



Basic System Management Configuration Guide, Cisco IOS Release 12.2SY

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Performing Basic System Management

This module 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.

- [Finding Feature Information, page 1](#)
- [Information About Performing Basic System Management, page 1](#)
- [How to Perform Basic System Management, page 5](#)
- [Configuration Examples for Performing Basic System Management, page 11](#)
- [Additional References, page 11](#)
- [Feature Information for Performing Basic System Management, page 12](#)

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

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

Information About Performing Basic System Management

- [System Name, page 2](#)
- [Command Aliases, page 2](#)
- [Minor Services, page 2](#)
- [Hidden Telnet Addresses, page 3](#)
- [EXEC Startup Delay, page 3](#)
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- [Switching and Scheduling Priorities, page 4](#)
- [System Buffer Size, page 4](#)

System Name

The system name, also called the hostname, 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.

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 the **save config** command easier to remember. Use word substitutions or abbreviations to tailor the command syntax for you and your user community.

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

Minor Services

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, Bootstrap Protocol (BOOTP), and Finger. For information about the HTTP server, see the “Using the Cisco Web Browser User Interface” chapter in the Cisco IOS Configuration Fundamentals Configuration Guide.

The TCP small server provides the following minor services:

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

The UDP small server provides the following minor services:

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

Minor services are disabled by default.

**Caution**

Enabling minor services creates the potential for certain types of denial-of-service (DoS) 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 minor 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.

- [BOOTP Server, page 3](#)
- [Finger Protocol, page 3](#)

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.

Because DHCP is based on the BOOTP, both of these service share the well-known UDP server port 67 (per the Internet standards and RFCs). For more information about DHCP configuration in the Cisco IOS software, see the *Cisco IOS IP Addressing 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.

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.

Hidden Telnet Addresses

You can hide addresses while attempting to establish 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 fails.

EXEC Startup Delay

To delay the startup of the EXEC process on noisy lines until the line has been idle for 3 seconds, use the **service exec-wait** command in global configuration mode.

This command is useful on noisy modem lines or when a modem attached to the line is configured to ignore Microcom Networking Protocol (MNP) or V.42 negotiations, and when MNP or V.42 modems are 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. This command is not useful on nonmodem lines or lines without some kind of login configured.

Idle Telnet Connections

Normally, data sent to noncurrent Telnet connections is accepted and discarded. When the **service telnet-zero-idle** command is enabled and 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 all messages sent by the host must 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.

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 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.

Number of TCP Transactions

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

John Nagle's algorithm (RFC 896) helps alleviate the small-packet problem in TCP. The first character typed after the connection establishment is sent in a single packet, but TCP holds any additional characters that are typed until the receiver acknowledges the previous packet. Then the second, larger packet is sent, and the 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.

Switching and Scheduling Priorities

The normal operation of the network server allows the switching operations to use as much of the central processor as 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.

System Buffer Size

You can adjust the initial buffer pool settings and limits at which temporary buffers are created and destroyed.

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, very big, large, 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.

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 outstanding buffers, the number of buffers in the free list, and the maximum number of buffers allowed in the free list.

How to Perform Basic System Management

- [Setting Basic System Parameters, page 5](#)

Setting Basic System Parameters

To set basic system parameters perform the following steps. You can perform these steps based on the customization requirements of your system.

SUMMARY STEPS

1. **hostname** *name*
2. **prompt** *string*
3. **alias** *mode alias-name alias-command-line*
4. **service tcp-small-servers**
5. **service udp-small-servers**
6. **no ip bootp server**
7. **ip finger**
8. **ip finger rfc-compliant**
9. **service hide-telnet-address**
10. **line** *line-number*
11. **busy-message**
12. **exit**
13. **service exec-wait**
14. **service telnet-zero-idle**
15. **load-interval** *seconds*
16. **service nagle**
17. **scheduler interval** *milliseconds*
18. **scheduler allocate** [*network-microseconds process-microseconds*]
19. **scheduler process-watchdog** { **hang** | **normal** | **reload** | **terminate** }
20. **buffers** { **small** | **middle** | **big** | **verybig** | **large** | **huge** | *type number* } { **permanent** | **max-free** | **min-free** | **initial** } *number*
21. **exit**
22. **show aliases** [*mode*]
23. **show buffers**

DETAILED STEPS

Step 1

hostname *name*

Use the **hostname** *name* command to perform the basic system management task of assigning a name for your device.

Example:

```
Router(config)# hostname host1
```

Step 2

prompt *string*

or

no service prompt config

By default, the CLI prompt consists of the system name followed by an angle bracket (>) for user EXEC mode or a pound sign (#) for privileged EXEC mode. Use the **prompt** *string* or the **no service prompt config** command to customize the CLI prompt for your system.

Example:

```
Router(config)# prompt Router123
```

or

Example:

```
Router(config)# no service prompt config
```

Step 3

alias *mode alias-name alias-command-line*

Use the **alias** *mode alias-name alias-command-line* command to create a command alias.

Example:

```
Router(config)# alias exec save config copy running-config startup-config
```

Step 4

service tcp-small-servers

Use the **service tcp-small-servers** command to enable minor TCP services such as chargen, daytime, discard, and echo.

Note The **no** form of the **service tcp-small-servers** command will appear in the configuration file when these basic services are disabled.

Example:

```
Router(config)# service tcp-small-servers
```

Step 5

service udp-small-servers

Use the **service udp-small-servers** command to enable minor UDP services such as chargen, daytime, discard, and echo.

Note The **no** form of the **service udp-small-servers** command will appear in the configuration file when these basic services are disabled.

Example:

```
Router(config)# service udp-small-servers
```

Step 6

no ip bootp server

Use the **no ip bootp server** command to disable the BOOTP server on your platform.

Example:

```
Router(config)# no ip bootp server
```

Step 7**ip finger**

Use the **ip finger** command to enable a Cisco device to respond to Finger (port 79) requests. 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.

Example:

```
Router(config)# ip finger
```

Step 8**ip finger rfc-compliant**

Use the **ip finger rfc-compliant** command to configure the finger protocol to be compliant with RFC 1288. The **ip finger rfc-compliant** command should not be configured for devices with more than 20 simultaneous users. When the **ip finger rfc-compliant** command is configured, the router will wait for input before displaying any information. 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.

Example:

```
Router(config)# ip finger rfc-compliant
```

Step 9**service hide-telnet-address**

Use the **service hide-telnet-address** command to configure the router to suppress Telnet addresses.

Example:

```
Router(config)# service hide-telnet-address
```

Step 10**line line-number**

Use the **line** command to enter line configuration mode.

Example:

```
Router(config)# line 1
```

Step 11**busy-message**

Use the **busy-message** 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.

Example:

```
Router(config-line)# busy-message
```

Step 12

```
exit
```

Use the **exit** command to exit line configuration mode and return to global configuration mode.

Example:

```
Router(config-line)# exit
```

Step 13**service exec-wait**

Use the **service exec-wait** command to delay the startup of the EXEC process on noisy lines until the line has been idle for 3 seconds.

Example:

```
Router(config)# service exec-wait
```

Step 14**service telnet-zero-idle**

Use the **service telnet-zero-idle** command to configure the Cisco IOS software to set the TCP window to zero (0) when the Telnet connection is idle.

Example:

```
Router(config)# service telnet-zero-idle
```

Step 15**load-interval** *seconds*

Use the **load-interval** *seconds* command to change the length of time for which a set of data is used to compute load statistics.

Example:

```
Router(config)# load-interval 100
```

Step 16**service nagle**

Use the **service nagle** command to enable the Nagle algorithm and thereby reduce the number of TCP transactions.

Example:

```
Router(config)# load-interval 100
```

Step 17**scheduler interval** *milliseconds*

Use the **scheduler interval** *milliseconds* command to define the maximum amount of time that can elapse without running the lowest-priority system processes.

Example:

```
Router(config)# scheduler interval 100
```

Step 18**scheduler allocate** [*network-microseconds process-microseconds*]

Use the **scheduler allocate** command 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.

Caution Cisco recommends that you do not change the default values of the **scheduler allocate** command.

Example:

```
Router(config)# scheduler allocate 5000 200
```

Step 19 **scheduler process-watchdog {hang | normal | reload | terminate}**

Use the **scheduler process-watchdog {hang | normal | reload | terminate}** command to configure the characteristics for a looping process.

Example:

```
Router(config)# scheduler process-watchdog hang
```

Step 20 **buffers {small | middle | big | verybig | large | huge | type number} {permanent | max-free | min-free | initial} number**

Use the **buffers {small | middle | big | verybig | large | huge | type number} {permanent | max-free | min-free | initial} number** command to adjust the system buffer size.

Example:

```
Router(config)# buffers small permanent 10
```

Caution Cisco does not recommend that you adjust these parameters. Improper settings can adversely impact the system performance.

Step 21 **exit**

Use the **exit** command to exit global configuration mode and return to privileged EXEC mode.

Example:

```
Router(config)# exit
```

Step 22 **show aliases [mode]**

Use the **show aliases [mode]** command to display a list of command aliases currently configured on your system, and the original command syntax for those aliases.

Example:

```
Router# show aliases exec
```

Step 23 **show buffers**

Use the **show buffers** command to display buffer information. For more information about this command, see the Cisco IOS Configuration Fundamentals Command Reference.

Example:

```
Router# show buffers
Buffer elements:
  1119 in free list (1119 max allowed)
  641606 hits, 0 misses, 619 created
Public buffer pools:
Small buffers, 104 bytes (total 50, permanent 50):
  48 in free list (20 min, 150 max allowed)
  2976557 hits, 0 misses, 0 trims, 0 created
  0 failures (0 no memory)
Middle buffers, 600 bytes (total 25, permanent 25, peak 37 @ 2w0d):
```



```

    25 in free list (10 min, 150 max allowed)
    445110 hits, 4 misses, 12 trims, 12 created
    0 failures (0 no memory)
Big buffers, 1536 bytes (total 50, permanent 50):
    50 in free list (5 min, 150 max allowed)
    58004 hits, 0 misses, 0 trims, 0 created
    0 failures (0 no memory)
VeryBig buffers, 4520 bytes (total 10, permanent 10):
    10 in free list (0 min, 100 max allowed)
    0 hits, 0 misses, 0 trims, 0 created
    0 failures (0 no memory)
Large buffers, 5024 bytes (total 0, permanent 0):
    0 in free list (0 min, 10 max allowed)
    0 hits, 0 misses, 0 trims, 0 created
    0 failures (0 no memory)
Huge buffers, 18024 bytes (total 0, permanent 0):
    0 in free list (0 min, 4 max allowed)
    0 hits, 0 misses, 0 trims, 0 created
    0 failures (0 no memory)
Interface buffer pools:
Syslog ED Pool buffers, 600 bytes (total 282, permanent 282):
    257 in free list (282 min, 282 max allowed)
    32 hits, 0 misses
IPC buffers, 4096 bytes (total 2, permanent 2):
    1 in free list (1 min, 8 max allowed)
    1 hits, 0 fallbacks, 0 trims, 0 created
    0 failures (0 no memory)
Header pools:
Header buffers, 0 bytes (total 511, permanent 256, peak 511 @ 2w0d):
    255 in free list (256 min, 1024 max allowed)
    171 hits, 85 misses, 0 trims, 255 created
    0 failures (0 no memory)
    256 max cache size, 256 in cache
    0 hits in cache, 0 misses in cache
Particle Clones:
    1024 clones, 0 hits, 0 misses
Public particle pools:
F/S buffers, 128 bytes (total 512, permanent 512):
    0 in free list (0 min, 512 max allowed)
    512 hits, 0 misses, 0 trims, 0 created
    0 failures (0 no memory)
    512 max cache size, 512 in cache
    0 hits in cache, 0 misses in cache
Normal buffers, 512 bytes (total 2048, permanent 2048):
    2048 in free list (1024 min, 4096 max allowed)
    0 hits, 0 misses, 0 trims, 0 created
    0 failures (0 no memory)
Private particle pools:
HQF buffers, 0 bytes (total 2000, permanent 2000):
    2000 in free list (500 min, 2000 max allowed)
    0 hits, 0 misses, 0 trims, 0 created
    0 failures (0 no memory)
Serial2/0 buffers, 512 bytes (total 256, permanent 256):
    0 in free list (0 min, 256 max allowed)
    256 hits, 0 fallbacks
    256 max cache size, 132 in cache
    124 hits in cache, 0 misses in cache
    10 buffer threshold, 0 threshold transitions
Serial2/1 buffers, 512 bytes (total 256, permanent 256):
    0 in free list (0 min, 256 max allowed)
    256 hits, 0 fallbacks
    256 max cache size, 132 in cache
    124 hits in cache, 0 misses in cache
    10 buffer threshold, 0 threshold transitions

```

Configuration Examples for Performing Basic System Management

There are no configuration examples for the Performing Basic System Management feature.

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Network Management commands	<i>Cisco IOS Network Management Command Reference</i>
Cisco IOS fundamental configuration commands	<i>Cisco IOS Configuration Fundamentals Command Reference</i>
Cisco IOS fundamental configurations	<i>Cisco IOS Configuration Fundamentals Configuration Guide</i>
Preventing UDP diagnostic port attacks	Defining Strategies to Protect Against UDP Diagnostic Port Denial of Service Attacks
DHCP configuration	<i>Cisco IOS IP Addressing Configuration Guide</i>

Standards

Standard	Title
None	--

MIBs

MIB	MIBs Link
None	To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFC	Title
RFC 896	<i>Congestion Control in IP/TCP Internetworks</i>
RFC 951	<i>Algorithms for Synchronizing Network Clocks</i>
RFC 1288	<i>The Finger User Information Protocol</i>
RFC 1534	<i>Interoperation Between DHCP and BOOTP</i>
RFC 2131	<i>Dynamic Host Configuration Protocol</i>

Technical Assistance

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

Feature Information for Performing Basic System Management

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

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

Table 1 Feature Information for Performing Basic System Management

Feature Name	Releases	Feature Information
Performing Basic System Management	10.0	This module describes the basic tasks to manage the general system features of the Cisco IOS software.

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



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.

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.

This module describes how to update the software clock from various sources.

- [Finding Feature Information, page 15](#)
- [Information About Setting Time and Calendar Services, page 15](#)
- [How to Set Time and Calendar Services, page 20](#)
- [Configuration Examples for Setting Time and Calendar Services, page 38](#)
- [Additional References, page 38](#)
- [Feature Information for Setting Time and Calendar Services, page 40](#)

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

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

Information About Setting Time and Calendar Services

- [Time and Calendar Services, page 15](#)
- [Network Time Protocol, page 16](#)
- [VINES Time Service, page 20](#)
- [Hardware Clock, page 20](#)

Time and Calendar Services

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:

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

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
- Logging and debugging messages
- NTP
- The hardware clock
- User **show** commands
- VINES Time Service

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

NTP is a protocol designed to time-synchronize a network of machines. NTP runs on UDP, which in turn runs on 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 Global Positioning System (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 has two ways to avoid synchronizing to a machine whose time may not be accurate. NTP will never synchronize to a machine that is not in turn synchronized. NTP will compare the time reported by several machines, and will not synchronize to a machine whose time is significantly different from 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, you cannot connect to a radio or atomic clock (for some specific platforms, however, you can connect to a GPS time-source device). Cisco recommends that the 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. 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 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 Cisco strongly recommends 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.

NTP services are disabled on all interfaces by default.

For more information about NTP, see the following sections:

- [Poll-Based NTP Associations, page 17](#)
- [Broadcast-Based NTP Associations, page 18](#)
- [NTP Access Group, page 18](#)
- [NTP Services on a Specific Interface, page 19](#)
- [Source IP Address for NTP Packets, page 19](#)
- [System as an Authoritative NTP Server, page 19](#)

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. A networking device can obtain time information on a network in two ways: by polling host servers and by listening to NTP broadcasts. This section focusses on the poll-based association modes. Broadcast-based NTP associations are discussed in the [Broadcast-Based NTP Associations, page 18](#) section.

The following are the 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 among all the polled time servers to synchronize with. Because 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. Because this is a peer-to-peer relationship, the host will also retain time-related information of the local networking device that it is communicating with. This mode should be used when a number of mutually redundant servers are interconnected via diverse network paths. Most stratum 1 and stratum 2 servers on the Internet 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 them 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.

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 more than 20 clients. Broadcast-based NTP associations are also recommended for use on networks that have limited bandwidth, system memory, or CPU resources.

A networking device operating in the broadcast client mode does not engage in any polling. Instead, it listens for NTP broadcast packets that are transmitted by broadcast time servers. Consequently, time accuracy can be marginally reduced because 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 broadcast client 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.

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 **ntp access-group {peer | query-only | serve | serve-only} {access-list-number | access-list-number-expanded | access-list-name} [kod]** command in global configuration mode.

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

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

The encrypted NTP authentication scheme should be used when a reliable form of access control is required. Unlike the access list-based restriction scheme that 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 they carry along with them is accepted.

The authentication process begins from the moment an NTP packet is created. Cryptographic checksum keys are generated using the message digest algorithm 5 (MD5) 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 authentication key, the time-stamp information that is contained within it is accepted by the receiving client. NTP synchronization packets that do not contain a matching authenticator key are 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 synchronize with and provide synchronization only to trusted time sources.

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 **ntp disable** command in interface configuration mode.

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 **ntp source interface** command in global configuration mode if you want to configure a specific 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** keyword in the **ntp peer** or **ntp server** command.

System as an Authoritative NTP Server

Use the **ntp master [stratum]** 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.



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.

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 releases.

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.

You can configure a hardware clock (system calendar) on any device 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 **ntp update-calendar** 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.

How to Set Time and Calendar Services

- [Configuring NTP, page 20](#)
- [Configuring VINES Time Service, page 29](#)
- [Configuring the Time and Date Manually, page 30](#)
- [Setting the Hardware Clock, page 32](#)
- [Configuring Time Ranges, page 34](#)
- [Verifying Time and Calendar Services, page 36](#)

Configuring NTP

NTP services are disabled on all interfaces by default. Perform the following tasks to configure NTP service on your networking device.

- [Restrictions, page 21](#)

- [Configuring Poll-Based NTP Associations, page 22](#)
- [Configuring Broadcast-Based NTP Associations, page 23](#)
- [Configuring NTP Authentication, page 25](#)
- [Configuring an External Reference Clock, page 26](#)

Restrictions

The NTP package contains a vulnerability that could allow an unauthenticated, remote attacker to cause a DoS condition. NTP versions 4.2.4p7 and earlier are vulnerable.

The vulnerability is due to an error in handling certain malformed messages. An unauthenticated, remote attacker could send a malicious NTP packet with a spoofed source IP address to a vulnerable host. The host that processes the packet sends a response packet back to the transmitter. This action could start a loop of messages between the two hosts that could cause both the hosts to consume excessive CPU resources, use up the disk space writing messages to log files, and consume the network bandwidth. These could cause a DoS condition on the affected hosts.

For more information, see the [Network Time Protocol Package Remote Message Loop Denial of Service Vulnerability](#) web page.

Cisco IOS software releases that supports NTPv4 are not affected. All other versions of Cisco IOS and Cisco IOS XE software are affected.

To display whether a device is configured with NTP, use the **show running-config | include ntp** command. If the output returns any of the following commands, then that device is vulnerable to the attack:

- **ntp broadcast client**
- **ntp master**
- **ntp multicast client**
- **ntp peer**
- **ntp server**

For more information on understanding Cisco IOS software releases, see the [White Paper: Cisco IOS Reference Guide](#) .

There are no workarounds other than disabling NTP on the device. Only packets destined for any configured IP address on the device can exploit this vulnerability. Transit traffic will not exploit this vulnerability.

Releases later than Cisco IOS Release 12.2(33)SXH7 will not process NTP mode 7 packets, and will display the message “NTP: Receive: dropping message: Received NTP private mode packet .7” if debugs for NTP are enabled. Configure the **ntp allow mode private** command to process NTP mode 7 packets. This command is disabled by default.



Note

NTP peer authentication is not a workaround and is a vulnerable configuration.

NTP services are disabled on all interfaces by default.

Networking devices running NTP can be configured to operate in variety of association modes when synchronizing time with reference time sources. A networking device can obtain time information on a network in two ways: by polling host servers and by listening to NTP broadcasts.

This section contains the following tasks:

Configuring Poll-Based NTP Associations

The following are the 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.

You can 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 or 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.

Perform the following task to configure the NTP server-peer relationship.

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 display 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.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ntp peer** *ip-address* [**normal-sync**] [**version** *number*] [**key** *key-id*] [**source** *interface-type interface-number*] [**prefer**]
4. **ntp server** *ip-address* [**version** *number*] [**key** *key-id*] [**source** *interface-type interface-number*] [**prefer**]
5. **end**

DETAILED STEPS

Command or Action	Purpose
Step 1 enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.

Command or Action	Purpose
<p>Step 2 <code>configure terminal</code></p> <p>Example:</p> <pre>Router# configure terminal</pre>	Enters global configuration mode.
<p>Step 3 <code>ntp peer ip-address [normal-sync] [version number] [key key-id] [source interface-type interface-number] [prefer]</code></p> <p>Example:</p> <pre>Router(config)# ntp peer 192.168.10.1 normal-sync version 2 prefer</pre>	Forms a peer association with another system.
<p>Step 4 <code>ntp server ip-address [version number] [key key-id] [source interface-type interface-number] [prefer]</code></p> <p>Example:</p> <pre>Router(config)# ntp server 192.168.10.1 version 2 prefer</pre>	Forms a server association with another system.
<p>Step 5 <code>end</code></p> <p>Example:</p> <pre>Router(config)# end</pre>	Exits global configuration mode and returns to privileged EXEC mode.

Configuring Broadcast-Based NTP Associations

A networking device operating in the broadcast client mode does not engage in any polling. Instead, it listens for NTP broadcast packets that are transmitted by broadcast time servers. Consequently, time accuracy can be marginally reduced because time information flows only one way.

You can set your networking device to listen for NTP broadcast packets propagated through a network. The time server that is transmitting NTP broadcast packets will also have to be enabled on the interface of the given device.

Perform the following task to configure broadcast-based NTP associations.



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 from the configuration when copying configuration files to other devices.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ntp broadcast version** *number*
5. **ntp broadcast client**
6. **ntp broadcastdelay** *microseconds*
7. **end**

DETAILED STEPS

Command or Action	Purpose
<p>Step 1 enable</p> <p>Example:</p> <pre>Router> enable</pre>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> • Enter your password if prompted.
<p>Step 2 configure terminal</p> <p>Example:</p> <pre>Router# configure terminal</pre>	<p>Enters global configuration mode.</p>
<p>Step 3 interface <i>type number</i></p> <p>Example:</p> <pre>Router(config)# interface ethernet 0/0</pre>	<p>Configures an interface and enters interface configuration mode.</p>
<p>Step 4 ntp broadcast version <i>number</i></p> <p>Example:</p> <pre>Router(config-if)# ntp broadcast version 2</pre>	<p>Configures the specified interface to send NTP broadcast packets.</p>
<p>Step 5 ntp broadcast client</p> <p>Example:</p> <pre>Router(config-if)# ntp broadcast client</pre>	<p>Configures the specified interface to receive NTP broadcast packets.</p>

Command or Action	Purpose
Step 6 <code>ntp broadcastdelay <i>microseconds</i></code> Example: <pre>Router(config-if)# ntp broadcastdelay 100</pre>	Adjusts the estimated round-trip delay for NTP broadcasts.
Step 7 <code>end</code> Example: <pre>Router(config-if)# end</pre>	Exits interface configuration mode and returns to privileged EXEC mode.

Configuring NTP Authentication

After NTP authentication is properly configured, your networking device will synchronize with and provide synchronization only to trusted time sources. To configure NTP authentication, perform the following task.



Note

In Cisco IOS software earlier than Release 12.0, the cryptotype value is displayed along with the NTP authentication key MD5 value when the **show running-config** command is entered. Copying and pasting the string cryptotype value that is displayed with the authentication key will result in authentication failure.

SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `ntp authenticate`
4. `ntp authentication-key number md5 key`
5. `ntp trusted-key key-id`
6. `ntp server ip-address key key-id`
7. `end`

DETAILED STEPS

Command or Action	Purpose
Step 1 <code>enable</code> Example: <pre>Router> enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.

Command or Action	Purpose
Step 2 <code>configure terminal</code> Example: <pre>Router# configure terminal</pre>	Enters global configuration mode.
Step 3 <code>ntp authenticate</code> Example: <pre>Router(config)# ntp authenticate</pre>	Enables the NTP authentication feature.
Step 4 <code>ntp authentication-key number md5 key</code> Example: <pre>Router(config)# ntp authentication-key 42 md5 key1</pre>	Defines the authentication keys. <ul style="list-style-type: none"> Each key has a key number, a type, and a value. As of Cisco IOS Release 10.0 the only key type supported is md5.
Step 5 <code>ntp trusted-key key-id</code> Example: <pre>Router(config)# ntp trusted-key 42</pre>	Defines trusted authentication keys. <ul style="list-style-type: none"> If a key is trusted, this system will be ready to synchronize to a system that uses this key in its NTP packets.
Step 6 <code>ntp server ip-address key key-id</code> Example: <pre>Router(config)# ntp server 172.16.22.44 key 2</pre>	Allows the software clock to be synchronized by an NTP time server.
Step 7 <code>end</code> Example: <pre>Router(config)# end</pre>	Exits global configuration mode and returns to privileged EXEC mode.

Configuring an External Reference Clock

Because Cisco's implementation of NTP does not support stratum 1 service, you cannot connect to a radio or atomic clock (for some specific platforms, however, you can connect to a GPS time source device). However, certain Cisco devices allow you to connect to an 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 on these platforms provide the ability to receive an Request to Send (RTS) time-stamp signal on the auxiliary port of your routing device.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **line aux** *line-number*
4. **ntp refclock** { **trimble** | **telecom-solutions** } **pps** { **cts** | **ri** | **none** } [**inverted**] [**pps-offset** *number*] [**stratum** *number*] [**timestamp-offset** *number*]
5. **end**
6. **show ntp associations**
7. **show ntp status**
8. **debug ntp refclock**

DETAILED STEPS

Command or Action	Purpose
<p>Step 1 enable</p> <p>Example:</p> <pre>Router> enable</pre>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> • Enter your password if prompted.
<p>Step 2 configure terminal</p> <p>Example:</p> <pre>Router# configure terminal</pre>	<p>Enters global configuration mode.</p>
<p>Step 3 line aux <i>line-number</i></p> <p>Example:</p> <pre>Router(config)# line aux 0</pre>	<p>Enters line configuration mode for the auxiliary port 0.</p>

Command or Action	Purpose
<p>Step 4 <code>ntp refclock {trimble telecom-solutions} pps {cts ri none} [inverted] [pps-offset number] [stratum number] [timestamp-offset number]</code></p> <p>Example:</p> <pre>Router(config-line)# ntp refclock trimble pps none stratum 1</pre>	<p>Configures an external reference clock.</p> <ul style="list-style-type: none"> 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 ntp refclock trimble pps none stratum number form of the command. Use this command to enable 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 ntp refclock telecom-solutions pps cts stratum number form of the command. Use this command to enable the driver that allows the Symmetricom GPS product to be used as the NTP reference clock source. To configure a pulse per second (PPS) signal as the source for NTP synchronization, use the ntp refclock telecom-solutions pps cts stratum number form of the command. To configure a PPS signal as the source for NTP synchronization, use the ntp refclock {trimble telecom-solutions} pps {cts ri} [inverted] [pps-offset number] [stratum number] [timestamp-offset number].
<p>Step 5 <code>end</code></p> <p>Example:</p> <pre>Router(config-line)# end</pre>	<p>Exits line configuration mode and returns to privileged EXEC mode.</p>
<p>Step 6 <code>show ntp associations</code></p> <p>Example:</p> <pre>Router# show ntp associations</pre>	<p>Displays the status of NTP associations, including the status of the GPS reference clock.</p>
<p>Step 7 <code>show ntp status</code></p> <p>Example:</p> <pre>Router# show ntp status</pre>	<p>Displays the status of NTP.</p>
<p>Step 8 <code>debug ntp refclock</code></p> <p>Example:</p> <pre>Router# debug ntp refclock</pre>	<p>Allows advanced monitoring of reference clock activities for the purposes of debugging.</p>

Configuring VINES Time Service

Time service is available when Banyan VINES is configured. This protocol is a standard part of VINES. Perform the following task to configure VINES Time Service.



Note

Support for Banyan VINES and XNS was 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.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vines time use-system**
4. **vines time set-system**
5. **exit**

DETAILED STEPS

Command or Action	Purpose
Step 1 enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2 configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3 vines time use-system Example: Router(config)# vines time use-system	Distributes the system software clock time to other VINES systems.
Step 4 vines time set-system Example: Router(config)# vines time set-system	Sets the software clock system time and date as derived from VINES time services.

Command or Action	Purpose
Step 5 <code>exit</code> Example: <code>Router(config)# exit</code>	Exits global configuration mode and returns to privileged EXEC mode.

Configuring the 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.

If you have an outside source to which the router can synchronize, you need not manually set the software clock. Perform the following task to configure the time and date manually.

SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `clock timezone zone hours-offset [minutes-offset]`
4. `clock summer-time zone recurring [week day month hh : mm week day month hh : mm [offset]]`
5. `clock summer-time zone date date month year hh:mm date month year hh : mm [offset]`
6. `exit`
7. `clock set hh : mm : ss date month year`

DETAILED STEPS

Command or Action	Purpose
Step 1 <code>enable</code> Example: <code>Router> enable</code>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2 <code>configure terminal</code> Example: <code>Router# configure terminal</code>	Enters global configuration mode.

Command or Action	Purpose
<p>Step 3 <code>clock timezone zone hours-offset [minutes-offset]</code></p> <p>Example:</p> <pre>Router(config)# clock timezone PST 2 30</pre>	<p>Configures the time zone used by the Cisco IOS software.</p> <ul style="list-style-type: none"> The <i>zone</i> argument is the name of the time zone (typically a standard acronym). The <i>hours-offset</i> argument is the number of hours the time zone is different from UTC. The <i>minutes-offset</i> argument is the number of minutes the time zone is different from UTC. <p>Note The <i>minutes-offset</i> 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.</p>
<p>Step 4 <code>clock summer-time zone recurring [week day month hh : mm week day month hh : mm [offset]]</code></p> <p>Example:</p> <pre>Router(config)# clock summer-time PST recurring 1 monday january 12:12 4 Tuesday december 12:12 120</pre>	<p>Configures summer time (daylight saving time) in areas where it starts and ends on a particular day of the week each year .</p> <ul style="list-style-type: none"> The <i>offset</i> argument is used to indicate the number of minutes to add to the clock during summer time.
<p>Step 5 <code>clock summer-time zone date date month year hh:mm date month year hh : mm [offset]</code></p> <p>Example:</p> <pre>Router(config)# clock summer-time PST date 1 january 1999 12:12 4 december 2001 12:12 120</pre>	<p>Configures a specific summer time start and end date.</p> <ul style="list-style-type: none"> The <i>offset</i> argument is used to indicate the number of minutes to add to the clock during summer time.
<p>Step 6 <code>exit</code></p> <p>Example:</p> <pre>Router(config)# exit</pre>	<p>Exits global configuration mode and returns to privileged EXEC mode.</p>
<p>Step 7 <code>clock set hh : mm : ss date month year</code></p> <p>Example:</p> <pre>Router# clock set 12:12:12 1 january 2011</pre>	<p>Sets the software clock.</p> <ul style="list-style-type: none"> Use this command if no other time sources are available. The time specified in this command is relative to the configured time zone. <p>Note 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.</p>

Setting 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.

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 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.

Perform the following task to set the hardware clock.

SUMMARY STEPS

1. **enable**
2. **calendar set** *hh : mm : ss day month year*
3. **configure terminal**
4. **clock calendar-valid**
5. **exit**
6. **clock read-calendar**
7. **clock update-calendar**
8. **show calendar**
9. **show clock [detail]**
10. **show ntp associations [detail]**
11. **show ntp status**
12. **show sntp**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	calendar set <i>hh : mm : ss day month year</i> Example: Router# calendar set 10:12:15 monday june 1999	Sets the hardware clock manually. Note Use this command when you have no access to an external time source.

	Command or Action	Purpose
Step 3	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 4	clock calendar-valid Example: Router(config)# clock calendar-valid	Enables the router to act as a valid time source to which network peers can synchronize. <ul style="list-style-type: none"> By default, the time maintained on the software clock is not considered to be reliable and will not be synchronized with NTP or VINES time service. To set the hardware clock as a valid time source, use this command.
Step 5	exit Example: Router(config)# exit	Exits global configuration mode and returns to privileged EXEC mode.
Step 6	clock read-calendar Example: Router# clock read-calendar	Sets the software clock to the new hardware clock setting.
Step 7	clock update-calendar Example: Router# clock update-calendar	Updates the hardware clock with a new software clock setting.
Step 8	show calendar Example: Router# show calendar	Displays the current hardware clock time.
Step 9	show clock [detail] Example: Router# show clock detail	Displays the current software clock time .

Command or Action	Purpose
Step 10 <code>show ntp associations [detail]</code> Example: <pre>Router# show ntp associations detail</pre>	Displays the status of NTP associations.
Step 11 <code>show ntp status</code> Example: <pre>Router# show ntp status</pre>	Displays the status of NTP.
Step 12 <code>show sntp</code> Example: <pre>Router# show sntp</pre>	Displays information about SNTP (Cisco 1003, Cisco 1004, Cisco 1005, Cisco 1600, Cisco 1720, or Cisco 1750 routers only).

Configuring Time Ranges

Cisco IOS software 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 and numbered access lists can reference 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. Cisco recommends that you use NTP to synchronize the system's software clock.

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 IP security.
- Policy-based routing and queueing functions are enhanced.
- When provider access rates vary by time of day, traffic can be rerouted automatically and 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 the 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 the need to analyze the many logs generated during peak hours.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **time-range** *time-range-name*
4. Do one of the following:
 - **absolute** [**start** *time date month year*] [**end** *time date month year*]
 -
 -
 - **periodic** *day-of-the-week hh : mm to [day-of-the-week] hh : mm*
5. **end**

DETAILED STEPS

Command or Action	Purpose
<p>Step 1 enable</p> <p>Example:</p> <pre>Router> enable</pre>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> • Enter your password if prompted.
<p>Step 2 configure terminal</p> <p>Example:</p> <pre>Router# configure terminal</pre>	<p>Enters global configuration mode.</p>
<p>Step 3 time-range <i>time-range-name</i></p> <p>Example:</p> <pre>Router(config)# time-range rangel</pre>	<p>Assigns a name to the time range to be configured and enters time range configuration mode.</p>

Command or Action	Purpose
<p>Step 4 Do one of the following:</p> <ul style="list-style-type: none"> • absolute [<i>start time date month year</i>] [<i>end time date month year</i>] • • • periodic <i>day-of-the-week hh : mm to [day-of-the-week] hh : mm</i> <p>Example:</p> <pre>Router(config-time-range)# absolute start 12:12 30 January 1999 end 12:12 30 December 2000</pre> <p>Example:</p> <p>or</p> <p>Example:</p> <pre>Router(config-time-range)# periodic monday 12:12 to friday 12:12</pre>	<p>Specifies when the time range will be in effect.</p> <ul style="list-style-type: none"> • Use some combination of these commands; multiple periodic commands are allowed; only one absolute command is allowed.
<p>Step 5 end</p> <p>Example:</p> <pre>Router(config-time-range)# end</pre>	<p>Exits time range configuration mode and returns to privileged EXEC mode.</p>

Verifying Time and Calendar Services

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

SUMMARY STEPS

1. **show calendar**
2. **show clock [detail]**
3. **show ntp associations detail**
4. **show ntp status**
5. **show sntp**

DETAILED STEPS

Step 1 **show calendar**

This command displays the current hardware clock time. The following is sample output from this command:

Example:

```
Router# show calendar
18:34:29 UTC Tue Jan 4 2011
```

Step 2

show clock [detail]

This command displays the current software clock time. The following is sample output from this command:

Example:

```
Router# show clock detail
*18:38:21.655 UTC Tue Jan 4 2011
Time source is hardware calendar
```

Step 3

show ntp associations detail

This command displays the status of NTP associations. The following is sample output from this command:

Example:

```
Router# show ntp associations detail
192.168.10.1 configured, insane, invalid, unsynced, stratum 16
ref ID .INIT., time 00000000.00000000 (00:00:00.000 UTC Mon Jan 1 1900)
our mode active, peer mode unspec, our poll intvl 64, peer poll intvl 1024
root delay 0.00 msec, root disp 0.00, reach 0, sync dist 15940.56
delay 0.00 msec, offset 0.0000 msec, dispersion 15937.50
precision 2**24, version 4
org time 00000000.00000000 (00:00:00.000 UTC Mon Jan 1 1900)
rec time 00000000.00000000 (00:00:00.000 UTC Mon Jan 1 1900)
xmt time D0CDE881.9A6A9005 (18:42:09.603 UTC Tue Jan 4 2011)
filtdelay = 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
filtoffset = 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
filtererror = 16000.0 16000.0 16000.0 16000.0 16000.0 16000.0 16000.0 16000.0
minpoll = 6, maxpoll = 10
192.168.45.1 configured, insane, invalid, unsynced, stratum 16
ref ID .INIT., time 00000000.00000000 (00:00:00.000 UTC Mon Jan 1 1900)
our mode client, peer mode unspec, our poll intvl 64, peer poll intvl 1024
root delay 0.00 msec, root disp 0.00, reach 0, sync dist 16003.08
delay 0.00 msec, offset 0.0000 msec, dispersion 16000.00
precision 2**24, version 4
org time 00000000.00000000 (00:00:00.000 UTC Mon Jan 1 1900)
rec time 00000000.00000000 (00:00:00.000 UTC Mon Jan 1 1900)
xmt time 00000000.00000000 (00:00:00.000 UTC Mon Jan 1 1900)
filtdelay = 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
filtoffset = 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
filtererror = 16000.0 16000.0 16000.0 16000.0 16000.0 16000.0 16000.0 16000.0
minpoll = 6, maxpoll = 10
```

Step 4

show ntp status

This command displays the status of NTP. The following is sample output from this command:

Example:

```
Router# show ntp status
Clock is unsynchronized, stratum 16, no reference clock
nominal freq is 250.0000 Hz, actual freq is 250.0000 Hz, precision is 2**24
reference time is 00000000.00000000 (00:00:00.000 UTC Mon Jan 1 1900)
clock offset is 0.0000 msec, root delay is 0.00 msec
root dispersion is 0.19 msec, peer dispersion is 0.00 msec
```

```
loopfilter state is 'FSET' (Drift set from file), drift is 0.000000000 s/s
system poll interval is 64, never updated.
```

Step 5**show sntp**

This command displays information about SNTP (Cisco 1003, Cisco 1004, Cisco 1005, Cisco 1600, Cisco 1720, or Cisco 1750 routers only). The following is sample output from this command:

Example:

```
Router# show sntp
SNTP server      Stratum   Version   Last Receive
172.168.10.1     16         1         never
Broadcast client mode is enabled.
Multicast client 224.0.1.1 is enabled.
```

Configuration Examples for Setting Time and Calendar Services

- [Example Configuring Clock Calendar and NTP, page 38](#)

Example Configuring Clock Calendar and NTP

In the following example, a router with a hardware clock that 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
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Network Management commands	<i>Cisco IOS Network Management Command Reference</i>
IP extended access lists	"Configuring IPv4 Addresses" chapter of the <i>Cisco IOS IP Addressing Configuration Guide</i>
IPX extended access lists	"Configuring Novell IPX" chapter of the <i>Cisco IOS Novell IPX Configuration Guide</i>
NTP package vulnerability	Network Time Protocol Package Remote Message Loop Denial of Service Vulnerability
Cisco IOS software releases	White Paper: Cisco IOS Reference Guide

Standards

Standard	Title
None	--

MIBs

MIB	MIBs Link
None	To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFC	Title
RFC 1305	<i>Network Time Protocol (Version 3) Specification, Impl</i>

Technical Assistance

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

Feature Information for Setting Time and Calendar Services

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

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

Table 2 *Feature Information for Setting Time and Calendar Services*

Feature Name	Releases	Feature Information
Network Time Protocol	11.2(1) 12.2(28)SB 12.2(33)SRA 12.2(33)SXI 12.2(33)SXJ 12.2(50)SY 12.2(58)SE 15.0(1)M 15.1(2)S	NTP is a protocol designed to time-synchronize a network of machines. NTP runs on UDP, which in turn runs on IP. NTP is documented in RFC 1305. The following commands were introduced or modified: ntp access-group , ntp allow mode passive , ntp authenticate , ntp authentication-key , ntp broadcast , ntp broadcast client , ntp broadcastdelay , ntp clear drift , ntp clock-period , ntp disable , ntp logging , ntp master , ntp max-associations , ntp multicast , ntp multicast client , ntp server , ntp source , ntp trusted-key , ntp update-calendar .

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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.

- [Finding Feature Information, page 43](#)
- [Restrictions for CPU Thresholding Notification, page 43](#)
- [Information About CPU Thresholding Notification, page 43](#)
- [How to Configure CPU Thresholding Notification, page 44](#)
- [Configuration Examples for CPU Thresholding Notification, page 47](#)
- [Additional References, page 47](#)
- [Feature Information for CPU Thresholding Notification, page 48](#)

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

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

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 44](#)
- [Falling Threshold, page 44](#)

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

- [Enabling CPU Thresholding Notification, page 44](#)
- [Defining CPU Thresholding Notification, page 45](#)
- [Setting the Entry Limit and Size of CPU Utilization Statistics, page 46](#)

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 <code>enable</code> Example: <pre>Router> enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2 <code>configure terminal</code> Example: <pre>Router# configure terminal</pre>	Enables global configuration mode.

Command or Action	Purpose
<p>Step 3 <code>snmp-server enable traps cpu threshold</code></p> <p>Example:</p> <pre>Router(config)# snmp-server enable traps cpu threshold</pre>	Enables CPU thresholding violation notification as traps and inform requests.
<p>Step 4 <code>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]</code></p> <p>Example:</p> <pre>Router(config)# snmp-server host 192.168.0.0 traps public cpu</pre>	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
<p>Step 1 <code>enable</code></p> <p>Example:</p> <pre>Router> enable</pre>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> • Enter your password if prompted.
<p>Step 2 <code>configure terminal</code></p> <p>Example:</p> <pre>Router# configure terminal</pre>	Enters global configuration mode.

Command or Action	Purpose
<p>Step 3 <code>process cpu threshold type {total process interrupt} rising percentage interval seconds [falling percentage interval seconds]</code></p> <p>Example:</p> <pre>Router(config)# process cpu threshold type total rising 80 interval 5 falling 20 interval 5</pre>	<p>Sets the CPU thresholding notifications types and values.</p> <ul style="list-style-type: none"> 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

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

DETAILED STEPS

Command or Action	Purpose
<p>Step 1 <code>enable</code></p> <p>Example:</p> <pre>Router> enable</pre>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> Enter your password if prompted.
<p>Step 2 <code>configure terminal</code></p> <p>Example:</p> <pre>Router# configure terminal</pre>	<p>Enters global configuration mode.</p>
<p>Step 3 <code>process cpu statistics limit entry-percentage number [size seconds]</code></p> <p>Example:</p> <pre>Router(config)# process cpu statistics limit entry-percentage 40 size 300</pre>	<p>Sets the process entry limit and the size of the history table for CPU utilization statistics.</p> <ul style="list-style-type: none"> 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

- [Setting a Rising CPU Thresholding Notification Example, page 47](#)
- [Setting a Falling CPU Thresholding Notification Example, page 47](#)

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	<i>Configuration Fundamentals Command Reference</i>

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

Feature Information for CPU Thresholding Notification

Table 3 **Feature Information for CPU Thresholding Notification**

Feature Name	Releases	Feature Information
CPU Thresholding Notification	12.0(26)S 12.3(4)T 12.2(25)S	<p>The following commands were introduced or modified:</p> <p>process cpu statistics limit entry-percentage, process cpu threshold type, snmp-server enable traps cpu, snmp-server host.</p>

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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.

- [Finding Feature Information, page 51](#)
- [Information About Memory Threshold Notifications, page 51](#)
- [How to Define Memory Threshold Notifications, page 52](#)
- [Configuration Examples for Memory Threshold Notifications, page 54](#)
- [Additional References, page 55](#)
- [Feature Information for Memory Threshold Notifications, page 56](#)

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

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

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 51](#)
- [Memory Reservation, page 52](#)

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

- [Setting a Low Free Memory Threshold, page 52](#)
- [Reserving Memory for Critical Notifications, page 53](#)

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. Do one of the following:
 - **memory free low-watermark processor *threshold***
 - **memory free low-watermark io *threshold***

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.

Command or Action	Purpose
<p>Step 2 <code>configure terminal</code></p> <p>Example:</p> <pre>Router# configure terminal</pre>	<p>Enters global configuration mode.</p>
<p>Step 3 Do one of the following:</p> <ul style="list-style-type: none"> • <code>memory free low-watermark processor <i>threshold</i></code> • <code>memory free low-watermark io <i>threshold</i></code> <p>Example:</p> <pre>Router(config)# memory free low-watermark processor 20000</pre> <p>Example:</p> <pre>Router(config)# memory free low-watermark io 20000</pre>	<p>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:</p> <ul style="list-style-type: none"> • <code>memory free low-watermark processor ?</code> <p>or</p> <ul style="list-style-type: none"> • <code>memory free low-watermark io ?</code>

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 <code>enable</code> Example: <pre>Router> enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> Enter your password if prompted.
Step 2 <code>configure terminal</code> Example: <pre>Router# configure terminal</pre>	Enters global configuration mode.
Step 3 <code>memory reserve critical <i>kilobytes</i></code> Example: <pre>Router(config)# memory reserve critical 1000</pre>	Reserves the specified amount of memory in kilobytes so that the router can issue critical notifications. <ul style="list-style-type: none"> 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 54](#)
- [Reserving Memory for Critical Notifications Example, page 55](#)

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: 20480000
```

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 and Fault Management module

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

Feature Information for Memory Threshold Notifications

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

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

Table 4 *Feature Information for Memory Threshold Notifications*

Feature Name	Releases	Feature Information
Memory Threshold Notifications	12.2(18)S 12.0(26)S 12.3(4)T	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.

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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.

- [Finding Feature Information, page 59](#)
- [Troubleshooting and Fault Management Task List, page 59](#)
- [Displaying System Information Using show Commands, page 60](#)
- [Testing Network Connectivity, page 62](#)
- [Logging System Messages, page 63](#)
- [Using Field Diagnostics on Line Cards, page 69](#)
- [Troubleshooting Specific Line Cards, page 70](#)
- [Storing Line Card Crash Information, page 70](#)
- [Creating Core Dumps for System Exceptions, page 70](#)
- [Enabling Debug Operations, page 76](#)
- [Enabling Conditionally Triggered Debugging, page 77](#)
- [Using the Environmental Monitor, page 81](#)

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

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

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:

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 show EXEC commands. 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.

Command	Purpose
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 [<i>memory-type</i>] [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.
Router# show pci { hardware bridge [<i>register</i>]}	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 [<i>class class</i> name name]	Displays subsystem information.
Router# show tcp [<i>line-number</i>]	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

- [Configuring the TCP Keepalive Packet Service, page 62](#)
- [Testing Connections with the ping Command, page 62](#)
- [Tracing Packet Routes, page 62](#)

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
<code>Router(config)# service {tcp-keepalives-in tcp-keepalives-out}</code>	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
<code>Router# ping [protocol] {host address}</code>	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 [<i>protocol</i>] [<i>destination</i>]	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, page 63](#)
- [Enabling Message Logging for a Slave Card, page 64](#)
- [Setting the Syslog Destination, page 64](#)
- [Configuring Synchronization of Logging Messages, page 64](#)
- [Enabling Time-Stamps on Log Messages, page 65](#)
- [Limiting the Error Message Severity Level and Facilities, page 65](#)
- [Defining the UNIX System Logging Facility, page 67](#)
- [Displaying Logging Information, page 68](#)
- [Logging Errors to a UNIX Syslog Daemon, page 68](#)
- [Setting the Syslog Source Address, page 68](#)

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 reenabling 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, as needed:

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

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 **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.

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

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:

SUMMARY STEPS

1. Router(config)# **line** [aux| console | vty] *beginning-line-number* [*ending-line-number*]
2. Router(config-line)# **logging synchronous** [level *severity-level* | all] [**limit** *number-of-buffers*]

DETAILED STEPS

Command or Action	Purpose
Step 1 Router(config)# line [aux console vty] <i>beginning-line-number</i> [<i>ending-line-number</i>]	Specifies the line to be configured for synchronous logging of messages.
Step 2 Router(config-line)# logging synchronous [level <i>severity-level</i> all] [limit <i>number-of-buffers</i>]	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	Enables log time stamps.
or	
Router(config)# service timestamps log datetime [msec] [localtime] [show-timezone]	

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 the table below for level descriptions). To do so, use the following commands in global configuration mode, as needed:

Command	Purposes
Router(config)# logging console <i>level</i>	Limits the number of messages logged to the console.
Router(config)# logging monitor <i>level</i>	Limits the number of messages logged to the terminal lines.
Router(config)# logging trap <i>level</i>	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 the table above) 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:

SUMMARY STEPS

1. Router(config)# **logging history** *level*
2. Router(config)# **logging history size** *number*

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# logging history <i>level</i>	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 <i>number</i>	Changes the number of syslog messages that can be stored in the history table.



Note

The table below 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. The table below lists the error message *level* keywords and corresponding UNIX syslog definitions in order from the most severe level to the least severe level.

Table 5 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. The table below 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 <i>facility-type</i>	Configures system log facilities.

Table 6 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.

Facility Type Keyword	Description
sys12	Indicates system use.
sys13	Indicates system use.
sys14	Indicates system use.
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 <i>slot-number</i> 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 [Logging Errors to a UNIX Syslog Daemon, page 68](#) for a general description of other keywords. The **local7** keyword specifies the logging facility to be used; see [Logging Errors to a UNIX Syslog Daemon, page 68](#) 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 <i>type number</i>	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 <i>slot-number</i> [previous post verbose wait]	<p>Specifies the line card on which you want to perform diagnostic testing.</p> <p>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:</p> <pre>Running Diags will halt ALL activity on the requested slot. [confirm]</pre> <p>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.</p>

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

Command	Purpose
Router# diag <i>slot-number</i> halt	Specifies the line card on which you want to stop diagnostic testing.
or	
Router# no diag <i>slot-number</i>	



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.

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
<pre>Router(config)# exception linecard {all slot <i>slot-number</i>} [corefile <i>filename</i> main-memory <i>size</i> [k m] queue-ram <i>size</i> [k m] rx-buffer <i>size</i> [k m] sqe-register-rx sqe-register-tx tx-buffer <i>size</i> [k m]]</pre>	<p>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.</p>

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, page 71](#)
- [Creating an Exception Memory Core Dump, page 74](#)

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, page 71](#)
- [Using FTP for Core Dumps, page 72](#)
- [Using rcp for Core Dumps, page 73](#)
- [Using a Flash Disk for Core Dumps, page 74](#)

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:

SUMMARY STEPS

1. **exception protocol tftp**
2. **exception dump *ip-address***
3. **exception core-file *[filepath/]filename***

DETAILED STEPS

Command or Action	Purpose
Step 1 exception protocol tftp Example:	(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.

Command or Action	Purpose
Step 2 <code>exception dump ip-address</code> Example:	Configures the router to dump a core file to the specified server if the router crashes.
Step 3 <code>exception core-file [filepath/]filename</code> Example:	(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:

SUMMARY STEPS

1. Router(config)# **ip ftp username** *username*
2. Router(config)# **ip ftp password**[type] **password**
3. Router(config)# **exception protocol ftp**
4. Router(config)# **exception dump** *ip-address*
5. Router(config)# **exception core-file** *filename*

DETAILED STEPS

Command or Action	Purpose
Step 1 Router(config)# ip ftp username <i>username</i>	(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.

	Command or Action	Purpose
Step 4	Router(config)# exception dump <i>ip-address</i>	Configures the router to dump a core file to a particular server if the router crashes.
Step 5	Router(config)# exception core-file <i>filename</i>	(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:

SUMMARY STEPS

1. **ip rcmd remote-username** *username*
2. **exception protocol rcp**
3. **exception dump** *ip-address*
4. **exception core-file** *filename*

DETAILED STEPS

	Command or Action	Purpose
Step 1	ip rcmd remote-username <i>username</i>	(Optional) Specifies the username sent by the router to the remote server with an rcp copy/write request. The remote rcp server must be 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 <i>ip-address</i> Example:	Configures the router to dump a core file to the specified server if the router crashes.
Step 4	exception core-file <i>filename</i> Example:	(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
<pre>Router(config)# exception flash [procmem iomem all] device-name [: partition-number] [erase no_erase]</pre>	Configures the router for a core dump using a flash disk.
<pre>Router(config)# exception core-file <i>filename</i></pre>	(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
<pre>Router(config)# exception memory minimum <i>bytes</i></pre>	<p>Triggers a core dump and system reload when the amount of free memory falls below the specified number of bytes.</p> <ul style="list-style-type: none"> Do not specify too low a memory value, as the router needs some amount 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.

Command	Purpose
Router(config)# memory check-interval <i>seconds</i>	(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 <i>bytes</i>	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 <i>filename</i>	(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, page 75](#)

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	Specifies the destination for the core dump file.
or	
Router(config)# exception flash	

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

Normally, the messages are displayed only on the console terminal. Refer to the section “[Setting the Syslog Destination, page 64](#)” 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, page 78](#)

- [Enabling Conditional Debugging Commands, page 78](#)
- [Specifying Multiple Debugging Conditions, page 80](#)
- [Conditionally Triggered Debugging Configuration Examples, page 80](#)

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 [<i>condition-id</i>]	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, page 78](#)
- [Displaying Messages for Multiple Interfaces, page 79](#)
- [Limiting the Number of Messages Based on Conditions, page 79](#)

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 <i>interface</i>	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:

SUMMARY STEPS

1. Router# **debug condition interface** *interface*
2. Router# **debug condition interface** *interface*

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router# debug condition interface <i>interface</i>	Enables debugging output for only the specified interface
Step 2	Router# debug condition interface <i>interface</i>	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 <i>username</i> called <i>dial-string</i> caller <i>dial-string</i> }	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:

SUMMARY STEPS

1. Router# **debug condition**{**username** *username* | **called** *dial-string* | **caller** *dial-string*}
2. Router# **debug condition**{**username** *username* | **called** *dial-string* | **caller** *dial-string*}

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router# debug condition { username <i>username</i> called <i>dial-string</i> caller <i>dial-string</i> }	Enables conditional debugging, and specifies the first condition.
Step 2	Router# debug condition { username <i>username</i> called <i>dial-string</i> caller <i>dial-string</i> }	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: Vt1 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: Vt1 Debug: Condition 4, username fred triggered, count 2
*Mar 1 00:04:43.283: Vt1 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: Vt1 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 Vt1
Condition 2: interface Se1 (2 flags triggered)
      Flags: Se1 Vt1
Condition 3: interface Vt1 (2 flags triggered)
      Flags: Vt1 Vt1
Condition 4: username fred (3 flags triggered)
      Flags: Se0 Vt1 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: Vt1 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: Vt1 Debug: Condition 1, interface Se0 cleared, count 2
*Mar 1 00:05:56.899: Vt1 Debug: Condition 3, interface Vt1 cleared, count 1
*Mar 1 00:05:56.899: Vt1 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.

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