**cns connect** *name* [**ping-interval** *interval-seconds*] [**retries** *number-retries*] [**timeout** *timeout-seconds*] [**sleep** *sleep-seconds*] **Example:** `Router(config)# cns connect ip-over-frame sleep 15`	Enters CNS connect configuration mode and defines the parameters of a CNS connect profile for connecting to the CNS configuration engine.

Step 9	**discover** {**line** *line-type* | **controller** *controller-type* | **interface** [*interface-type*] | **dlci** [**subinterface** *subinterface-number*]}
	or
	template *name*
	Example:
	`Router(config-cns-conn)# discover interface serial`
	`Router(config-cns-conn)# template setup-frame`
		The **discover** command defines the interface parameters within a CNS connect profile for connecting to the CNS configuration engine.
		The **template** command specifies a list of CNS connect templates within a CNS connect profile to be applied to a router's configuration.

Step 10	Repeat Step 9 as needed.	—

	Command or Action	Purpose
Step 11	Repeat Step 8 to Step 10 as needed.	—
Step 12	**cns config initial** {*ip-address* | *host-name*} [**encrypt**] [*port-number*] [**page** *page*] [**syntax-check**] [**no-persist**] [**source** *ip-address*] [**event**] [**inventory**] **Example:** `Router(config)# cns config initial 10.1.1.1`	Initiates the CNS connect functionality.

Configuration Examples for CNS Frame Relay Zero Touch

This section provides the following configuration examples:

- Configuring Aggregator Router Interfaces: Example, page 428
- Configuring IP over Frame Relay Using the CNS Zero Touch Solution: Example, page 429
- Configuring IP over Frame Relay over T1 Using Using the CNS Zero Touch Solution: Example, page 429

Configuring Aggregator Router Interfaces: Example

The following examples show how to configure a standard serial interface and a serial interface bound to a controller on an aggregator router (also known as the DCE). In order for connectivity to be established, the aggregator router must have a point-to-point subinterface configured.

Standard Serial Interface

```
interface Serial0/1
 no ip address
 encapsulation frame-relay
 frame-relay intf-type dce

interface Serial0/1.1 point-to-point
 ip address ip-address mask
 frame-relay interface-dlci dlci
```

Serial Interface Bound to a Controller

```
controller T1 0
 framing sf
 linecode ami
 channel-group 0 timeslots 1-24

interface Serial0:0
 no ip address
 encapsulation frame-relay
 frame-relay intf-type dce

interface Serial0:0.1 point-to-point
 ip address ip-address mask
 frame-relay interface-dlci dlci
```

Configuring IP over Frame Relay Using the CNS Zero Touch Solution: Example

The following example shows the bootstrap configuration for configuring IP over Frame Relay on a CPE router:

```
cns template connect setup-frame
 cli encapsulation frame-relay
 exit

cns template connect ip-over-frame
 cli frame-relay interface-dlci ${dlci}
 cli ip address dynamic
 exit

cns template connect ip-route
 cli ip route 0.0.0.0 0.0.0.0 ${next-hop}
 exit

cns connect ip-over-frame
 discover interface Serial
 template setup-frame
 discover dlci
 template ip-over-frame
 template ip-route

cns config initial 10.1.1.1
```

Configuring IP over Frame Relay over T1 Using Using the CNS Zero Touch Solution: Example

The following example shows the bootstrap configuration for configuring IP over Frame Relay over T1 on a CPE router:

```
cns template connect setup-frame
 cli encapsulation frame-relay
 exit

cns template connect ip-over-frame
 cli frame-relay interface-dlci ${dlci}
 cli ip address dynamic
 exit

cns template connect ip-route
 cli ip route 0.0.0.0 0.0.0.0 ${next-hop}
 exit

cns template connect t1-controller
 cli framing esf
 cli linecode b8zs
 cli channel-group 0 timeslots 1-24 speed 56
 exit

cns connect ip-over-frame-over-t1
 discover controller T1
 template t1-controller
 discover interface
 template setup-frame
 discover dlci
 template ip-over-frame
 template ip-route
```

```
cns config initial 10.1.1.1
```

Additional References

The following sections provide references related to the CNS Frame Relay Zero Touch feature.

Related Documents

Related Topic	Document Title
Commands for CNS	*Cisco IOS Configuration Fundamentals and Network Management Command Reference*, Release 12.3 T
CNS Flow-Through Provisioning feature	*CNS Flow-Through Provisioning*, Cisco IOS Release 12.2(8)T feature module

Standards

Standards	Title
None	—

MIBs

MIBs	MIBs Link
None	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

RFCs	Title
None	—

Technical Assistance

Description	Link
Technical Assistance Center (TAC) home page, containing 30,000 pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/public/support/tac/home.shtml

Command Reference

This section documents only modified commands.

- **cli (cns)**
- **cns config connect-intf**
- **cns connect**
- **cns template connect**
- **config-cli**
- **discover (cns)**
- **ip address dynamic**
- **line-cli**
- **template (cns)**

Command Scheduler

First Published: May 19, 2003
Last Updated: June 19, 2006

The Command Scheduler feature provides the ability to schedule some EXEC command-line interface (CLI) commands to run at specific times or at specified intervals.

Finding Feature Information in This Module

Your Cisco IOS software release may not support all of the features documented in this module. To reach links to specific feature documentation in this module and to see a list of the releases in which each feature is supported, use the "Feature Information for Command Scheduler" section on page 453.

Finding Support Information for Platforms and Cisco IOS and Catalyst OS Software Images

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

Restrictions for Command Scheduler

The EXEC CLI specified in a Command Scheduler policy list must neither generate a prompt nor can it be terminated using keystrokes. Command Scheduler is designed as a fully automated facility, and no manual intervention is permitted.

Information About Command Scheduler

To configure Command Scheduler, you should understand the following concept:

- Command Scheduler Overview, page 434

Command Scheduler Overview

Command Scheduler allows customers to schedule fully-qualified EXEC mode CLI commands to run once, at specified intervals, or at specified calendar dates and times. Originally designed to work with CNS commands, Command Scheduler has a broader application. Using the CNS image agent feature, remote routers residing outside a firewall or using Network Address Translation (NAT) addresses can use Command Scheduler to launch CLI at intervals to update the image running in the router.

Command Scheduler has two basic processes. A policy list is configured containing lines of fully-qualified EXEC CLI commands to be run at the same time or interval. One or more policy lists are then scheduled to run after a specified interval of time or at a specified calendar date and time. Each scheduled occurrence can be set to run once only or on a recurring basis.

How to Configure Command Scheduler

This section contains the following procedures:

- Configuring Command Scheduler Policy Lists, page 434 (required)
- Configuring Command Scheduler Occurrences, page 436 (required)

Configuring Command Scheduler Policy Lists

Use this task to set up the lists of EXEC commands to be run at the same time or at the same interval.

Command Scheduler Policy Lists

Policy lists consist of one or more lines of fully-qualified EXEC CLI commands. All commands in a policy list are executed when the policy list is run by Command Scheduler using the **kron occurrence** command. Use separate policy lists for CLI commands that are run at different times. No editor function is available, and the policy list is run in the order in which it was configured. To delete an entry, use the **no** form of the **cli** command followed by the appropriate EXEC command. If an existing policy list name is used, new entries are added to the end of the policy list. To view entries in a policy list, use the **show running-config** command. If a policy list is scheduled to run only once, it will not be displayed by the **show running-config** command after it has run.

Policy lists can be configured after the policy list has been scheduled, but each policy list must be configured before it is scheduled to run.

Prerequisites

The EXEC CLI to be run by Command Scheduler must be tested on the routing device to determine if it will run without generating a prompt or allowing execution interruption by keystrokes. Initial testing is important because Command Scheduler will delete the entire policy list if any CLI syntax fails. Removing the policy list ensures that any CLI dependencies will not generate more errors.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **kron policy-list** *list-name*
4. **cli** *command*
5. Repeat Step 4 to add other EXEC CLI commands to a policy list to be executed at the same time or interval.
6. **exit**

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	**`kron policy-list`** *`list-name`*
	Example:
	`Router(config)# kron policy-list cns-weekly`
		Specifies a name for a new or existing Command Scheduler policy list and enters kron-policy configuration mode.
		• If the value of the *list-name* argument is new, a new policy list structure is created.
		• If the value of the *list-name* argument exists, the existing policy list structure is accessed. No editor function is available, and the policy list is run in the order in which it was configured.

Step 4	**`cli`** *`command`*
	Example:
	`Router(config-kron-policy)# cli cns image retrieve server http://10.19.2.3/cnsweek/ status http://10.19.2.3/cnsstatus/week/`
		Specifies the fully-qualified EXEC command and associated syntax to be added as an entry in the specified Command Scheduler policy list.
		• Each entry is added to the policy list in the order in which it is configured.
		Note EXEC commands that generate a prompt or can be terminated using keystrokes will result in an error on execution.

	Command or Action	Purpose
Step 5	Repeat Step 4. **Example:** `Router(config-kron-policy)# cli cns config retrieve`	Repeat Step 4 to add other EXEC CLI commands to a policy list to be executed at the same time or interval. • Each entry is added to the policy list in the order in which it is configured. **Note** EXEC commands that generate a prompt or can be terminated using keystrokes will result in an error on execution.

Step 6	`exit`
	Example:
	`Router(config-kron-policy)# exit`
		Exits kron-policy configuration mode and returns the router to global configuration mode.

Configuring Command Scheduler Occurrences

Use this task to schedule one or more Command Scheduler policy lists to run at a specific date and time or a recurring interval.

Command Scheduler Occurrences

An occurrence for Command Scheduler is defined as a scheduled event. Policy lists are configured to run after a period of time since the scheduling was set or at a specified calendar date and time. Policy lists can be run once, as a one-time event, or as recurring events over time.

Command Scheduler occurrences can be scheduled before the associated policy list has been configured, but a warning will advise you to configure the policy list before it is scheduled to run.

Prerequisites

The clock time must be set on the routing device before a Command Scheduler occurrence is scheduled to run. If the clock time is not set, a warning message will appear on the console screen after the **kron occurrence** command has been entered. Use the **clock** command or Network Time Protocol (NTP) to set the clock time.

Restrictions

- No more than 31 policy lists can be scheduled to run at the same time.
- If a one-time occurrence is scheduled, the occurrence will not be displayed by the **show running-config** command after the occurrence has run.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **kron occurrence** *occurrence-name* [**user** *username*] {**in** [[*numdays***:**]*numhours***:**]*nummin* | **at** *hours***:***min* [[*month*] *day-of-month*] [*day-of-week*]} {**oneshot** | **recurring**}
4. **policy-list** *list-name*

5. Repeat Step 4 to add other Command Scheduler policies to be executed at the same time or interval.
6. **end**
7. **show kron schedule**

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	**kron occurrence** *occurrence-name* [**user** *username*] {**in** [[*numdays*:]*numhours*:]*nummin* | **at** *hours*:*min* [[*month*] *day-of-month*] [*day-of-week*]} {**oneshot** | **recurring**}
	Example:
	`Router(config)# kron occurrence may user sales at 6:30 may 20 oneshot`
		Specifies a name and schedule for a new or existing Command Scheduler occurrence and enters kron-occurrence configuration mode.
		• If the value of the *occurrence-name* attribute is new, a new occurrence list structure is created.
		• If the value of the *occurrence-name* attribute exists, the existing occurrence structure is accessed. The occurrence is run in configured order with no editor function.
		• Use the **in** keyword to specify a delta time interval with a timer that starts when this command is configured.
		• Use the **at** keyword to specify a calendar date and time.

Step 4	**policy-list** *list-name* **Example:** `Router(config-kron-occurrence)# policy-list sales-may`	Specifies a Command Scheduler policy list. • Each entry is added to the occurrence list in the order in which it is configured. **Note** If the CLI commands in a policy list generate a prompt or can be terminated using keystrokes, an error will be generated and the policy list will be deleted on the execution of the occurrence.
Step 5	Repeat Step 4. **Example:** `Router(config-kron-occurrence)# policy-list itd-may`	Repeat Step 4 to add other Command Scheduler policies to be executed at the same time or interval. • Each entry is added to the occurrence list in the order in which it is configured. **Note** If the CLI commands in a policy generate a prompt or can be terminated using keystrokes, an error will be generated and the policy will be deleted on the execution of the occurrence.

	Command or Action	Purpose
Step 6	**exit** **Example:** Router(config-kron-occurrence)# exit	Exits kron-occurrence configuration mode, and returns the router to global configuration mode. • Repeat this step one more time to exit global configuration mode.
Step 7	**show kron schedule** **Example:** Router# show kron schedule	Displays the status and schedule information of Command Scheduler occurrences.

Examples

In the following example, output information is displayed about the status and schedule of all configured Command Scheduler occurrences:

```
Router# show kron schedule

Kron Occurrence Schedule
cns-weekly inactive, will run again in 7 days 01:02:33
may inactive, will run once in 32 days 20:43:31 at 6:30 on May 20
```

Troubleshooting Tips

Use the **debug kron** command in privileged EXEC mode to troubleshoot Command Scheduler command operations. Use any debugging command with caution because the volume of output generated can slow or stop the router operations.

Configuration Examples for Command Scheduler

This section contains the following configuration example:

- Configuring Command Scheduler: Examples, page 438

Configuring Command Scheduler: Examples

In the following example, a Command Scheduler policy named cns-weekly is configured to run two sets of EXEC CLI involving CNS commands. The policy is then scheduled with two other policies to run every seven days, one hour and thirty minutes.

```
kron policy-list cns-weekly
 cli cns image retrieve server http://10.19.2.3/week/ status http://10.19.2.5/status/week/
 cli cns config retrieve page /testconfig/config.asp no-persist
!
kron occurrence week in 7:1:30 recurring
 policy-list cns-weekly
 policy-list itd-weekly
 policy-list mkt-weekly
```

In the following example, a Command Scheduler policy named sales-may is configured to run a CNS command to retrieve a specified image from a remote server. The policy is then scheduled to run only once on May 20, at 6:30 a.m.

```
kron policy-list sales-may
 cli cns image retrieve server 10.19.2.3 status 10.19.2.3
!
kron occurrence may at 6:30 May 20 oneshot
 policy-list sales-may
```

In the following example, a Command Scheduler policy named image-sunday is configured to run a CNS command to retrieve a specified image from a remote server. The policy is then scheduled to run every Sunday at 7:30 a.m.

```
kron policy-list image-sunday
 cli cns image retrieve server 10.19.2.3 status 10.19.2.3
!
kron occurrence sunday user sales at 7:30 sunday recurring
 policy-list image-sunday
```

Additional References

The following sections provide additional information related to Command Scheduler.

Related Documents

Related Topic	Document Title
CNS commands	*Cisco IOS Network Management Command Reference*, Release 12.2 SR
CNS Configuration Engine	*Cisco Intelligence Engine 2100 Configuration Registrar Manual*, Release 1.1 or later *Cisco CNS Configuration Engine Administrator's Guide*
CNS Configuration Agent	CNS Configuration section of the *Cisco IOS Network Management Command Reference*, Release 12.4
CNS Event Agent	CNS Configuration section of the *Cisco IOS Network Management Command Reference*, Release 12.4
Command Scheduler	CNS Configuration section of the *Cisco IOS Network Management Command Reference*, Release 12.4

Standards

Standards	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	—

MIBs

MIBs	MIBs Link
No new or modified MIBs are supported by this feature, and support for existing MIBs has not been modified by this feature.	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

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

Technical Assistance

Description	Link
The Cisco Technical Support & Documentation website contains thousands of pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/techsupport

Command Reference

This section documents new and modified commands only.

- **cli**
- **debug kron**
- **kron occurrence**
- **kron policy-list**
- **policy-list**
- **show kron schedule**

cli

To specify EXEC command-line interface (CLI) commands within a Command Scheduler policy list, use the **cli** command in kron-policy configuration mode. To delete a CLI command from the current policy list, use the **no** form of this command.

cli *command*

no cli *command*

Syntax Description

command	EXEC-mode CLI command that must not generate a prompt or allow interruption by a keystroke.

Command Default

No CLI commands are specified.

Command Modes

Kron-policy configuration

Command History

Release	Modification
12.3(1)	This command was introduced.
12.2(33)SRA	This command was integrated into Cisco IOS Release 12.2(33)SRA.

Usage Guidelines

Use the **cli** command in conjunction with the **kron policy-list** command to create a policy list containing EXEC CLI commands to be scheduled to run on the router at a specified time. Use the **kron occurrence** and **policy-list** commands to schedule one or more policy lists to run at the same time or interval.

The Command Scheduler process is useful to automate the running of EXEC commands at recurring intervals, and it can be used in remote routers to minimize manual intervention.

Examples

The following example shows how to configure the EXEC command **cns image retrieve** within the policy list named three-day-list:

```
Router(config)# kron policy-list three-day-list
Router(config-kron-policy)# cli cns image retrieve server https://10.19.2.3/cns/image/
status https://10.19.2.3/cnsstatus/imageinfo/
```

Related Commands

Command	Description
kron occurrence	Specifies schedule parameters for a Command Scheduler occurrence and enters kron-occurrence configuration mode.
kron policy-list	Specifies a name for a Command Scheduler policy and enters kron-policy configuration mode.
policy-list	Specifies the policy list associated with a Command Scheduler occurrence.

debug kron

To display debugging messages about Command Scheduler policies or occurrences, use the **debug kron** command in privileged EXEC mode. To disable debugging output, use the **no** form of this command.

debug kron {**all** | **exec-cli** | **info** | **major**}

no debug kron {**all** | **exec-cli** | **info** | **major**}

Syntax Description

all	Displays all debugging output about Command Scheduler policy lists or occurrences.
exec-cli	Displays detailed debugging output about Command Scheduler policy list command-line interface (CLI) commands.
info	Displays debugging output about Command Scheduler policy lists, occurrence warnings, or progress information.
major	Displays debugging output about Command Scheduler policy list or occurrence failures.

Defaults

If no keyword is specified, all debugging messages are displayed.

Command Modes

Privileged EXEC

Command History

Release	Modification
12.3(1)	This command was introduced.
12.2(33)SRA	This command was integrated into Cisco IOS Release 12.2(33)SRA.

Usage Guidelines

Use the **debug kron** command to display the output of a scheduled EXEC **show** command on the console.

Examples

The following example shows debugging messages for the EXEC CLI **show version** after the CLI was run at a scheduled interval:

```
Router# debug kron exec-cli

Kron cli occurrence messages debugging is on
2w6d: Call parse_cmd 'show version'
2w6d: Kron CLI return 0
'
**CLI 'show version':
Cisco Internetwork Operating System Software IOS (tm) C2600 Software (C2600-I-M
```

Related Commands

Command	Description
show kron schedule	Displays the status and schedule information for Command Scheduler occurrences.

kron occurrence

To specify schedule parameters for a Command Scheduler occurrence and enter kron-occurrence configuration mode, use the **kron occurrence** command in global configuration mode. To delete a Command Scheduler occurrence, use the **no** form of this command.

kron occurrence *occurrence-name* [**user** *username*] {**in** [[*numdays*:]*numhours*:]*nummin* | **at** *hours*:*min* [[*month*] *day-of-month*] [*day-of-week*]} {**oneshot** | **recurring**}

no kron occurrence *occurrence-name* [**user** *username*] {**in** [[*numdays*:]*numhours*:]*nummin* | **at** *hours*:*min* [[*month*] *day-of-month*] [*day-of-week*]} {**oneshot** | **recurring**}

Syntax Description

occurrence-name	Name of occurrence. Length of *occurrence-name* is from 1 to 31 characters. If the *occurrence-name* is new, an occurrence structure will be created. If the *occurrence-name* is not new, the existing occurrence will be edited.
user	(Optional) Used to identify a particular user.
username	(Optional) Name of user.
in	Identifies that the occurrence is to run after a specified time interval. The timer starts when the occurrence is configured.
numdays:	(Optional) Number of days. If used, add a colon after the number.
numhours:	(Optional) Number of hours. If used, add a colon after the number.
nummin	Number of minutes.
at	Identifies that the occurrence is to run at a specified calendar date and time.
hours:	Hour as a number using the twenty-four hour clock. Add a colon after the number.
min	Minute as a number.
month	(Optional) Month name. If used, you must also specify *day-of-month*.
day-of-month	(Optional) Day of month as a number.
day-of-week	(Optional) Day of week name.
oneshot	Identifies that the occurrence is to run only one time. After the occurrence has run, the configuration is removed.
recurring	Identifies that the occurrence is to run on a recurring basis.

Command Default

No schedule parameters are specified.

Command Modes

Global configuration

Command History

Release	Modification
12.3(1)	This command was introduced.
12.2(33)SRA	This command was integrated into Cisco IOS Release 12.2(33)SRA.

Usage Guidelines

Prior to Cisco IOS Release 12.4, when you configured a kron occurrence for a calendar time when the system clock was not set, you received a printf message stating that the clock was not set and the occurrence would not be scheduled until it was set.

Beginning in Cisco IOS Release 12.4, when you configure a kron occurrence for a calendar time when the system clock is not set, the occurrence is scheduled but a printf message appears stating that the clock is not set and that it currently reads <current clock time>.

If you set the clock, the schedule of the occurrence is affected in one of the following ways:

- A new clock time set for less than 3 hours after the occurrence is scheduled to happen causes the occurrence to happen immediately.
- A new clock time set for less than 3 hours before the occurrence is scheduled to happen causes the occurrence to happen as scheduled.
- A new clock time set for more than 3 hours after the occurrence is scheduled to happen causes the occurrence to be rescheduled for the next regular calendar time.
- A new clock time set for more than 3 hours before the occurrence is scheduled to happen causes the occurrence to be rescheduled for the previous regular calendar time.

Use the **kron occurrence** and **policy-list** commands to schedule one or more policy lists to run at the same time or interval.

Use the **kron policy-list** command in conjunction with the **cli** command to create a Command Scheduler policy containing EXEC command-line interface (CLI) commands to be scheduled to run on the router at a specified time.

Use the **show kron schedule** command to display the name of each configured occurrence and when it will next run.

The Command Scheduler process is useful to automate the running of EXEC commands at recurring intervals, and it can be used in remote routers to minimize manual intervention.

Examples

The following example shows how to create a Command Scheduler occurrence named info-three and schedule it to run every three days, 10 hours, and 50 minutes. The EXEC CLI in the policy named three-day-list is configured to run as part of occurrence info-three.

```
Router(config)# kron occurrence info-three user IT2 in 3:10:50 recurring
Router(config-kron-occurrence)# policy-list three-day-list
```

The following example shows how to create a Command Scheduler occurrence named auto-mkt and schedule it to run once on June 4 at 5:30 a.m. The EXEC CLI in the policies named mkt-list and mkt-list2 are configured to run as part of occurrence auto-mkt.

```
Router(config)# kron occurrence auto-mkt user marketing at 5:30 jun 4 oneshot
Router(config-kron-occurrence)# policy-list mkt-list
Router(config-kron-occurrence)# policy-list mkt-list2
```

Related Commands

Command	Description
cli	Specifies EXEC CLI commands within a Command Scheduler policy list
kron policy-list	Specifies a name for a Command Scheduler policy and enters kron-policy configuration mode.

Command	Description
policy-list	Specifies the policy list associated with a Command Scheduler occurrence.
show kron schedule	Displays the status and schedule information for Command Scheduler occurrences.

kron policy-list

To specify a name for a Command Scheduler policy and enter kron-policy configuration mode, use the **kron policy-list** command in global configuration mode. To delete the policy list, use the **no** form of this command.

kron policy-list *list-name*

no kron policy-list *list-name*

Syntax Description

list-name	String from 1 to 31 characters that specifies the name of the policy.

Command Default

If the specified list name does not exist, a new policy list is created.

Command Modes

Global configuration

Command History

Release	Modification
12.3(1)	This command was introduced.
12.2(33)SRA	This command was integrated into Cisco IOS Release 12.2(33)SRA.

Usage Guidelines

Use the **kron policy-list** command in conjunction with the **cli** command to create a Command Scheduler policy containing EXEC command-line interface (CLI) commands to be scheduled to run on the router at a specified time. Use the **kron occurrence** and **policy-list** commands to schedule one or more policy lists to run at the same time or interval.

When the *list-name* is new, a policy list structure is created. When the *list-name* is not new, the existing policy list is edited.

The Command Scheduler process is useful to automate the running of EXEC commands at recurring intervals, and it can be used in remote routers to minimize manual intervention.

Examples

The following example shows how to create a policy named sales-may and configure EXEC CLI commands to run the CNS command that retrieves an image from a server:

```
Router(config)# kron policy-list sales-may
Router(config-kron-policy)# cli cns image retrieve server https://10.21.2.3/imgsvr/ status
https://10.21.2.5/status/
```

Related Commands

Command	Description
cli	Specifies EXEC CLI commands within a Command Scheduler policy list.

Command	Description
kron occurrence	Specifies schedule parameters for a Command Scheduler occurrence and enters kron-occurrence configuration mode.
policy-list	Specifies the policy list associated with a Command Scheduler occurrence.

policy-list

To associate a policy list with a Command Scheduler occurrence, use the **policy-list** command in kron-occurrence configuration mode. To delete a policy list from the Command Scheduler occurrence, use the **no** form of this command.

policy-list *list-name*

no policy-list *list-name*

Syntax Description

list-name	Name of the policy list.

Command Default

No policy list is associated.

Command Modes

Kron-occurrence configuration

Command History

Release	Modification
12.3(1)	This command was introduced.
12.2(33)SRA	This command was integrated into Cisco IOS Release 12.2(33)SRA.

Usage Guidelines

Use the **policy-list** command with the **kron occurrence** command to schedule one or more policy lists to run at the same time or interval. Use the **kron policy-list** command in conjunction with the **cli** command to create a Command Scheduler policy list containing EXEC command line interface (CLI) commands to be scheduled to run on the router at a specified time.

When the *list-name* is new, a policy list structure is created. When the *list-name* is not new, the existing policy list is edited.

The Command Scheduler process is useful to automate the running of EXEC commands at recurring intervals, and can it be used in remote routers to minimize manual intervention.

Examples

The following example shows how to create a Command Scheduler occurrence named may and associate a policy list named sales-may with the occurrence:

```
Router(config)# kron occurrence may at 6:30 may 20 oneshot
Router(config-kron-occurrence)# policy-list sales-may
```

Related Commands

Command	Description
cli	Specifies EXEC CLI commands within a Command Scheduler policy list.

Command	Description
kron occurrence	Specifies schedule parameters for a Command Scheduler occurrence and enters kron-occurrence configuration mode.
kron policy-list	Specifies a name for a Command Scheduler policy and enters kron-policy configuration mode.

show kron schedule

To display the status and schedule information of Command Scheduler occurrences, use the **show kron schedule** command in user EXEC or privileged EXEC mode.

show kron schedule

Syntax Description

This command has no arguments or keywords.

Command Modes

User EXEC

Privileged EXEC

Command History

Release	Modification
12.3(1)	This command was introduced.
12.2(33)SRA	This command was integrated into Cisco IOS Release 12.2(33)SRA.

Usage Guidelines

Use the **show kron schedule** command to view all currently configured occurrences and when they are next scheduled to run.

Examples

The following sample output displays each configured policy name and the time interval before the policy is scheduled to run:

```
Router# show kron schedule

Kron Occurrence Schedule
week inactive, will run again in 7 days 01:02:33
may inactive, will run once in 32 days 20:43:31 at 6:30 on Jun 20
```

Table 21 describes the significant fields shown in the display.

Table 21 show kron schedule Field Descriptions

Field	Description
week inactive	The policy list named week is currently inactive.
run again in 7 days 01:02:33	Time in days, hours, minutes and seconds before the policy will run. This policy is scheduled to run on a recurring basis.
run once in 32 days 20:434:31	Time in days, hours, minutes and seconds before the policy will run. This policy is scheduled to run just once.

Related Commands

Command	Description
kron occurrence	Specifies schedule parameters for a Command Scheduler occurrence and enters kron-occurrence configuration mode.
policy-list	Specifies the policy list associated with a Command Scheduler occurrence.

Feature Information for Command Scheduler

Table 22 lists the release history for this feature.

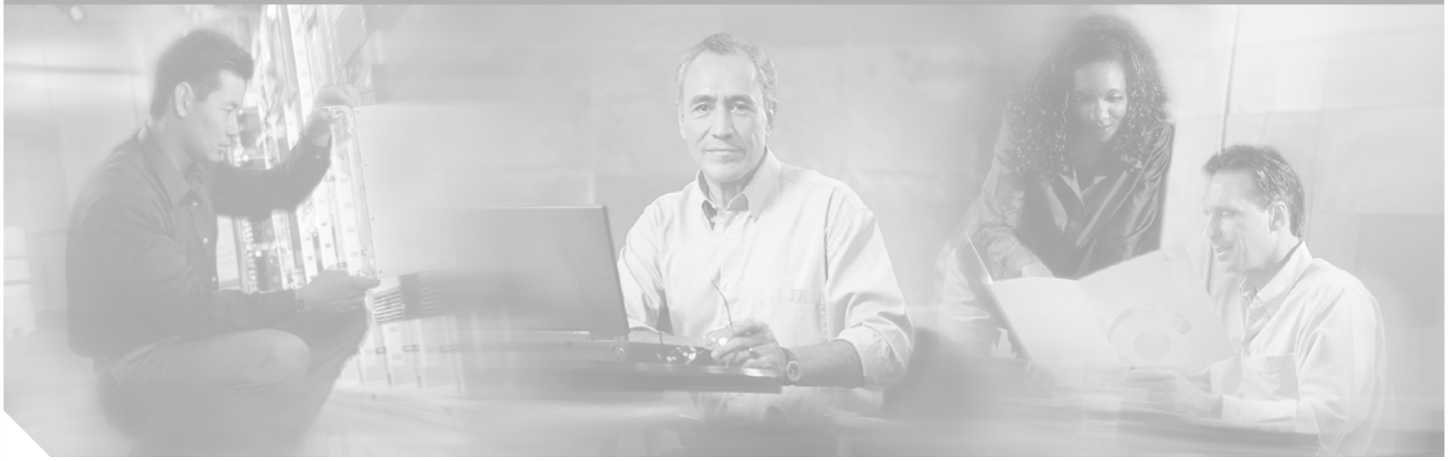
Not all commands may be available in your Cisco IOS software release. For release information about a specific command, see the command reference documentation.

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

Note Table 22 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 22 Feature Information for Command Scheduler

Feature Name	Releases	Feature Information
Command Scheduler	12.3(1), 12.2(33)SRA	In 12.3(1), this feature was introduced. The following commands were introduced or modified by this feature: **cli**, **debug kron**, **kron occurrence**, **kron policy-list**, **policy-list**, **show kron schedule**



Part 7: Distributed Director Configuration

DistributedDirector Enhancements for Cisco IOS Release 12.1(5)T

This feature module describes the DistributedDirector Enhancements for Cisco IOS Release 12.1(5)T feature and includes the following sections:

Feature Overview

The DistributedDirector Enhancements for Cisco IOS Release 12.1(5)T feature consists of the following modified features for the DistributedDirector, which were introduced in Cisco IOS Release 11.1(28)IA:

- Enhanced Fault Tolerance with Multiple Resource Records
- Event Recording with Syslog
- Enhanced Server Verification with Multiple Port Connect Tests

The DistributedDirector Enhancements for Cisco IOS Release 12.1(5)T feature also consists of several unrelated new commands. These commands can be found in the Command Reference section.

Enhanced Fault Tolerance with Multiple Resource Records

Before this enhancement, DistributedDirector would return a single Resource Record (RR) in each Domain Name System (DNS) response. A single RR is normally sufficient, but for some applications, server failover will occur more rapidly when applications are provided IP addresses of multiple servers.

The Enhanced Fault Tolerance with Multiple Resource Records feature enables DistributedDirector to return multiple RRs. The number of RRs returned in a single reply is configurable. The default number of RRs returned is one.

Event Recording with Syslog

The Event Recording with Syslog feature enables DistributedDirector to log events by way of the industry-standard syslog system. Server state is logged, providing a useful log of when servers are considered up or down. The logging priority level is notification with priority level five. Additionally, the server selection process, DNS request, and DNS response may be logged. The logging priority level is informational with priority level six.

Enhanced Server Verification with Multiple Port Connect Tests

Before this enhancement, DistributedDirector could evaluate server status by performing a TCP connect test to a single server port. The Enhanced Server Verification with Multiple Port Connect Tests feature allows multiple port connect tests to be specified. If any one of the connect tests fails, the server is considered down.

Benefits

The features provided in Cisco IOS Release 12.1(5)T help make networks that use DistributedDirector more robust. These features ensure that applications have more useful information and perform better server verification, and they allow administrators to track DistributedDirector better. In particular:

- The Enhanced Fault Tolerance with Multiple Resource Records feature provides better fault tolerance for clients.
- The Event Recording with Syslog feature provides the ability to examine DNS traffic and the way in which servers are chosen.
- The Enhanced Server Verification with Multiple Port Connect Tests feature better reflects the reality that some services span several ports and require that all ports be up.

Restrictions

Enhanced Fault Tolerance with Multiple Resource Records

Configuring DistributedDirector to return a large number of records can reduce the benefit of using DistributedDirector to select the best server.

Event Recording with Syslog

Extensive syslog output is provided when logging server selection. Therefore, this feature should not be used when a heavy request load is expected.

Related Documents

For more information on the Cisco DistributedDirector, see the following documents, which are located on Cisco Connection Online (CCO) at http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml:

- *Cisco DistributedDirector 2500 Series Installation and Configuration Guide*
- *Cisco DistributedDirector 4700-M Installation and Configuration Guide*
- *Release Notes for Cisco DistributedDirector System Software*
- *Cisco DistributedDirector Enhancements for Release 11.1(18)IA*

- *Cisco DistributedDirector Enhancements for Release 11.1(25)IA*
- *Cisco DistributedDirector Enhancements for Release 11.1(28)IA*

Supported Platforms

- Cisco DistributedDirector 2501
- Cisco DistributedDirector 2502
- Cisco DistributedDirector 4700

Determining Platform Support Through Cisco Feature Navigator

Cisco IOS software is packaged in feature sets that support specific platforms. To get updated information regarding platform support for this feature, access Cisco Feature Navigator. Cisco Feature Navigator dynamically updates the list of supported platforms as new platform support is added for the feature.

Cisco Feature Navigator is a web-based tool that enables you to determine which Cisco IOS software images support a specific set of features and which features are supported in a specific Cisco IOS image. You can search by feature or release. Under the release section, you can compare releases side by side to display both the features unique to each software release and the features in common.

To access Feature Navigator, you must have an account on Cisco.com. If you have forgotten or lost your account information, send a blank e-mail to cco-locksmith@cisco.com. An automatic check will verify that your e-mail address is registered with Cisco.com. If the check is successful, account details with a new random password will be e-mailed to you. Qualified users can establish an account on Cisco.com by following the directions at http://www.cisco.com/register.

Cisco Feature Navigator is updated regularly when major Cisco IOS software releases and technology releases occur. For the most current information, go to the Cisco Feature Navigator home page at the following URL:

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

Availability of Cisco IOS Software Images

Platform support for particular Cisco IOS software releases is dependent on the availability of the software images for those platforms. Software images for some platforms may be deferred, delayed, or changed without prior notice. For updated information about platform support and availability of software images for each Cisco IOS software release, refer to the online release notes or, if supported, Cisco Feature Navigator.

Supported Standards, MIBs, and RFCs

Standards

None

MIBs

None

To obtain lists of supported MIBs by platform and Cisco IOS release, and to download MIB modules, go to the Cisco MIB website on Cisco.com at the following URL:

http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml

RFCs

None

Configuration Tasks

See the following sections for configuration tasks for this feature. Each task is optional.

- Configuring Enhanced Fault Tolerance with Multiple Resource Records(Optional)
- Configuring Event Recording with Syslog (Optional)
- Configuring Enhanced Server Verification with Multiple Port Connect Tests (Optional)
- Verifying Enhanced Fault Tolerance with Multiple Resource Records (Optional)
- Verifying Event Recording with Syslog (Optional)
- Verifying Enhanced Server Verification with Multiple Port Connect Tests (Optional)

Configuring Enhanced Fault Tolerance with Multiple Resource Records

To configure the Enhanced Fault Tolerance with Multiple Resource Records feature on the DistributedDirector for a host name, use the following command in global configuration mode:

Command	Purpose
`Router(config)# ip director host host-name [a	mx] multiple integer`	Configures the number of RRs that the DistributedDirector returns for each DNS response.

Configuring Event Recording with Syslog

To configure the Event Recording with Syslog feature on the DistributedDirector for a host name, use the following commands in global configuration mode:

Command	Purpose

`Router(config)# logging host`
`Router(config)# logging trap informational`
`Router(config)# ip director host host-name [a
	mx] logging`	Configures the DistributedDirector to log events to syslog.

Configuring Enhanced Server Verification with Multiple Port Connect Tests

To configure the Enhanced Server Verification with Multiple Port Connect Tests feature on the DistributedDirector, use the following commands in global configuration mode:

Command	Purpose
Router(config)# **ip director host** *host-name* [**a** | **mx**] **connect** *port-1* [**interval**] *connection-interval n* Router(config)# **ip director host** *host-name* [**a** | **mx**] **connect** *port-2* [**interval**] *connection-interval n* Router(config)# **ip director host** *host-name* [**a** | **mx**] **connect** *port-n* [**interval**] *connection-interval n*	Enables the DistributedDirector to verify that a server is available. When you configure multiple **ip director host connect** commands for the same host name but with different port numbers, the DistributedDirector verifies that all of the ports are accessible. If any of the ports is not accessible, the host is considered down.

Verifying Enhanced Fault Tolerance with Multiple Resource Records

To verify that the DistributedDirector is configured to return the best servers for RRs for each DNS, use the **show ip director hosts** command.

Verifying Event Recording with Syslog

To verify that the DistributedDirector is configured to send to syslog the DNS request and response information, use the **show ip director hosts** command.

Verifying Enhanced Server Verification with Multiple Port Connect Tests

To verify that the DistributedDirector is configured with a specific connection interval to specified distributed servers, use the **show ip director hosts** command.

Configuration Examples

This section provides the following configuration examples:

- Enhanced Fault Tolerance with Multiple Resource Records Example
- Event Recording with Syslog Example
- Enhanced Server Verification with Multiple Port Connect Tests Example

Enhanced Fault Tolerance with Multiple Resource Records Example

In the following examples, the DistributedDirector is configured to return the best three servers for A resource record on host name www.xyz.com, the best two servers for A resource record on host name alias.xyz.com, and the best two servers for MX resource mail.xyz.com, respectively:

```
ip director host www.xyz.com multiple 3
ip director host alias.xyz.com a multiple 2
ip director host mail.xyz.com mx multiple 2
```

Event Recording with Syslog Example

Before configuring the DistributedDirector to syslog events regarding DNS requests on a specific resource record, the following must be typed on the command line:

```
logging 172.21.34.2
logging trap informational
```

Note The IP address specified above is the IP address of the log server in which the syslog messages get recorded.

In the following examples, the DistributedDirector is configured to syslog events regarding DNS requests on A resource record for host name www.xyz.com, DNS requests on A resource record for host name alias.xyz.com, and DNS requests on MX host name mail.xyz.com, respectively:

```
ip director host www.xyz.com logging
ip director host alias.xyz.com a logging
ip director host mail.xyz.com mx logging
```

Enhanced Server Verification with Multiple Port Connect Tests Example

In the following example, the DistributedDirector is configured with a connection interval of 5 minutes to distributed servers on port 80 and port 90. The distributed servers will only be considered accessible if both port 80 and port 90 are accessible:

```
ip director host www.xyz.com connect 80 5
ip director host www.xyz.com connect 90 5
```

Command Reference

The following new and modified commands are pertinent to this feature. To see the command pages for these commands and other commands used with this feature, go to the *Cisco IOS Master Commands List*, Release 12.4, at http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124mindx/124index.htm.

New Commands

- **ip director access-group local**
- **ip director drp retries**
- **ip director drp timeout**
- **ip director drp timeout lookup**
- **ip director drp timeout measure**
- **ip director host active-close**
- **ip director host tolerance**
- **ip director host verify-url**
- **ip director server reinstatement**
- **ip director server route-map**
- **ip director server verify-url**

- **ip director server weights**
- **show ip director drp**

Modified Commands

- **ip director host connect**
- **ip director host logging**
- **ip director host multiple**

DNS Server Support for NS Records

This feature module describes the DNS Server Support for NS Records feature and includes the following sections:

Feature Overview

Domain Name System (DNS) is a client/server mechanism used to access a distributed database. The server portion of the DNS client/server mechanism is the name server (NS). An NS can be responsible for presenting information about a portion of the DNS distributed database or can be a forwarding/caching NS. In the latter case, the NS queries other NSs rather than maintaining a local portion of the DNS database.

DistributedDirector has improved server load-balancing capacity with the DNS Server Support for NS Records feature. This feature adds support for NS records to the Cisco IOS DNS server. With this feature, the DistributedDirector can distribute the server-selection process to multiple DistributedDirectors, improving overall server capacity.

Benefits

This feature allows an NS to delegate server responsibility for a domain by returning an NS record when queried. This function is useful to DistributedDirector because a computationally load can be distributed over a large number of DistributedDirectors, so each DistributedDirector can be free to perform computational expensive actions to select the best server.

Related Documents

For more information on the Cisco DistributedDirector, see the following documents, which are located on Cisco.com at http://www.cisco.com/univercd/cc/td/doc/product/iaabu/distrdir/index.htm:

- *Cisco DistributedDirector 4700-M Installation and Configuration Guide*
- *Release Notes for Cisco DistributedDirector System Software*
- *Cisco DistributedDirector Enhancements for Release 11.1(18)IA*
- *Cisco DistributedDirector Enhancements for Release 11.1(25)IA*
- *Cisco DistributedDirector Enhancements for Release 11.1(28)IA*
- *Cisco DistributedDirector Enhancements for Release 12.1(5)T*
- *Dynamic Feedback Protocol Support in DistributedDirector*

Supported Platforms

- Cisco DistributedDirector 4500

Supported Standards, MIBs, and RFCs

Standards

None

MIBs

None

To obtain lists of supported MIBs by platform and Cisco IOS release, and to download MIB modules, go to the Cisco MIB website on Cisco.com at the following URL:

http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml

RFCs

DNS is defined in RFC 1035.

Configuration Tasks

See the following sections for configuration tasks for this feature. Each task in the list is identified as either required or optional.

- Configuring DNS Server Support for NS Records (required)
- Verifying DNS Server Support for NS Records (optional)

Configuring DNS Server Support for NS Records

To configure the DistributedDirector to create an NS resource record to be returned when the DNS server is queried for the associated domain, use the following commands in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# ip host www.xyz.com ns ns.xyz.com`	Configures the DistributedDirector to create an NS resource record to be returned when the DNS server is queried for the associated domain.
Step 2	`Router(config)# ip host ns.xyz.com 10.0.0.1 10.0.0.2 10.0.0.3`	Defines a static host-name-to-address mapping in the host cache.
Step 3	`Router(config)# ip director host ns.xyz.com priority random 1`	Configures the order in which the DistributedDirector considers metrics when picking a server.
Step 4	`Router(config)# ip dns primary xyz.com soa ns.xyz.com`	Identifies the DistributedDirector as the primary DNS NS for a domain and as the SOA record source.

Verifying DNS Server Support for NS Records

To verify that the DistributedDirector is configured with NS record support, use the **show running-config** command or the **show host** command.

Configuration Examples

This section provides the following configuration example:

- DNS Server Support for NS Records Example

DNS Server Support for NS Records Example

The following example shows a top-level DistributedDirector using a low-cost metric, such as portion or random, to distribute load over second-level DistributedDirectors. Second-level DistributedDirectors then use more expensive metrics, such as drp-ext or drp-rtt, to perform more precise server selection. The relevant portions of this configuration are show below:

Top-Level DistributedDirector

```
ip host www.xyz.com ns ns.xyz.com
ip host ns2.xyz.com 10.0.0.1 10.0.0.2 10.0.0.3
ip director host ns.xyz.com priority random 1
ip dns primary www.xyz.com soa ns2.xyz.com
```

Second-Level DistributedDirector

```
ip host www.xyz.com 10.0.0.4 10.0.0.5 10.0.0.6
ip director host www.xyz.com priority drp-ext 1
ip director host www.xyz.com priority drp-rtt 2
ip director server 10.0.0.4 drp-association 10.0.0.7
ip director server 10.0.0.5 drp-association 10.0.0.8
ip director server 10.0.0.6 drp-association 10.0.0.9
```

Command Reference

The following new command is pertinent to this feature. To see the command pages for this command and other commands used with this feature, go to the *Cisco IOS Master Commands List*, Release 12.4, at http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124mindx/124index.htm.

- **ip host ns**

DistributedDirector Configurable Cache

Feature History

Release	Modification
12.2(8)T	This feature was introduced.

This document describes the DistributedDirector Configurable Cache feature in Cisco IOS Release 12.2(8)T. It includes the following sections:

Feature Overview

DistributedDirector maintains an internal cache of entries that is dynamically configurable. This internal configurable cache consists of sorting events that occur on a per-client basis. Users can configure both the size of this internal cache and the amount of time for which the DistributedDirector system will retain per-client sorting information.

The DistributedDirector Configurable Cache feature allows users to configure their systems in order to limit the amount of memory that DistributedDirector uses for Domain Name System (DNS) caching. When a query that is a duplicate of a previous query comes from the client within the cache timeout period, the same response can be produced without the use of any Director Response Protocol (DRP) queries or sorting.

The DistributedDirector Cache Auto Refresh feature works in the background to continuously update all entries in the DistributedDirector cache. Once this background refresh feature is initiated, DistributedDirector periodically updates all expired cache entries. The DistributedDirector cache saves the latest answers to all past DNS queries received since cache auto refresh was initiated, and any repeat request is served directly from the cache when caching is enabled.

Benefits

- Use of this feature limits the amount of memory that DistributedDirector uses for DNS caching.
- This feature allows the user to configure how long an entry remains in the cache.

Related Features and Technologies

DistributedDirector Cache Auto Refresh

Related Documents

DistributedDirector Cache Auto Refresh, Cisco IOS Release 12.2(8)T feature module

Supported Platforms

- Cisco 2600 series
- Cisco 3620 series
- Cisco 3640 series
- Cisco 3660 series
- Cisco 3725 series
- Cisco 3745 series
- Cisco 7200 series

Determining Platform Support Through Cisco Feature Navigator

Cisco IOS software is packaged in feature sets that support specific platforms. To get updated information regarding platform support for this feature, access Cisco Feature Navigator. Cisco Feature Navigator dynamically updates the list of supported platforms as new platform support is added for the feature.

Cisco Feature Navigator is a web-based tool that enables you to quickly determine which Cisco IOS software images support a specific set of features and which features are supported in a specific Cisco IOS image. You can search by feature or release. Under the release section, you can compare releases side by side to display both the features unique to each software release and the features in common.

To access Feature Navigator, you must have an account on Cisco.com. If you have forgotten or lost your account information, send a blank e-mail to cco-locksmith@cisco.com. An automatic check will verify that your e-mail address is registered with Cisco.com. If the check is successful, account details with a new random password will be e-mailed to you. Qualified users can establish an account on Cisco.com by following the directions at http://www.cisco.com/register.

Cisco Feature Navigator is updated regularly when major Cisco IOS software releases and technology releases occur. For the most current information, go to the Cisco Feature Navigator home page at the following URL: http://www.cisco.com/go/fn.

Supported Standards, MIBs, and RFCs

Standards

No new standards are supported by this feature.

MIBs

No new MIBs are supported by this feature.

To obtain lists of supported MIBs by platform and Cisco IOS release, and to download MIB modules, go to the Cisco MIB website on Cisco.com at the following URL:

http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml

RFCs

No new RFCs are supported by this feature.

Prerequisites

The sorting cache must be enabled on DistributedDirector. To enable the sorting cache, use the **ip director cache** command.

Configuration Tasks

See the following sections for configuration tasks for this feature. Each task in the list is identified as either required or optional.

- Configuring the Size of the Cache (optional)
- Configuring How Long the System Retains Sorting Information (optional)

Configuring the Size of the Cache

To configure the variable size of the DistributedDirector cache, use the following commands in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# ip director cache`	Enables the sorting cache on DistributedDirector.
Step 2	`Router(config)# ip director cache size 1500`	Configures the maximum number of cache entries, where *entries* equals 1500.

Configuring How Long the System Retains Sorting Information

To configure how long the DistributedDirector system will retain per-client sorting information, use the following command in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# ip director cache`	Enables the sorting cache on DistributedDirector.
Step 2	`Router(config)# ip director cache time 100`	Configures how long the DistributedDirector system will retain per-client sorting information, where *seconds* equals 100.

Verifying DistributedDirector Cache Information

To show DistributedDirector cache information, use the **show ip director cache** command.

```
Router# show ip director cache

Director cache is on
Cache current size = 2 maximum size = 2000
Cache time for sort cache entries:60 secs
Director sort cache hits = 8
Entries:
www.myserver.org:for client 172.17.2.78, used 3 times, valid for:
00:00:42
server 172.21.34.10, rank 0, priority 0
              random incomplete:0
              DRP route lookup external to AS incomplete:0
              administrative preference incomplete:0
              DRP route lookup internal to AS complete:40
              DRP distance to associated server incomplete:0
              portion incomplete:0
              Round-trip time from DRP to client incomplete:0
              DFP originated weight incomplete:0
              Route-map evaluation incomplete:0
              Boomerang evaluation incomplete:0
server 172.21.34.10, rank 0, priority 0, best
              random incomplete:0
              DRP route lookup external to AS incomplete:0
              administrative preference incomplete:0
              DRP route lookup internal to AS complete:30
              DRP distance to associated server incomplete:0
              portion incomplete:0
              Round-trip time from DRP to client incomplete:0
              DFP originated weight incomplete:0
              Route-map evaluation incomplete:0
              Boomerang evaluation incomplete:0
www.boom1.com:for client 172.17.2.78, used 5 times, valid for:00:00:13
server 172.21.34.10, rank 0, priority 0
              random incomplete:0
              DRP route lookup external to AS incomplete:0
              administrative preference incomplete:0
              DRP route lookup internal to AS complete:40
              DRP distance to associated server incomplete:0
              portion incomplete:0
              Round-trip time from DRP to client incomplete:0
              DFP originated weight incomplete:0
              Route-map evaluation incomplete:0
              Boomerang evaluation incomplete:0
server 172.21.34.10, rank 0, priority 0, best
```

```
random incomplete:0
DRP route lookup external to AS incomplete:0
administrative preference incomplete:0
DRP route lookup internal to AS complete:30
DRP distance to associated server incomplete:0
portion incomplete:0
Round-trip time from DRP to client incomplete:0
DFP originated weight incomplete:0
Route-map evaluation incomplete:0
Boomerang evaluation incomplete:0
```

Configuration Examples

This section provides the following configuration examples:

- Configuring the Size of the Cache Example
- Configuring How Long the System Retains Sorting Information Example

Configuring the Size of the Cache Example

The following example configures the maximum number of cache entries:

```
Router(config)# ip director cache size 1500

Cache size shrinked to 1500

Router# show running-config

ip host myhost 172.18.18.10 172.18.18.20 172.18.18.30
.
.
.
ip director host myhost
ip dns primary myhost soa myhost myhost@com
no ip director drp synchronized
ip director cache size 1500
```

Configuring How Long the System Retains Sorting Information Example

The following example configures how long the DistributedDirector system will retain per-client sorting information:

```
Router(config)# ip director cache time 100

Router# show running-config

ip host myhost 172.18.18.10 172.18.18.20 172.18.18.30
.
.
.
ip director host myhost
ip dns primary myhost soa myhost myhost@com
no ip director drp synchronized
ip director cache time 100
```

Command Reference

The following new commands are pertinent to this feature. To see the command pages for these commands and other commands used with this feature, go to the *Cisco IOS Master Commands List*, Release 12.4, at http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124mindx/124index.htm.

- **ip director cache size**
- **ip director cache time**

DistributedDirector Cache Auto Refresh

Feature History

Release	Modification
12.2(8)T	This feature was introduced.

This document describes the DistributedDirector Cache Auto Refresh feature in Cisco IOS Release 12.2(8)T. It includes the following sections:

Feature Overview

The DistributedDirector Cache Auto Refresh feature works in the background to continuously update all entries in the DistributedDirector cache. Once this background refresh feature is initiated, DistributedDirector periodically updates all expired cache entries. The DistributedDirector cache saves the latest answers to all past Domain Name System (DNS) queries received since cache auto refresh was initiated, and any repeat request is served directly from the cache when caching is enabled.

The new **ip director cache refresh** command enables the automatic background refresh feature for the DistributedDirector cache.

Benefits

Once the cache auto refresh feature is enabled, the cache will actively and continuously update every expired entry. This feature allows DistributedDirector to return answers to queries according to the latest and most accurate network information.

Related Technologies

DistributedDirector Configurable Cache

Related Documents

DistributedDirector Configurable Cache, Cisco IOS Release 12.2(8)T feature module

Supported Platforms

- Cisco 2600 series
- Cisco 3620 series
- Cisco 3640 series
- Cisco 3660 series
- Cisco 3725 series
- Cisco 3745 series
- Cisco 7200 series

Determining Platform Support Through Feature Navigator

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Feature Navigator is updated regularly when major Cisco IOS software releases and technology releases occur. For the most current information, go to the Feature Navigator home page at the following URL:

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

Supported Standards, MIBs, and RFCs

Standards

No new standards are supported by this feature.

MIBs

No new MIBs are supported by this feature.

To obtain lists of supported MIBs by platform and Cisco IOS release, and to download MIB modules, go to the Cisco MIB website on Cisco.com at the following URL:

http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml

RFCs

No new RFCs are supported by this feature.

Prerequisites

The sorting cache must be enabled on DistributedDirector. To enable the sorting cache, use the **ip director cache** command.

Configuration Tasks

See the following section for configuration tasks for cache auto refresh. Each task in the list is identified as either required or optional.

- Enabling Cache Auto Refresh (required)

Enabling Cache Auto Refresh

To enable cache auto refresh for DistributedDirector, use the **ip director cache refresh** command.

	Command	Purpose
Step 1	`Router(config)#` **`ip director cache`**	Enables the sorting cache on DistributedDirector.
Step 2	`Router(config)#` **`ip director cache refresh`**	Enables the DistributedDirector Cache Auto Refresh feature.

To turn off cache auto refresh, use the **no ip director cache refresh** command.

	Command	Purpose
Step 1	`Router(config)#` **`no ip director cache refresh`**	Disables the DistributedDirector Cache Auto Refresh feature.

Verifying the Cache Auto Refresh Feature

To verify that the DistributedDirector Cache Auto Refresh feature is configured, enter the **show running-config** command.

```
Router(config)# ip director cache

Router(config)# ip director cache refresh

Router# show running-config

ip host myhost 172.22.2.10 172.22.2.20 172.22.2.30
.
.
.
ip director cache refresh
```

Configuration Examples

This section provides the following configuration example:

- Enabling the Cache Auto Refresh Feature Example

Enabling the Cache Auto Refresh Feature Example

In the following example, the cache auto refresh background feature for DistributedDirector is enabled:

```
Router(config)# ip director cache

Router(config)# ip director cache refresh

Router# show running-config

ip host myhost 172.22.2.10 172.22.2.20 172.22.2.30
.
.
.
ip director cache refresh
```

Command Reference

The following new commands are pertinent to this feature. To see the command pages for these commands and other commands used with this feature, go to the *Cisco IOS Master Commands List*, Release 12.4, at http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124mindx/124index.htm.

- **ip director cache refresh**

DistributedDirector Boomerang Support

Feature History

Release	Modification
12.2(8)T	Boomerang support was introduced.

This document describes boomerang support for DistributedDirector in Cisco IOS Release 12.2(8)T. It includes the following sections:

Feature Overview

Boomerang is a Director Response Protocol (DRP) metric for DistributedDirector. The boomerang server provides a way to select a content server with the fastest response time from a group of redundant content servers. Instead of relying on static maps, boomerang dynamically recognizes problems such as congestion and link failures and avoids them. The content server with the fastest response time, as determined by the priority of the configured metrics, is determined to be the best site.

When the boomerang metric is active, DistributedDirector instructs the DRP to send Domain Name System (DNS) responses directly back to the querying client. The DNS response contains the addresses of the sites associated with the particular DRP agent. All involved DRPs send back their DNS responses at the same time. The packet of the DRP that is closest to the client will arrive first. The client may take the first answer and ignore subsequent ones, a standard behavior of all local DNS server implementations. The DRP agent allows configuration for full boomerang support.

The boomerang metric may or may not be used by DistributedDirector. Whether the boomerang metric is used depends on whether other metrics are specified at higher priority (and therefore have a lower priority number) than the boomerang metric. If a metric at higher priority successfully determines the best site, then that is what DistributedDirector uses. DistributedDirector reaches the boomerang metric only if all other metrics of higher priority than boomerang are unable to determine the best site.

If and when the boomerang metric is reached, all other metrics after it (that is, metrics that have a lower priority and a higher priority number) are effectively ignored. They are ignored because the actual resolution of the best site is determined not by DistributedDirector but by which boomerang reply reaches the DNS client first. DistributedDirector is not made aware of the best site as determined by the boomerang metric.

The boomerang metric can be used alone or along with other metrics at the same or different priority levels. If boomerang is specified at the same priority as other metrics, then boomerang decides the best site. If boomerang is specified with other metrics at different priorities, then the higher-priority metrics are examined in turn until there is no tie among sites, with the result that the best site can be determined. If the consideration extends to the boomerang metric, then boomerang is the deciding metric. All other metrics of a higher priority number (lower priority) than boomerang are ignored. The concept of weight does not apply to the boomerang metric.

The DRP is a simple User Datagram Protocol (UDP)-based application developed by Cisco Systems. It enables the Cisco DistributedDirector product to query routers (DRP Server Agents) in the field for Border Gateway Protocol (BGP) and Interior Gateway Protocol (IGP) routing table metrics between distributed servers and clients. DistributedDirector, a separate standalone product, uses DRP to transparently redirect end-user service requests to the topologically closest responsive server. DRP enables DistributedDirector to provide dynamic, scalable, and “network intelligent” Internet traffic load distribution among multiple geographically dispersed servers.

DRP Server Agents are border routers (or peers to border routers) that support the geographically distributed servers for which DistributedDirector service distribution is desired. Note that, because DistributedDirector makes decisions based on BGP and IGP information, all DRP Server Agents must have access to full BGP and IGP routing tables.

Benefits

The boomerang metric provides a way to select a site with the fastest response time. Instead of relying on static maps, it dynamically recognizes congestion and link failures and avoids them.

Restrictions

Both DistributedDirector and the DRP agents should be able to communicate with each other using the boomerang protocol. Therefore, when DistributedDirector is upgraded to include the boomerang functionality, the DRP agents must be made aware of the presence of the boomerang protocol.

Related Features and Technologies

- Director Response Protocol
- User Datagram Protocol
- Border Gateway Protocol
- Interior Gateway Protocol

Related Documents

- *Boomerang Support in the DRP Agent*, Cisco IOS Release 12.2(8)T feature module
- "Configuring IP Services" chapter of *Cisco IOS Configuration Fundamentals Configuration Guide,* Release 12.2

Supported Platforms

- Cisco 2600 series
- Cisco 3620 series
- Cisco 3640 series
- Cisco 3660 series
- Cisco 3725 series
- Cisco 3745 series
- Cisco 7200 series

Determining Platform Support Through Feature Navigator

Cisco IOS software is packaged in feature sets that support specific platforms. To get updated information regarding platform support for this feature, access Feature Navigator. Feature Navigator dynamically updates the list of supported platforms as new platform support is added for the feature.

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Feature Navigator is updated regularly when major Cisco IOS software releases and technology releases occur. For the most current information, go to the Feature Navigator home page at the following URL:

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

Supported Standards, MIBs, and RFCs

Standards

No new or modified standards are supported by this feature.

MIBs

No new MIBs are supported by this feature.

To obtain lists of supported MIBs by platform and Cisco IOS release, and to download MIB modules, go to the Cisco MIB website on Cisco.com at the following URL:

http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml

RFCs

No new RFCs are supported by this feature.

Prerequisites

You must be using DistributedDirector with DRP metrics, including boomerang.

Configuration Tasks

See the following sections for configuration tasks for the boomerang metric feature. Each task in the list is identified as either required or optional.

- Setting DistributedDirector and DRP Clock Synchronization (optional)
- Configuring the Default Metric (optional)
- Specifying the Host Priority of the Boomerang Metric (required)

Setting DistributedDirector and DRP Clock Synchronization

To activate clock synchronization between of the DistributedDirector and the DRP clocks, use the **ip director drp synchronized** command.

Command	Purpose
`Router(config)# ip director drp synchronized`	Activates or deactivates clock synchronization between DistributedDirector and the DRP.

To deactivate clock synchronization between DistributedDirector and DRPs, use the **no ip director drp synchronized** command.

Command	Purpose
`Router(config)# no ip director drp synchronized`	Deactivates clock synchronization between DistributedDirector and the DRP.

Configuring the Default Metric

To set the boomerang metric as the default metric, use the **ip director default priorities boomerang** command.

Command	Purpose
`Router(config)# ip director default priorities boomerang 1`	Configures DistributedDirector to select a server using the boomerang metric at priority level *num*, where *num* is 1.

To remove boomerang as the default metric, use the **no ip director default priorities boomerang** command.

Command	Purpose
`Router(config)# **no ip director default priorities**`	Removes boomerang as the default metric.

Specifying the Host Priority of the Boomerang Metric

To configure the order in which DistributedDirector considers metrics when selecting a server, use the **ip director host priority** command.

Command	Purpose
`Router(config)# **ip director host boom1 priority boomerang**`	Configures DistributedDirector to select a server using the boomerang metric, where *hostname* is boom1.

To deactivate all priorities on all metrics associated with the defined hostname, use the **no** form of this command.

Command	Purpose
`Router(config)# **no ip director host boom1 priority**`	Deactivates all priorities on all metrics associated with the defined hostname, where *hostname* is boom1.

Verifying Boomerang Information

Step 1 To verify that the boomerang metric is configured, enter the **show running-config** command.

```
Router# show running-config

ip host boom1 172.22.2.10 172.22.2.20 172.22.2.30
ip director server 172.22.2.20 drp-association 172.24.4.2
ip director server 172.22.2.30 drp-association 172.24.4.3
ip director server 172.22.2.10 drp-association 172.24.4.1
ip director host boom1
no ip director cache
ip dns primary boom1 soa boom1 boom1@com
ip director host boom1 priority boomerang 1
no ip director drp synchronized
```

Step 2 To view information about all hosts, enter the **show ip director** command.

```
Router# show ip director

Distributed Director status:
Queries received: 0
Queries replied: 0
Queries received in the last second: 0
Queries received in the last minute: 0
Incomplete information selections: 0
TTL for reply RRs when sorted by DD: 0 secs
Queries awaiting processing by DD: 0
Queries awaiting metric info = 0
Director cache is on
Cache time for sort cache entries: 60 secs
Director sort cache hits = 0
Director Response Protocol:
  0 requests, 0 replies, 0 requeries, 0 bad replies
  Authentication key-chain "not defined"
  Output queue length = 0
  Maximum DRP query retry number = 2
  Timeout for each DRP lookup query = 1 secs
  Timeout for each DRP measurement query = 4 secs
```

Step 3 To view information about a specified host, enter the **show ip director host** command. The following command provides information about a host named boom1.

```
Router# show ip director host boom1

Host boom1 (A queries):
  Queries received: 0, queries replied: 0
  Servers:
    Server 172.22.2.10:
      Advertised 0 times as best server, last at never
      Server status: Untested, updated never
  Host specific priorities:
    Boomerang evaluation = 1
```

Configuration Examples

This section provides the following configuration examples:

- Setting DistributedDirector and DRP Clock Synchronization Example
- Configuring the Default Metric Example
- Specifying the Host Priority of the Boomerang Metric Example

Setting DistributedDirector and DRP Clock Synchronization Example

In the following example, DistributedDirector and DRP clock synchronization is activated:

```
Router(config)# ip director drp synchronized

Router# show running-config

ip host boom1 172.22.2.10 172.22.2.20 172.22.2.30
ip director server 172.22.2.20 drp-association 172.24.4.2
ip director server 172.22.2.30 drp-association 172.24.4.3
ip director server 172.22.2.10 drp-association 172.24.4.1
ip director host boom1
.
.
.
ip director drp synchronized
```

Configuring the Default Metric Example

In the following example, the boomerang metric is specified with a priority of 1:

```
Router(config)# ip director default priorities boomerang 1

Router# show running-config

ip host boom1 172.22.2.10 172.22.2.20 172.22.2.30
.
.
.
ip director host boom1
no ip director cache
ip dns primary boom1 soa boom1 boom1@com
ip director host boom1 priority boomerang 1
```

Specifying the Host Priority of the Boomerang Metric Example

The following example specifies the per-host priority of the metric, with a host named boom1, where the DRP internal metric is specified with a priority number of 1 and boomerang is specified with a priority number of 2:

```
Router(config)# ip director host boom1 priority drp-int 1 boomerang 2

Router# show running-config

ip host boom1 172.22.2.10 172.22.2.20 172.22.2.30
.
.
.
ip director host boom1
no ip director cache
ip dns primary boom1 soa boom1 boom1@com
ip director host boom1 priority drp-int 1 boomerang 2
```

Command Reference

The following new and modified commands are pertinent to this feature. To see the command pages for these commands and other commands used with this feature, go to the *Cisco IOS Master Commands List*, Release 12.4, at http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124mindx/124index.htm.

New Commands

- **ip director drp synchronized**

Modified Commands

- **ip director default priorities**
- **ip director host priority**

DRP Agent—Boomerang Support

Feature History

Release	Modification
12.2(8)T	This feature was introduced.

This document describes Boomerang Support in theDRP Agent in Cisco IOS Release 12.2(8)T. It includes the following sections:

Feature Overview

When a boomerang Director Response Protocol (DRP) agent receives a Domain Name System (DNS) racing message from boomerang servers, the DRP extracts the domain name specified in the DNS message. The boomerang DRP agent can be configured on this specified domain using the new **ip drp domain** command.

A racing message occurs when DistributedDirector receives a DNS query from a DNS client for a host name that has the boomerang metric configured. DistributedDirector issues a DNS racing message to the different DRP agents. In the message, it instructs each DRP agent to respond directly to the client with the answer. The instruction also specifies whether the response should be sent at an absolute time or after a certain delay, which is determined by the configuration on DistributedDirector.

Boomerang is a DRP metric for DistributedDirector. When the boomerang metric is active, DistributedDirector instructs the DRP to send DNS responses directly back to the querying client. The DNS response contains the addresses of the sites associated with the specific DRP agent. All involved DRPs send back their DNS responses at the same time. The packet of the DRP that is nearest to the client in terms of delay will arrive first. The client may take the first answer and ignore subsequent ones, a standard behavior of all local DNS server implementations. The DRP agent allows configuration for full boomerang support. The commands described in this document can be used only on a DRP agent. The boomerang client is the DRP agent.

The boomerang metric enables the boomerang agent on the DRP to talk to other boomerang servers, such as the CR-4400 content router switch. The metric promotes interoperability among the different content routers within Cisco. The boomerang agent on the DRP agent is also able to communicate with any boomerang server, not just servers implemented on DistributedDirector.

The DRP is a simple User Datagram Protocol (UDP)-based application developed by Cisco Systems. It enables the Cisco DistributedDirector product to query routers (DRP server agents) in the field for Border Gateway Protocol (BGP) and Interior Gateway Protocol (IGP) routing table metrics between distributed servers and clients. DistributedDirector, a separate standalone product, uses DRP to transparently redirect end-user service requests to the topologically closest responsive server. DRP enables DistributedDirector to provide dynamic, scalable, and “network intelligent” Internet traffic load distribution among multiple geographically dispersed servers.

Benefits

The boomerang metric provides a way to select a site with the fastest response time. Instead of relying on static maps, it dynamically recognizes congestion and link failures and avoids them.

Restrictions

Both DistributedDirector and the DRP agents should be able to communicate with each other using the boomerang protocol. Therefore, when DistributedDirector is upgraded to include the boomerang functionality, the DRP agents must be made aware of the presence of the boomerang protocol.

Related Features and Technologies

- Director Response Protocol
- User Datagram Protocol
- Border Gateway Protocol
- Interior Gateway Protocol

Related Documents

- *DistributedDirector Boomerang Support*, Cisco IOS Release 12.2(8)T feature module
- “Configuring IP Services” chapter of *Cisco IOS Configuration Fundamentals Configuration Guide,* Release 12.2

Supported Platforms

Boomerang support in the DRP Agent is supported on the following platforms:

- Cisco 2600 series
- Cisco 7200 series
- Cisco 7500 series

Determining Platform Support Through Cisco Feature Navigator

Cisco IOS software is packaged in feature sets that support specific platforms. To get updated information regarding platform support for this feature, access Cisco Feature Navigator. Cisco Feature Navigator dynamically updates the list of supported platforms as new platform support is added for the feature.

Cisco Feature Navigator is a web-based tool that enables you to quickly determine which Cisco IOS software images support a specific set of features and which features are supported in a specific Cisco IOS image. You can search by feature or release. Under the release section, you can compare releases side by side to display both the features unique to each software release and the features in common.

To access Feature Navigator, you must have an account on Cisco.com. If you have forgotten or lost your account information, send a blank e-mail to cco-locksmith@cisco.com. An automatic check will verify that your e-mail address is registered with Cisco.com. If the check is successful, account details with a new random password will be e-mailed to you. Qualified users can establish an account on Cisco.com by following the directions at http://www.cisco.com/register.

Cisco Feature Navigator is updated regularly when major Cisco IOS software releases and technology releases occur. For the most current information, go to the Cisco Feature Navigator home page at the following URL: http://www.cisco.com/go/fn.

Supported Standards, MIBs, and RFCs

Standards

No new or modified standards are supported by this feature.

MIBs

No new MIBs are supported by this feature.

To obtain lists of supported MIBs by platform and Cisco IOS release, and to download MIB modules, go to the Cisco MIB website on Cisco.com at the following URL:

http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml

RFCs

No new RFCs are supported by this feature.

Configuration Tasks

See the following sections for configuration tasks for boomerang support in the DRP agent. Each task in the list is identified as either required or optional.

- Adding a New Domain or Configuring an Existing Domain (required)
- Configuring the Domain Name Alias (optional)
- Configuring the Server Address of a Domain (optional)
- Configuring the IP TTL (optional)
- Configuring the DNS TTL (optional)

Adding a New Domain or Configuring an Existing Domain

To add a new domain to the DistributedDirector client or to configure an existing domain, use the following command in global configuration mode. The boomerang client is the DRP agent, and this command is configured on the DRP agent. This command puts the client in boomerang configuration mode.

Command	Purpose
`Router(config)# ip drp domain www.boom1.com`	Specifies a domain to be added or configured and enters boomerang configuration mode. The domain in this example is named www.boom1.com.

Configuring the Domain Name Alias

To configure an alias name for a specified domain, use the following commands.

	Command	Purpose
Step 1	`Router(config)# ip drp domain www.boom1.com`	Specifies a domain to be added or configured and enters boomerang configuration mode.
Step 2	`Router(config-boomerang)# alias www.boom2.com`	Configures an alias name for a specified domain. The alias name in this example is www.boom2.com

Configuring the Server Address of a Domain

To configure the server address for a specified boomerang domain, use the following commands.

	Command	Purpose
Step 1	`Router(config)# ip drp domain www.boom1.com`	Specifies a domain to be added or configured and enters boomerang configuration mode.
Step 2	`Router(config-boomerang)# server 172.16.101.101`	Configures an IP address for a specified domain.

Configuring the IP TTL

To configure the IP time to live (TTL) value for packets sent from the boomerang client to the DNS client in number of hops, use the following commands.

	Command	Purpose
Step 1	`Router(config)# ip drp domain www.boom1.com`	Specifies a domain to be added or configured and enters boomerang configuration mode.
Step 2	`Router(config-boomerang)# ttl ip 2`	Configures the maximum number of hops between the boomerang client and the DNS client, after which the boomerang response packet fails. The number of hops in this example is 2.

Configuring the DNS TTL

To configure the number of seconds for which an answer received from the boomerang client will be cached by the DNS client, use the **ttl dns** command in boomerang configuration mode.

	Command	Purpose
Step 1	Router(config)# **ip drp domain www.boom1.com**	Specifies a domain to be added or configured and enters boomerang configuration mode.
Step 2	Router(config-boomerang)# **ttl dns 10**	Configures the number of seconds for which the DNS client can cache a boomerang reply from a boomerang client. The number of seconds in this example is 10.

Verifying Boomerang Information on the DRP Agent

Step 1 Enter the **show ip drp boomerang** command to display boomerang information on the DRP agent. The output of this command verifies information such as the status of the content server (whether it is up or down), the number of DNS requests received, and the number of requests dropped because the server is down.

```
Router# show ip drp boomerang

DNS packets with unknown domain 0

Domain www.boom1.com
Content server            172.16.101.101 up
Origin server                    0.0.0.0
DNS A record requests                  0
Dropped (server down)                  0
Dropped (no origen server)             0
Security failures                      0

Alias www.boom2.com
DNS A record requests                  0
```

Step 2 Enter the **show ip drp** command to display additional information such as the number of requests received from DistributedDirector, the total number of boomerang requests, and the number of boomerang responses made by this DRP agent.

```
Router# show ip drp

Director Responder Protocol Agent is enabled
3 director requests:
0 successful route table lookups
0 successful measured lookups
0 no route in table
0 nortt
0 DRP packet failures returned
3 successful echos
6 Boomerang requests
0 Boomerang-raced DNS responses
Authentication is enabled, using "DD" key-chain
rttprobe source port is     :53
rttprobe destination port is:53
```

Troubleshooting Tips

If the **ip drp domain** *domain-name* command is configured on the DRP agent, but a corresponding server address is not specified for this domain name, then the content-server field defaults to 0.0.0.0. The **show ip drp boomerang** displays this information.

This configuration would effectively remove the DRP agent from the boomerang race. To include it again, enter boomerang configuration mode and specify a server address:

```
Router(config)# ip drp domain www.boom1.com
Router(config-boomerang)# server 172.16.101.101
```

Configuration Examples

This section provides the following configuration examples:

- Adding a New Domain or Configuring an Existing Domain Example
- Configuring the Domain Name Alias Example
- Configuring the Server Address of a Domain Example
- Configuring the IP TTL Example
- Configuring the DNS TTL Example

Adding a New Domain or Configuring an Existing Domain Example

In the following example, a domain named www.boom1.com is added on the boomerang client:

```
Router(config)# ip drp domain www.boom1.com

Router# show running-config
.
.
ip drp domain www.boom1.com
```

Configuring the Domain Name Alias Example

In the following example, the domain name alias is configured for www.boom1.com. The new alias for www.boom1.com is www.boom2.com:

```
Router(config)# ip drp domain www.boom1.com
Router(config-boomerang)# alias www.boom2.com

Router# show running-config
.
.
ip drp domain www.boom1.com
alias www.boom2.com
```

Configuring the Server Address of a Domain Example

In the following example, the server address is configured for www.boom1.com. The server address for www.boom1.com is 172.16.101.101:

```
Router(config)# ip drp domain www.boom1.com
Router(config-boomerang)# server 172.16.101.101

Router# show running-config
.
.
ip drp domain www.boom1.com
content-server 172.16.101.101
```

Configuring the IP TTL Example

In the following example, the number of hops that occur between the boomerang client and the DNS client before the boomerang response packet fails is 2:

```
Router(config)# ip drp domain www.boom1.com
Router(config-boomerang)# ttl ip 2

Router# show running-config
.
.
ip drp domain www.boom1.com
ip-ttl 2
```

Configuring the DNS TTL Example

In the following example, the number of seconds for which the DNS client can cache a boomerang reply from a boomerang client is configured to be 10:

```
Router(config)# ip drp domain www.boom1.com
Router(config-boomerang)# ttl dns 10

Router# show running-config
.
.
ip drp domain www.boom1.com
dns-ttl 10
```

Command Reference

The following new commands are pertinent to this feature. To see the command pages for these commands and other commands used with this feature, go to the *Cisco IOS Master Commands List*, Release 12.4, at http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124mindx/124index.htm.

- **alias (boomerang configuration)**
- **ip drp domain**
- **server (boomerang configuration)**
- **show ip drp boomerang**
- **ttl dns**
- **ttl ip**

DistributedDirector MIB Support

Feature History

Release	Modification
12.2(8)T	This feature was introduced.

This document describes DistributedDirector MIB support and the enhancements and modifications made to the Cisco IOS Simple Network Management Protocol (SNMP) infrastructure in order to support DistributedDirector in Cisco IOS Release 12.2(8)T. It includes the following sections:

- Feature Overview, page 495
- Supported Platforms, page 497
- Supported Standards, MIBs, and RFCs, page 498
- Prerequisites, page 498
- Configuration Tasks, page 498
- Configuration Examples, page 500
- Command Reference, page 501

Feature Overview

Network management takes place between two major types of systems: those in control, called managing systems, and those observed and controlled, called managed systems. The most common type of managing system is called a *network management system* (NMS). Managed systems can include hosts, servers, or network components such as routers or intelligent repeaters.

To promote interoperability, cooperating systems must adhere to a common framework and a common language, called a *protocol*. In the Internet network management framework, that protocol is the SNMP.

In a managed device, specialized low-impact software modules, called *agents*, access information about the device and make it available to the NMS. Managed devices maintain values for a number of variables and report those, as required, to the NMS. For example, an agent might report such data as the number of bytes and packets passing in and out of the device, or the number of broadcast messages sent and received. In the Internet network management framework, each variable is referred to as a *managed object*, which is anything that an agent can access and report back to the NMS.

All managed objects are contained in the Management Information Base (MIB), which is a database of the managed objects. The managed objects, or variables, can be set or read to provide information on network devices and interfaces. An NMS can control a managed device by sending a message to an agent of that managed device requiring the device to change the value of one or more of its variables.

The Cisco DistributedDirector MIB provides MIB support for DistributedDirector. This MIB contains DistributedDirector statistics, configurations, and status.

The DistributedDirector MIB contains five groups of object type definitions:

- ciscoDistDirGeneralGroup—A group of objects related to DistributedDirector general configurations, statistics, and status.
- ciscoDistDirHostGroup—A group of objects related to DistributedDirector host-specific configurations, statistics, and status.
- ciscoDistDirServerGroup—A group of objects related to DistributedDirector server-specific configurations, statistics, and status.
- ciscoDistDirMappingGroup—A group of objects related to associations between DistributedDirector host names and real servers.
- ciscoDistDirNotificatonGroup—A group of objects related to DistributedDirector significant events.

The DistributedDirector MIB defines the following tables:

- cddGeneralMetricProfTable—DistributedDirector metric profiles. A profile contains priority and weight values of DistributedDirector metrics, which can be applied to specific hosts or to the DistributedDirector default configuration.
- cddHostTable—DistributedDirector virtual host name or subdomain-specific configurations, statistics, and status entries.
- cddHostConnectCfgTable—DistributedDirector per-host server connect test configuration information entries.
- cddHostTolCfgTable—DistributedDirector per-host priority-level metric tolerance configuration information entries.
- cddServerTable—DistributedDirector server-specific information entries. This information includes the configuration parameters and statistics for each server.
- cddServerPortTable—DistributedDirector server port-specific information entries. This information includes the configuration parameters, statistics, and availability status for each service port on servers.
- cddServerPortMetricTable—DistributedDirector per-service per-metric weight entries.
- cddHostServerMappingTable—DistributedDirector associations of virtual host name to real server.

The DistributedDirector MIB defines the following notifications:

- ciscoDistDirEventServerUp—This trap is generated whenever a distributed server changes to the “up” state.
- ciscoDistDirEventServerDown—This trap is generated whenever a distributed server changes to the “down” state.
- ciscoDistDirEventHitRateHigh—This trap is generated whenever the incoming Domain Name system (DNS) HTTP query rate reaches a certain threshold. Use the Event MIB described in RFC 2981 to control the trigger of this notification.

The ciscoDistDirEventServerUp and ciscoDistDirEventServerDown notifications can be enabled or disabled using the Cisco IOS **snmp-server enable traps director** and **snmp-server host** commands.

The **snmp-server host** command is used in conjunction with the **snmp-server enable traps director** command. Use the **snmp-server enable traps director** command to specify which DistributedDirector SNMP notifications are sent globally. For a host to receive most notifications, at least one **snmp-server enable traps director** command and the **snmp-server host** command for that host must be enabled.

Benefits

The DistributedDirector MIB provides network management functionality to DistributedDirector.

Restrictions

The DistributedDirector MIB implementation for Cisco IOS Release 12.2(8)T supports read-only capability to the objects defined in the MIB.

Related Features and Technologies

- Event MIB
- SNMP
- Network management

Related Documents

- The "Configuring SNMP Support" chapter of *Cisco IOS Configuration Fundamentals Configuration Guide,* Release 12.2
- The "SNMP Commands" chapter of *Cisco IOS Configuration Fundamentals Command Reference,* Release 12.2
- RFC 1157, "Simple Network Management Protocol"
- Event MIB: RFC 2981, *Event MIB*

Supported Platforms

- Cisco 2600 series
- Cisco 3620 series
- Cisco 3640 series
- Cisco 3660 series
- Cisco 7200 series

Determining Platform Support Through Cisco Feature Navigator

Cisco IOS software is packaged in feature sets that support specific platforms. To get updated information regarding platform support for this feature, access Cisco Feature Navigator. Cisco Feature Navigator dynamically updates the list of supported platforms as new platform support is added for the feature.

Cisco Feature Navigator is a web-based tool that enables you to quickly determine which Cisco IOS software images support a specific set of features and which features are supported in a specific Cisco IOS image. You can search by feature or release. Under the release section, you can compare releases side by side to display both the features unique to each software release and the features in common.

To access Cisco Feature Navigator, you must have an account on Cisco.com. If you have forgotten or lost your account information, send a blank e-mail to cco-locksmith@cisco.com. An automatic check will verify that your e-mail address is registered with Cisco.com. If the check is successful, account details with a new random password will be e-mailed to you. Qualified users can establish an account on Cisco.com by following the directions at http://www.cisco.com/register.

Cisco Feature Navigator is updated regularly when major Cisco IOS software releases and technology releases occur. For the most current information, go to the Cisco Feature Navigator home page at the following URL:

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

Supported Standards, MIBs, and RFCs

Standards

No new or modified standards are supported by this feature.

MIBs

- Cisco DistributedDirector MIB (CISCO-DIST-DIRECTOR-MIB.my)
- Event MIB (EVENT-MIB.my)

To obtain lists of supported MIBs by platform and Cisco IOS release, and to download MIB modules, go to the Cisco MIB website on Cisco.com at the following URL:

http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml

RFCs

- Event MIB: RFC 2981, *Event MIB*

Prerequisites

DistributedDirector must be running on the router.

Configuration Tasks

See the following sections for configuration tasks for the DistributedDirector MIB support feature. Each task in the list is identified as either required or optional.

- Enabling DistributedDirector SNMP Notifications (required)
- Specifying the Recipient of an SNMP Notification (required)

Enabling DistributedDirector SNMP Notifications

To enable DistributedDirector SNMP notifications, use the following command in global configuration mode:

Command	Purpose
`Router(config)# snmp-server enable traps director`	Enables DistributedDirector SNMP notifications.

To disable DistributedDirector SNMP notifications, use the following command in global configuration mode:

Command	Purpose
`Router(config)# no snmp-server enable traps director`	Disables DistributedDirector SNMP notifications.

Specifying the Recipient of an SNMP Notification

To specify the recipient of a DistributedDirector SNMP notification, use the following command in global configuration mode:

Command	Purpose
`Router(config)# snmp-server host 10.0.0.1 public director`	Specifies the recipient of a DistributedDirector SNMP notification, where the host 10.0.0.1 is using the community string defined as “public.”

To remove the specified recipient, use the following command in global configuration mode:

Command	Purpose
`Router(config)# no snmp-server host` *`host-address`* `director`	Removes the recipient of a DistributedDirector SNMP notification.

Verifying DistributedDirector Notification Information

Enter the **show running-config** command to verify that DistributedDirector SNMP notification information is configured. Both server up and server down information is included, unless you specify one or the other.

```
Router# show running-config

ip host myhost 172.22.2.10 172.22.2.20 172.22.2.30
.
.
.
snmp-server enable traps director server-up server-down
```

Configuration Examples

This section provides the following configuration examples:

- Enabling DistributedDirector SNMP Notifications Example
- Specifying the Recipient of an SNMP Notification Example

Enabling DistributedDirector SNMP Notifications Example

In the following example, both ciscoDistDirEventServerUp and ciscoDistDirEventServerDown notifications are enabled:

```
Router(config)#  snmp-server enable traps director

Router# show running-config

ip host myhost 172.22.2.10 172.22.2.20 172.22.2.30
.
.
.
snmp-server enable traps director server-up server-down
```

Specifying the Recipient of an SNMP Notification Example

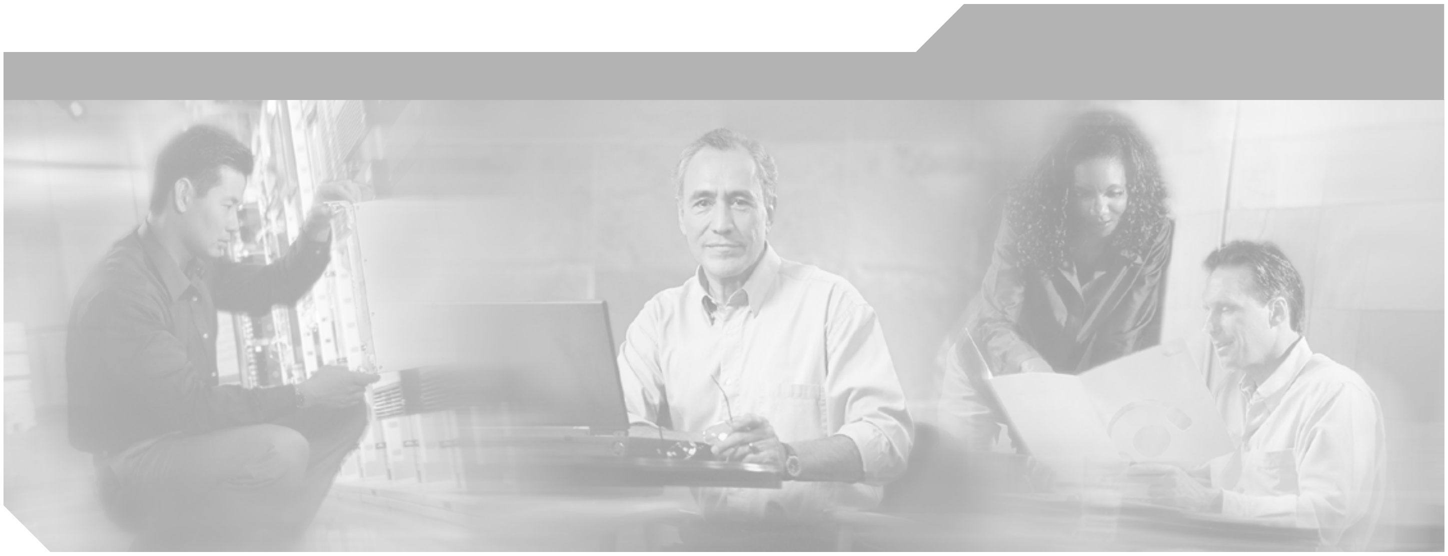
In the following example, the ciscoDistDirEventServerUp and ciscoDistDirEventServerDown notifications are to be sent to the host 10.0.0.1 using the community string defined as “public”:

```
Router(config)# snmp-server host 10.0.0.1 public director

Router# show snmp

Chassis:8768490
0 SNMP packets input
    0 Bad SNMP version errors
    0 Unknown community name
    0 Illegal operation for community name supplied
    0 Encoding errors
    0 Number of requested variables
    0 Number of altered variables
    0 Get-request PDUs
    0 Get-next PDUs
    0 Set-request PDUs
0 SNMP packets output
    0 Too big errors (Maximum packet size 1500)
    0 No such name errors
    0 Bad values errors
    0 General errors
    0 Response PDUs
    0 Trap PDUs

SNMP logging:enabled
    Logging to 10.0.0.1.162, 0/10, 0 sent, 0 dropped.
```

Command Reference

The following modified commands are pertinent to this feature. To see the command pages for these commands and other commands used with this feature, go to the *Cisco IOS Master Commands List*, Release 12.4, at http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124mindx/124index.htm.

- **snmp-server enable traps director**
- **snmp-server host**



Part 8: VPN Device Manager Client for Cisco IOS Software (XSM Configuration)

VPN Device Manager Client for Cisco IOS Software (XSM Configuration)

Feature History

Release	Modification
12.1(6)E	This feature was introduced.
12.2(9)YE, 12.2(9)YO1	This feature was integrated into Cisco IOS Release 12.2YE and 12.2YO.
12.2(13)T	This feature was integrated into Cisco IOS Release 12.2T for inclusion in Release 12.3.
12.2(14)S	This feature was integrated into Cisco IOS Release 12.2S.

This document was written for Release 12.1(6)E, and last updated January 2003 for Release 12.2(14)S.

Note For the primary documentaiton of the latest version of the VPN Device Manager (version 1.2), see the "Installation Guide and Release Notes for VPN Device Manager 1.2" at http://www.cisco.com/univercd/cc/td/doc/product/rtrmgmt/vdm/vdm12rn.htm

This document describes the command-line interface (CLI) Cisco IOS commands required to activate the VPN Device Manager (VDM) client and includes the following sections:

Feature Overview

VDM software is installed directly onto Cisco VPN devices. It allows network administrators to use a web browser to manage and configure site-to-site VPNs on a single device. VDM implements a wizard-based GUI that allows simplified VPN configuration of the device on which it resides and peer-to-peer interfaces from that device to remote devices. VDM requires configuration of some Cisco IOS commands before it can be fully operational.

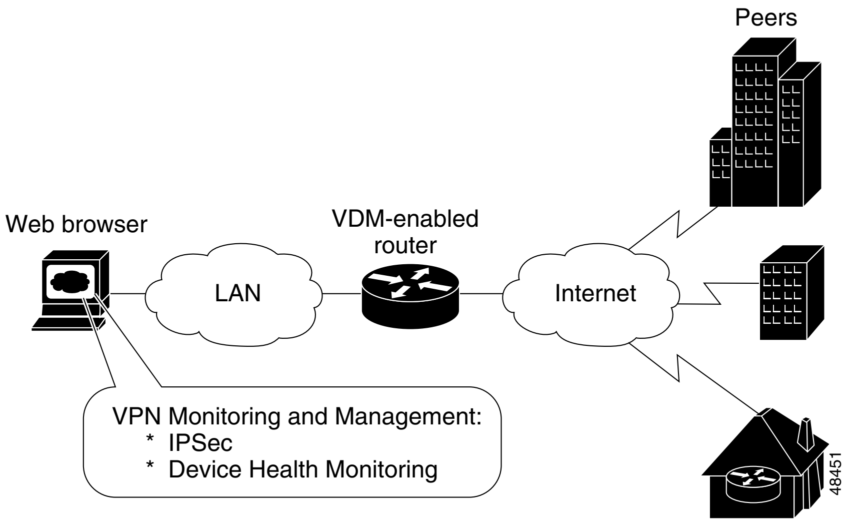
Note In addition to having the relevant Cisco IOS image installed on your device, make sure the VDM client software has been preinstalled in the device Flash memory. If it has not been, you must download it from Cisco.com. See the *Installation and Release Notes for VPN Device Manager* for the product version you are using for details on completing this task. See the VPN Device Manager index (http://www.cisco.com/warp/public/cc/pd/nemnsw/vpdvmn) for further information.

VDM also monitors general system statistics and VPN-specific information such as tunnel throughput and errors. The graphing capability allows comparison of such parameters as traffic volume, tunnel counts, and system utilization. VDM supports site-to-site VPNs. Its step-by-step wizards simplify the configuration of common VPN setups, interfaces, and policies, including:

- IPSec tunnels
- Preshared keys and Internet Key Exchange (IKE) policies

Figure 22 shows a simplified VDM deployment within a VPN.

Figure 22 Simplified VDM Deployment



XML Subscription Manager

XML Subscription Manager (XSM) is an HTTP-based service for retrieving information from a Cisco device. Once remote applications (such as VDM) are connected to the XSM server, they can subscribe to data sets called XML Request Descriptors (XRDs). These are XML-formatted messages describing configuration (access-control lists (ACLs), interfaces, crypto-maps, and others) and monitoring information (CPU, memory usage, interface statistics, and others).

XSM provides remote applications such as VDM with a constantly updated stream of data about Cisco device status by supplying real-time data without repeated device polling.

CLI Commands for VDM

This document gives details about Cisco IOS commands specific to VDM functionality. These commands are not related to general VPN functions but are designed to manage VDM itself via the XSM server. By using the Java-enabled VDM application, you can perform all VPN-related configuration and monitoring tasks within the application.

These commands are designed to complement VDM. The following tasks are performed by specific Cisco IOS XSM commands (command name in parentheses):

- Enabling VDM to receive data from the XSM feature set on the device (**xsm**)
- Enabling basic device monitoring, configuration, and data delivery for VDM (**xsm edm**)
- Enabling VPN-specific monitoring, configuration, and data delivery for VDM (**xsm vdm**)
- Enabling access to switch operations (for example, configuring switch ports and VLANs) when running VDM on a switch (**xsm dvdm**)
- Enabling collection of selected statistics generic to embedded devices on the XSM server (**xsm history edm**)
- Enabling collection of specific selected VPN statistics on the XSM server (**xsm history vdm**)
- Clearing VDM client sessions (**clear xsm**)
- Displaying information about the XSM server and VDM (**show xsm status**)
- Displaying all XRDs available to VDM (**show xsm xrd-list**)
- Setting user privilege levels for viewing VDM monitoring and configuration data (**xsm privilege monitor level** and **xsm privilege configuration level**)

For more information on VDM, the *Installation and Release Notes for VPN Device Manager* for the product version you are using or the Documentation CD-ROM that shipped with the product. See the VPN Device Manager index (http://www.cisco.com/warp/public/cc/pd/nemnsw/vpdvmn) for further information.

Related Features and Technologies

- Virtual Private Networks (VPNs)
- Security

Related Documents

- *Access VPN Solutions Using Tunneling Technology*
- *Access VPDN Dial-in Using L2TP*
- *Access VPDN Dial-in Using IPSec Over L2TP*
- *Cisco IOS Dial Technologies Command Reference*, Release 12.2
- *Cisco IOS Security Configuration Guide,* Release 12.2
- *Cisco IOS Security Command Reference,* Release 12.2

- "Configuring Virtual Private Networks" chapter in the Virtual Templates, Profiles, and Networks part of the *Cisco IOS Dial Technologies Configuration Guide,* Release 12.2
- *Installation and Release Notes for VPN Device Manager*
- VDM chapter in the *Cisco Enterprise VPN Configuration Guide*
- *VPN Device Manager*
- *IPSec VPN Acceleration Services Module Installation and Configuration Note*

Supported Platforms

The XSM Cisco IOS commands are available on the following VDM-enabled platforms:

- Cisco 1700 series routers
- Cisco 2600 series routers
- Cisco 3620, 3640, and 3660 routers
- Cisco 7100 series routers
- Cisco 7200 series routers
- Cisco 7400 series routers
- Cisco Catalyst 6500 series switches with IPSec VPN Acceleration Services Module installed
- Cisco 7600 series Internet routers with IPSec VPN Acceleration Services Module installed

This feature is supported on the following platforms in Cisco IOS Release 12.2(14)S:

- Cisco 7200 series
- Cisco 7400 series

Determining Platform Support Through Cisco Feature Navigator

Cisco IOS software is packaged in feature sets that support specific platforms. To get updated information regarding platform support for this feature, access Cisco Feature Navigator. Cisco Feature Navigator dynamically updates the list of supported platforms as new platform support is added for the feature.

Cisco Feature Navigator is a web-based tool that enables you to quickly determine which Cisco IOS software images support a specific set of features and which features are supported in a specific Cisco IOS image. You can search by feature or release. Under the release section, you can compare releases side by side to display both the features unique to each software release and the features in common.

To access Cisco Feature Navigator, you must have an account on Cisco.com. If you have forgotten or lost your account information, send a blank e-mail to cco-locksmith@cisco.com. An automatic check will verify that your e-mail address is registered with Cisco.com. If the check is successful, account details with a new random password will be e-mailed to you. Qualified users can establish an account on Cisco.com by following the directions at http://www.cisco.com/register.

Cisco Feature Navigator is updated regularly when major Cisco IOS software releases and technology releases occur. For the most current information, go to the Cisco Feature Navigator home page at the following URL:

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

Availability of Cisco IOS Software Images

Platform support for particular Cisco IOS software releases is dependent on the availability of the software images for those platforms. Software images for some platforms may be deferred, delayed, or changed without prior notice. For updated information about platform support and availability of software images for each Cisco IOS software release, refer to the online release notes or, if supported, Cisco Feature Navigator.

Supported Standards, MIBs, and RFCs

Standards

No new or modified standards are supported by this feature.

MIBs

No new or modified MIBs are supported by this feature.

To obtain lists of supported MIBs by platform and Cisco IOS release, and to download MIB modules, go to the Cisco MIB website on Cisco.com at the following URL:

http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml

RFCs

No new or modified RFCs are supported by this feature.

Prerequisites

The VDM client software must be installed on your device. It might already have been installed if you chose the VPN option at the time of configuration.

Configuring VDM

See the following sections for configuration tasks for this feature. Each task in the list is identified as either required or optional.

- Enabling the XSM Server for VDM (required)
- Configuring XSM Privilege Levels for XRDs (optional)
- Disabling the XSM Server for VDM (optional)
- Verifying VDM Status on the XSM Server (optional)
- Clearing XSM Client Sessions (optional)
- Configuring XSM Statistics Collection (optional)

Enabling the XSM Server for VDM

Use the **xsm** command in global configuration mode to activate XSM clients (such as VDM) on your device. Enabling this command also enables the **xsm vdm** and **xsm edm** global configuration commands, so there is no need to enable them separately.

Command	Purpose
`Router(config)# xsm`	Enables XSM client access to the device.

Configuring XSM Privilege Levels for XRDs

To set the minimum required privilege levels and grant appropriate access to view, monitor, or configure the XSM client (such as VDM), use the following commands in global configuration mode. Privilege levels set on the device determine which access level users possess (configuration and monitoring, monitoring only, or neither).

Users with privilege levels lower than the required monitoring privilege level will not have access to either the configuration or monitoring data required for subscription to XML Request Descriptors (XRDs). The higher the number, the higher the privilege level. The privilege level for the **xsm privilege configuration level** command must be greater than or equal to that of the **xsm privilege monitor level** command.

Command	Purpose
`Router(config)# xsm privilege configuration level number`	Enables configuration privilege level to subscribe to XRDs. • *number*—Privilege level (1–15). Privilege level 15 is the default.
`Router(config)# xsm privilege monitor level number`	Enables monitor privilege level to subscribe to XRDs. • *number*—Privilege level (1–15). Privilege level 15 is the default.

Disabling the XSM Server for VDM

To disable the XSM server, use the command below in global configuration mode. Disabling this command also disables the **xsm vdm** and **xsm edm** global configuration commands.

Command	Purpose
`Router(config)# no xsm`	Disables XSM server.

Verifying VDM Status on the XSM Server

Use the **show xsm status** command to verify the status of clients (such as VDM) on the XSM server.

Command	Purpose
`Router# show xsm status`	Displays information and status about clients subscribed to the XSM server.

Use the **show xsm xrd-list** command to verify all XML Request Descriptors (XRDs) for XSM clients (such as VDM) made available by subscription to the XSM server.

Command	Purpose
`Router# show xsm xrd-list`	Displays all XRDs for clients subscribed to the XSM server.

Clearing XSM Client Sessions

Use the **clear xsm** command to clear data from XSM clients (such as VDM) on the XSM server. To disconnect a specific client, you must identify the session number. Use the **show xsm status** command to obtain specific session numbers.

Command	Purpose
`Router# clear xsm [session number]`	Clears XSM client sessions. • **session**—XSM session ID. • *number*—Number of the specific XSM client session you are clearing.

Configuring XSM Statistics Collection

To configure the XSM server and its related clients (such as VDM) for Embedded Device Manager (EDM) or VPN-specific statistics collection of up to 5 days of data, use the following commands in global configuration mode.

Command	Purpose
`Router(config)# xsm history edm`	Enables statistics collection for the EDM on the XSM server.
`Router(config)# xsm history vdm`	Enables specific VPN statistics collection on the XSM server.

Configuration Examples for VDM

This section provides the following configuration examples:

- Enabling the XSM Server for VDM Example
- Configuring XSM Privilege Levels for XRDs Example
- Disabling the XSM Server for VDM Example
- Configuring XSM Statistics Collection Example

Enabling the XSM Server for VDM Example

The following example shows how to enable the XSM client on the device:

```
xsm
```

Configuring XSM Privilege Levels for XRDs Example

The following example shows how to set a privilege level of 11, for subscription to XRDs:

```
xsm privilege monitor level 11
```

Disabling the XSM Server for VDM Example

The following example shows how to enable and then disable the XSM client on the device to troubleshoot VDM:

```
no xsm
xsm
```

Configuring XSM Statistics Collection Example

The following example shows how to configure the XSM server and its related clients (such as VDM) for Embedded Device Manager (EDM) or VPN-specific statistics collection of up to 5 days of data:

```
xsm history edm
xsm history vdm
```

Command Reference

The following modified commands are pertinent to this feature. To see the command pages for these commands and other commands used with this feature, go to the *Cisco IOS Master Commands List*, Release 12.4, at http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124mindx/124index.htm.

- **clear xsm**
- **crypto mib topn**
- **show xsm status**
- **show xsm xrd-list**
- **xsm**
- **xsm dvdm**
- **xsm edm**
- **xsm history edm**
- **xsm history vdm**
- **xsm privilege configuration level**
- **xsm privilege monitor level**
- **xsm vdm**

Glossary

Internet Key Exchange (IKE)—A key management protocol standard used in conjunction with IPSec and other standards. IPSec can be configured without IKE, but IKE enhances IPSec by providing additional features, flexibility, and ease of configuration for the IPSec standard. IKE authenticates the IPSec peers, negotiates IPSec keys, and negotiates IPSec security associations. Before any IPSec traffic can be passed, each router/firewall/host must be able to verify the identity of its peer. This can be done by manually entering preshared keys into both hosts or by a CA service.

IP security (IPSec)—A framework of open standards that provides data confidentiality, data integrity, and data authentication between participating peers. IPSec provides these security services at the IP layer.

Virtual Private Network (VPN)—A virtual network that uses advanced encryption and tunneling to permit organizations to establish secure, end-to-end, private network connections over public IP infrastructure networks, such as the Internet or extranets.

VPN Device Manager (VDM)—A browser-based tool for configuring and monitoring VPNs on a VPN-enabled device. VDM allows users to configure and monitor advanced VPN functionality within Cisco devices.

XML Subscription Manager (XSM)— A Cisco IOS subsystem that allows embedded device managers such as VDM to receive XML-based configuration and monitoring information for managing network devices.

XML Request Descriptor (XRD)—A specific requested type of data from XSM.

Embedded Device Manager (EDM)—An XSM adapter that publishes general network device configuration and monitoring information for device managers such as VDM.