Cisco 12000 Series Router SIP and SPA Software Configuration Guide (Cisco IOS)

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Americas Headquarters
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
http://www.cisco.com
Tel: 408 526-4000
800 553-NETS (6387)
Fax: 408 527-0883

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TABLES

Preface

This preface describes the objectives and organization of this document and explains how to find additional information on related products and services. This preface contains the following sections:

Document Change History

Table 1 provides a list of the changes to this document.

Table 1 Document Change History Table

Release No.	Revision	Date	Change Summary
12.0(31)S	Release 12.0(31)S	April 26, 2005	Initial release and 1st publication. Provides Cisco IOS commands and configuration procedures for the following SPAs installed in a Cisco 12000 SIP-400 or a Cisco 12000 SIP-600: • 1-Port 10-Gigabit Ethernet SPA • 5-Port 10 Gigabit Ethernet SPA • 10-Port Gigabit Ethernet SPA • 2-Port and 4-Port Clear Channel T3/E3 SPA • 2-Port and 4-Port Channelized T3 SPA • 1-Port OC-192c/STM-64 POS/RPR SPA
12.0(31)S2	Release 12.0(31)S2	September 22, 2005	Support for the following hardware by the Cisco 12000 SIP-600 was introduced on the Cisco 12000 series router: • 2-Port OC-48c/STM-16 POS SPA

Table 1 Document Change History Table (continued)

Release No.	Revision	Date	Change Summary
12.0(32)S	Release 12.0(32)S	January 20, 2006	Support for the following SPA interface processor (SIP) hardware was introduced on the Cisco 12000 series routers: • Cisco 12000 SIP-401 • Cisco 12000 SIP-501 • Cisco 12000 SIP-601 Support for the following SPAs with the SIP 401/501/601 was introduced on Cisco 12000 series routers: • 1-Port 10-Gigabit Ethernet SPA • 8-Port FastEthernet SPA • 10-Port Gigabit Ethernet SPA Support for the following hardware by the Cisco 12000 SIP-601 was introduced on the Cisco 12000 series router: • 1-Port OC-192c/STM-64 POS/RPR SPA • 1-Port OC-192c/STM-64 POS/RPR XFP SPA Support for the following hardware by the Cisco 12000 SIP-501 and Cisco 12000 SIP-601 was introduced on the Cisco 12000 series router: • 2-Port OC-48c/STM-16 POS SPA
12.0(32)SY	Release 12.0(32)SY	June 26, 2006	Support for the following hardware by the Cisco 12000 SIP-401, Cisco 12000 SIP-501 and Cisco 12000 SIP-601 was introduced on the Cisco 12000 series router: • 8-Port Fast Ethernet SPA (SPA-8X1FE-TX-V2) • 1-Port 10-Gigabit Ethernet SPA (SPA-1X10GE-L-V2) • 2-Port Gigabit Ethernet SPA (SPA-2X1GE-V2) • 5-Port Gigabit Ethernet SPA (SPA-5x1GE-V2) • 10-Port Gigabit Ethernet SPA (SPA-10X1GE-V2) • 2-Port OC-3c/STM-1 and OC-12c/STM-4 POS SPA • 4-Port OC-3c/STM-1 and OC-12c/STM-4 POS SPA • 8-Port OC-3c/STM-1 and OC-12c/STM-4 POS SPA • 4-Port OC-3c/STM-1 POS SPA • 8-Port OC-3c/STM-1 POS SPA

Objectives

This document describes the configuration and troubleshooting of SPA interface processors (SIPs) and shared port adapters (SPAs) that are supported on a Cisco 12000 Series Router.

Organization

This document contains the following chapters:

Chapter	Title	Description
Part 1	Shared Port Adapters	Covers IOS Software and SIP and SPA overview.
Chapter 1	Using Cisco IOS Software	Provides an introduction to accessing the command-line interface (CLI) and using the Cisco IOS Software and related tools.
Chapter 2	SIP and SPA Product Overview	Provides an introduction to modular services cards (SIPs) and shared port adapters (SPAs).
Chapter 3	Overview of the Cisco 12000 Series Router SIPs	Provides an overview of the release history, and feature and Management Information Base (MIB) support for the SIPs supported on the Cisco 12000 Series Routers.
Part 2	Gigabit Ethernet Shared Port Adapters	Covers Gigabit Ethernet SPA Configuration.
Chapter 4	Overview of the Gigabit Ethernet SPAs	Provides an overview of the release history, and feature and Management Information Base (MIB) support for the Gigabit Ethernet SPAs on the Cisco 12000 series router.
Chapter 5	Configuring the Fast Ethernet and Gigabit Ethernet SPAs	Describes how to configure the Gigabit Ethernet SPAs on the Cisco 12000 Series Router.
Chapter 6	Troubleshooting the Gigabit Ethernet SPA	This chapter describes techniques that you can use to troubleshoot the operation of your GigabitEthernet SPAs.
Chapter 7	Command Summary for Gigabit Ethernet SPAs	Provides an alphabetical list of the most significant commands that are needed to configure, monitor, and maintain the Fast Ethernet and Gigabit Ethernet shared port adapter (SPA) cards.
Part 3	Serial Shared Port Adapters	Covers Serial SPAs.
Chapter 8	Overview of the Serial SPAs	Provides an overview of the release history, features, and MIBs for the 2 and 4-Port T3/E3 SPA and the 2 or 4-Port CT3 SPA.
Chapter 9	Configuring the 2-Port and 4-Port Channelized T3 SPA	Provides information about configuring the 2-Port and 4-Port Channelized T3 Shared Port Adapters (SPAs) on the Cisco 12000 series routers.
Chapter 10	Configuring the 2-Port and 4-Port T3/E3 SPAs	Provides information about configuring the 2-Port and 4-Port T3/E3 Shared Port Adapters (SPAs) on the Cisco 12000 Series routers.
Chapter 13	Command Summary for Serial SPAs	Provides an alphabetical list of some of the related commands to configure, monitor, and maintain Serial SPAs.
Part 4	Packet over SONET Shared Port Adapters	Covers POS SPAs.

Chapter	Title	Description
Chapter 14	Chapter 14, "Overview of the POS SPAs"	Provides an overview of the release history, and feature and Management Information Base (MIB) support for the Packet over SONET (POS) SPAs on the Cisco 12000 Series Router.
Chapter 15	Configuring the POS SPAs	Provides information about configuring the Packet over SONET (POS) SPAs on the Cisco 12000 SIP-600 series routers.
Chapter 16	Command Summary for the POS SPAs	Provides an alphabetical list of some of the related commands to configure, monitor, and maintain POS SPAs.
Part 5	Field-Programmable Devices	Covers FPDs.
Chapter 17	Upgrading Field-Programmable Devices	Provides information about upgrading the Field-Programmable Gate Array (FPGA) on the Cisco 12000 Series Router.
Chapter 18	Command Summary for FPDs	Provides an alphabetical list of some of the related commands to configure, monitor, and upgrade FPD images for SPAs on the Cisco 12000 Series Router.
Chapter 19	SIP and SPA Command Reference	Describes Cisco IOS software command reference information including syntax, usage guidelines, and examples for all new and modified commands for SPAs on a Cisco 12000 Series Router.

Related Documentation

This section refers you to other documentation that also might be useful as you configure your Cisco 12000 Series Router. The documentation listed below is available online.

- *Cisco 7600 Series Router SIP, SSC, and SPA Hardware Installation Guide*
- *Cisco 7600 Series Router SIP, SSC, and SPA Software Configuration Guide*
- *Cisco IOS Release Release Notes for Cisco 12000 Series Routers*
- *Regulatory Compliance and Safety Information for Cisco 12000 Series Routerss*

Cisco 12000 Series Router Documentation

As you configure SIPs and SPAs on your Cisco 12000 Series Router, you should also refer to the following companion publication for important hardware installation information:

- *Cisco 7600 Series Router SIP, SSC, and SPA Hardware Installation Guide*

Some of the other Cisco 12000 Series Router publications might be useful to you as you configure your Cisco 12000 Series Router. The following URL provides a wide range of documentation for the various Cisco 12000 Series Routers and their accompanying field replaceable units (FRUs):

http://www.cisco.com/univercd/cc/td/doc/product/core/cis12000/

Several other publications are also related to the Cisco 12000 Series Router. For a complete reference of related documentation, refer to the various roadmap documents located at the following URL:

http://www.cisco.com/univercd/cc/td/doc/product/core/cis12000/roadmap/

Cisco IOS Software Publications

Your router, switch, or gateway and the Cisco IOS software running on it contain extensive features. You can find documentation for Cisco IOS software features at the following URL:

http://www.cisco.com/univercd/cc/td/doc/product/software/

Cisco IOS Release 12.0 S Software Publications

Documentation for Cisco IOS Release 12.0 S, including release notes and system error messages, can be found at the following URL:

http://www.cisco.com/univercd/cc/td/doc/product/software/ios120/

Document Conventions

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

This documentation uses the following conventions:

Convention	Description
^ or Ctrl	The ^ and Ctrl symbols represent the Control key. For example, the key combination ^D or Ctrl-D means hold down the Control key while you press the D key. Keys are indicated in capital letters but are not case sensitive.
string	A string is a nonquoted set of characters shown in italics. For example, when setting an SNMP *community* string to *public*, do not use quotation marks around the string or the string will include the quotation marks.

Command syntax descriptions use the following conventions:

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

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

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

Examples use the following conventions:

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

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

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

Note Means *reader take note*. Notes contain helpful suggestions or references to materials not contained in this manual.

Obtaining Documentation

Obtaining Documentation

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

Cisco.com

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

http://www.cisco.com/techsupport

You can access the Cisco website at this URL:

http://www.cisco.com

You can access international Cisco websites at this URL:

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

Product Documentation DVD

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

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

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

Cisco Ordering tool:

http://www.cisco.com/en/US/partner/ordering/

Cisco Marketplace:

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

Ordering Documentation

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

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

Cisco will continue to support documentation orders using the Ordering tool:

- Registered Cisco.com users (Cisco direct customers) can order documentation from the Ordering tool:

  http://www.cisco.com/en/US/partner/ordering/

- Instructions for ordering documentation using the Ordering tool are at this URL:

  http://www.cisco.com/univercd/cc/td/doc/es_inpck/pdi.htm

- Nonregistered Cisco.com users can order documentation through a local account representative by calling Cisco Systems Corporate Headquarters (California, USA) at 408 526-7208 or, elsewhere in North America, by calling 1 800 553-NETS (6387).

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

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

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

We appreciate your comments.

Cisco Product Security Overview

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

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

From this site, you can perform these tasks:

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

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

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

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

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

Reporting Security Problems in Cisco Products

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

- Emergencies—security-alert@cisco.com

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

- Nonemergencies—psirt@cisco.com

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

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

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

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

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

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

Obtaining Technical Assistance

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

Cisco Technical Support & Documentation Website

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

http://www.cisco.com/techsupport

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

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

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

Submitting a Service Request

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

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

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

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

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

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

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

Definitions of Service Request Severity

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

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

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

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

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

Obtaining Additional Publications and Information

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

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

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

- *Cisco Press* publishes a wide range of general networking, training and certification titles. Both new and experienced users will benefit from these publications. For current Cisco Press titles and other information, go to Cisco Press at this URL:

  http://www.ciscopress.com

- *Packet* magazine is the Cisco Systems technical user magazine for maximizing Internet and networking investments. Each quarter, Packet delivers coverage of the latest industry trends, technology breakthroughs, and Cisco products and solutions, as well as network deployment and troubleshooting tips, configuration examples, customer case studies, certification and training information, and links to scores of in-depth online resources. You can access Packet magazine at this URL:

  http://www.cisco.com/packet

- *iQ Magazine* is the quarterly publication from Cisco Systems designed to help growing companies learn how they can use technology to increase revenue, streamline their business, and expand services. The publication identifies the challenges facing these companies and the technologies to help solve them, using real-world case studies and business strategies to help readers make sound technology investment decisions. You can access iQ Magazine at this URL:

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

  or view the digital edition at this URL:

  http://ciscoiq.texterity.com/ciscoiq/sample/

- *Internet Protocol Journal* is a quarterly journal published by Cisco Systems for engineering professionals involved in designing, developing, and operating public and private internets and intranets. You can access the Internet Protocol Journal at this URL:

  http://www.cisco.com/ipj

- Networking products offered by Cisco Systems, as well as customer support services, can be obtained at this URL:

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

- Networking Professionals Connection is an interactive website for networking professionals to share questions, suggestions, and information about networking products and technologies with Cisco experts and other networking professionals. Join a discussion at this URL:

  http://www.cisco.com/discuss/networking

- World-class networking training is available from Cisco. You can view current offerings at this URL:

  http://www.cisco.com/en/US/learning/index.html

PART 1

Shared Port Adapters

CHAPTER 1

Using Cisco IOS Software

This chapter provides useful information as you prepare to configure a shared port adapter (SPA) using the Cisco IOS software. It includes the following sections:

Accessing the CLI Using a Router Console

This section describes how to access the command-line interface (CLI) using a directly-connected console or by using Telnet to obtain a remote console:

For more detailed information about configuring and accessing a router through various services, refer to the *Cisco IOS Terminal Services Configuration Guide* and *Cisco IOS Terminal Services Command Reference* publications.

For more information about making the console cable connections, refer to the *Cisco 7600 Series Router SIP, SSC, and SPA Hardware Installation Guide*.

Accessing the CLI Using a Directly-Connected Console

This section describes how to connect to the console port on the router and use the console interface to access the CLI.

Connecting to the Console Port

Before you can use the console interface on the router using a terminal or PC, perform the following steps:

Step 1 Configure your terminal emulation software with the following settings:

- 9600 bits per second (bps)
- 8 data bits
- No parity
- 2 stop bits

Note These are the default serial communication parameters on the router. For information about how to change those defaults to meet the requirements of your terminal or host, refer to the *Cisco IOS Terminal Services Configuration Guide*.

Step 2 Connect a terminal or PC to the console port using a rollover cable.

To make this connection, attach one end of an RJ-45 to RJ-45 rollover cable to the router console port. Attach the other end of the cable to an ASCII terminal or a PC running terminal emulation software. The ASCII terminal or PC port might require an RJ-45-to-DB-9 or an RJ-45-to-DB-25 adapter.

Using the Console Interface

To access the CLI using the console interface, complete the following steps:

Step 1 After you attach the terminal hardware to the console port on the router (and have configured your terminal emulation software with the proper settings), the following prompt appears:

```
Press Return for Console prompt
```

Step 2 Press **Return** to enter user EXEC configuration mode. The following prompt appears:

```
Router>
```

Step 3 From user EXEC configuration mode, enter the **enable** command as shown in the following example:

```
Router> enable
```

Step 4 At the password prompt, enter your system's password. The following example shows entry of the password called "enablepass":

```
Password: <enablepass>
```

Step 5 When the enable password is accepted, the privileged EXEC configuration mode prompt appears:

```
Router#
```

Step 6 You now have access to the CLI in privileged EXEC configuration mode and you can enter the necessary commands to complete your desired tasks.

Step 7 To exit the console session, enter the **quit** command as shown in the following example:

```
Router# quit
```

Accessing the CLI from a Remote Console Using Telnet

This section describes how to connect to the console interface on a router using Telnet to access the CLI.

Preparing to Connect to the Router Console Using Telnet

Before you can access the router remotely using Telnet from a TCP/IP network, you need to configure the router to support virtual terminal lines (vtys) using the **line vty** global configuration command. You also should configure the vty lines to require login and specify a password.

Note To prevent disabling login on the line, be careful that you specify a password with the **password** command when you configure the **login** line configuration command. If you are using authentication, authorization, and accounting (AAA), you should configure the **login authentication** line configuration command. To prevent disabling login on the line for AAA authentication when you configure a list with the **login authentication** command, then you must also configure that list using the **aaa authentication login** global configuration command. For more information about AAA services, refer to the *Cisco IOS Security Configuration Guide* and *Cisco IOS Security Command Reference* publications.

In addition, before you can make a Telnet connection to the router you must have a valid host name for the router, or have an IP address configured on the router. For more information about requirements for connecting to the router using Telnet, information about customizing your Telnet services, and using Telnet key sequences, refer to the *Cisco IOS Terminal Services Configuration Guide.*

Using Telnet to Access a Console Interface

To access a console interface using Telnet, complete the following steps:

Step 1 From your terminal or PC, enter one of the following commands:

- **connect** *host* [*port*] [*keyword*]
- **telnet** *host* [*port*] [*keyword*]

where *host* is the router host name or an IP address, *port* is a decimal port number (23 is the default), and *keyword* is a supported keyword. For more information, refer to the *Cisco IOS Terminal Services Command Reference*.

Note If you are using an access server, then you also will need to specify a valid port number with the host name or IP address, such as **telnet 172.20.52.40 2003**.

The following example shows the telnet command to connect to the router named Router:

```
unix_host% telnet Router
Trying 172.20.52.40...
Connected to 172.20.52.40.
Escape character is '^]'.
unix_host% connect
```

Step 2 At the password prompt, enter your login password. The following example shows entry of the password called “mypass”:

```
User Access Verification

Password: <mypass>
```

Note If no password has been configured, press **Return**.

Step 3 From user EXEC configuration mode, enter the **enable** command as shown in the following example:

```
Router> enable
```

Step 4 When the enable password is accepted, the privileged EXEC configuration mode prompt appears:

```
Router#
```

Step 5 You now have access to the CLI in privileged EXEC configuration mode and you can enter the necessary commands to complete your desired tasks.

Step 6 To exit the Telnet session, use the **exit** or **logout** command as shown in the following example:

```
Router# logout
```

Accessing the CLI From a Remote Console Using a Modem

To access the router remotely using a modem through an asynchronous connection, you need to configure the AUX port and attach a modem to it.

For more information about making a modem connection using the AUX port on the Cisco 12000 Series Router, refer to the *Cisco 12000 Series Router Shared Port Adapter Hardware Installation Guide*.

For detailed guidelines on making a connection to the router using a modem, and using reverse Telnet, refer to *Configuring a Modem on the AUX Port for EXEC Dialin Connectivity* located at the following URL:

http://www.cisco.com/warp/public/471/mod-aux-exec.html

Using Keyboard Shortcuts

Commands are not case sensitive. You can abbreviate commands and parameters if the abbreviations contain enough letters to be different from any other currently available commands or parameters. You can scroll through the last 20 commands stored in the history buffer, and enter or edit the command at the prompt.

Table 1-1 lists the keyboard shortcuts for entering and editing commands.

Table 1-1 Keyboard Shortcuts

Keystrokes	Purpose
Press **Ctrl-B** or press the left arrow key[1]	Move the cursor back one character
Press **Ctrl-F** or press the right arrow key[1]	Move the cursor forward one character
Press **Ctrl-A**	Move the cursor to the beginning of the command line
Press **Ctrl-E**	Move the cursor to the end of the command line
Press **Esc B**	Move the cursor back one word
Press **Esc F**	Move the cursor forward one word

1. The arrow keys function only on ANSI-compatible terminals such as VT100s.

Using the History Buffer to Recall Commands

The history buffer stores the last 20 commands you entered. History substitution allows you to access these commands without retyping them, by using special abbreviated commands.

Table 1-2 lists the history substitution commands.

Table 1-2 History Substitution Commands

Command	Purpose
Ctrl-P or the up arrow key.[1]	Recall commands in the history buffer, beginning with the most recent command. Repeat the key sequence to recall successively older commands.
Ctrl-N or the down arrow key.[1]	Return to more recent commands in the history buffer after recalling commands with Ctrl-P or the up arrow key. Repeat the key sequence to recall successively more recent commands.
`Router# show history`	While in EXEC mode, list the last several commands you have just entered.

1. The arrow keys function only on ANSI-compatible terminals such as VT100s.

Understanding Command Modes

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

When you log in to the CLI, you are in user EXEC mode. User EXEC mode contains only a limited subset of commands. To have access to all commands, you must enter privileged EXEC mode, normally by using a password. From privileged EXEC mode you can issue any EXEC command—user or privileged mode—or you can enter global configuration mode. Most EXEC commands are one-time commands. For example, **show** commands show important status information, and **clear** commands clear counters or interfaces. The EXEC commands are not saved when the software reboots.

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

ROM monitor mode is a separate mode used when the Cisco IOS software cannot load properly. If a valid software image is not found when the software boots or if the configuration file is corrupted at startup, the software might enter ROM monitor mode.

Table 1-3 describes how to access and exit various common command modes of the Cisco IOS software. It also shows examples of the prompts displayed for each mode.

Table 1-3 Accessing and Exiting Command Modes

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

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

Getting Help

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

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

Command	Purpose
help	Provides a brief description of the help system in any command mode.
*abbreviated-command-entry***?**	Provides a list of commands that begin with a particular character string. (No space between command and question mark.)
abbreviated-command-entry<**Tab**>	Completes a partial command name.
?	Lists all commands available for a particular command mode.
command **?**	Lists the keywords or arguments that you must enter next on the command line. (Space between command and question mark.)

Example: How to Find Command Options

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

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

Table 1-4 shows examples of how you can use the question mark (**?**) to assist you in entering commands. The table steps you through configuring an IP address on a serial interface on a Cisco 7206 router that is running Cisco IOS Release 12.0(3).

Table 1-4 How to Find Command Options

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

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

`Router(config)#` **`interface serial ?`**
`  <0-6>     Serial interface number`
`Router(config)#` **`interface serial 4 ?`**
`  /`
`Router(config)#` **`interface serial 4/ ?`**
`  <0-3>     Serial interface number`
`Router(config)#` **`interface serial 4/0 ?`**
`<cr>`
`Router(config)#` **`interface serial 4/0`**
`Router(config-if)#`
	Enter interface configuration mode by specifying the serial interface that you want to configure using the **interface serial** global configuration command.
	Enter **?** to display what you must enter next on the command line. In this example, you must enter the serial interface slot number and port number, separated by a forward slash.
	When the <cr> symbol is displayed, you can press **Enter** to complete the command.
	You are in interface configuration mode when the prompt changes to `Router(config-if)#`.

Table 1-4 How to Find Command Options (continued)

<table>
<tr><th>Command</th><th>Comment</th></tr>
<tr><td><pre>Router(config-if)# ?
Interface configuration commands:
  .
  .
  .
  ip   Interface Internet Protocol config commands
  keepalive   Enable keepalive
  lan-name   LAN Name command
  llc2   LLC2 Interface Subcommands
  load-interval   Specify interval for load calculation for an
                      interface
  locaddr-priority   Assign a priority group
  logging   Configure logging for interface
  loopback   Configure internal loopback on an interface
  mac-address   Manually set interface MAC address
  mls   mls router sub/interface commands
  mpoa   MPOA interface configuration commands
  mtu   Set the interface Maximum Transmission Unit (MTU)
  netbios   Use a defined NETBIOS access list or enable
                      name-caching
  no   Negate a command or set its defaults
  nrzi-encoding   Enable use of NRZI encoding
  ntp   Configure NTP
  .
  .
  .
Router(config-if)#</pre></td><td>Enter ? to display a list of all the interface configuration commands available for the serial interface. This example shows only some of the available interface configuration commands.</td></tr>
<tr><td><pre>Router(config-if)# ip ?
Interface IP configuration subcommands:
  access-group   Specify access control for packets
  accounting   Enable IP accounting on this interface
  address   Set the IP address of an interface
  authentication   authentication subcommands
  bandwidth-percent   Set EIGRP bandwidth limit
  broadcast-address   Set the broadcast address of an interface
  cgmp   Enable/disable CGMP
  directed-broadcast Enable forwarding of directed broadcasts
  dvmrp   DVMRP interface commands
  hello-interval   Configures IP-EIGRP hello interval
  helper-address   Specify a destination address for UDP broadcasts
  hold-time   Configures IP-EIGRP hold time
  .
  .
  .
Router(config-if)# ip</pre></td><td>Enter the command that you want to configure for the interface. This example uses the ip command.

Enter ? to display what you must enter next on the command line. This example shows only some of the available interface IP configuration commands.</td></tr>
</table>

Table 1-4 How to Find Command Options (continued)

Command	Comment
Router(config-if)# **ip address ?** A.B.C.D IP address negotiated IP Address negotiated over PPP Router(config-if)# **ip address**	Enter the command that you want to configure for the interface. This example uses the **ip address** command. Enter **?** to display what you must enter next on the command line. In this example, you must enter an IP address or the **negotiated** keyword. A carriage return (<cr>) is not displayed; therefore, you must enter additional keywords or arguments to complete the command.
Router(config-if)# **ip address 172.16.0.1 ?** A.B.C.D IP subnet mask Router(config-if)# **ip address 172.16.0.1**	Enter the keyword or argument that you want to use. This example uses the 172.16.0.1 IP address. Enter **?** to display what you must enter next on the command line. In this example, you must enter an IP subnet mask. A <cr> is not displayed; therefore, you must enter additional keywords or arguments to complete the command.
Router(config-if)# **ip address 172.16.0.1 255.255.255.0 ?** secondary Make this IP address a secondary address <cr> Router(config-if)# **ip address 172.16.0.1 255.255.255.0**	Enter the IP subnet mask. This example uses the 255.255.255.0 IP subnet mask. Enter **?** to display what you must enter next on the command line. In this example, you can enter the **secondary** keyword, or you can press **Enter**. A <cr> is displayed; you can press **Enter** to complete the command, or you can enter another keyword.
Router(config-if)# **ip address 172.16.0.1 255.255.255.0** Router(config-if)#	In this example, Enter is pressed to complete the command.

Using the no and default Forms of Commands

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

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

Saving Configuration Changes

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

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

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

```
[OK]
Router#
```

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

Filtering Output from the show and more Commands

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

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

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

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

```
Router# show interface | include protocol

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

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

Finding Support Information for Platforms and Cisco IOS Software Images

Cisco IOS software is packaged in feature sets consisting of software images that support specific platforms. The feature sets available for a specific platform depend on which Cisco IOS software images are included in a release. To identify the set of software images available in a specific release or to find out if a feature is available in a given Cisco IOS software image, you can use Cisco Feature Navigator or the software release notes.

Using Cisco Feature Navigator

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

Using Software Advisor

To see if a feature is supported by a Cisco IOS release, to locate the software document for that feature, or to check the minimum software requirements of Cisco IOS software with the hardware installed on your router, Cisco maintains the Software Advisor tool on Cisco.com at
http://www.cisco.com/cgi-bin/Support/CompNav/Index.pl

You must be a registered user on Cisco.com to access this tool.

Using Software Release Notes

Cisco IOS software releases include release notes that provide the following information:

- Platform support information
- Memory recommendations
- New feature information
- Open and resolved severity 1 and 2 caveats for all platforms

Release notes are intended to be release-specific for the most current release, and the information provided in these documents may not be cumulative in providing information about features that first appeared in previous releases. Refer to Cisco Feature Navigator for cumulative feature information.

CHAPTER 2

SIP and SPA Product Overview

This chapter provides an introduction to modular services cards (SIPs) and shared port adapters (SPAs). It includes the following sections:

- Introduction to SIPs and SPAs, page 2-1
- SPA Optics Compatibility, page 2-3
- SIP and SPA Compatibility, page 2-4

For more hardware details for the specific SIP and SPAs that are supported on the Cisco 12000 series router, refer to the companion publication, *Cisco 7600 Series Router SIP, SSC, and SPA Hardware Installation Guide*.

Introduction to SIPs and SPAs

SIPs and SPAs are a new carrier card and port adapter architecture to increase modularity, flexibility, and density across Cisco Systems routers for network connectivity. This section describes the SIPs and SPAs and provides some guidelines for their use.

SPA Interface Processors

The following list describes some of the general characteristics of a SIP:

- A SIP is a carrier card that inserts into a router slot like a line card. It provides no network connectivity on its own.
- A SIP can contain two or more subslots, which are used to house one or more SPAs. The SPA provides interface ports for network connectivity.
- During normal operation the SIP should reside in the router fully populated either with functional SPAs in all subslots, or with a blank filler panel inserted in any empty subslots.
- SIPs support online insertion and removal (OIR) while SPAs are inserted in their subslots.

Shared Port Adapters

The following list describes some of the general characteristics of a SPA:

- A SPA is a modular type of port adapter that inserts into a subslot of a compatible SIP carrier card to provide network connectivity and increased interface port density. A SIP can hold one or more SPAs, depending on the SIP type.
- SPAs are available in the following sizes, as shown in Figure 2-1 and Figure 2-2:
  - Single-height SPA—Inserts into a single SIP subslot.
  - Double-height SPA—Inserts into two single, vertically aligned SIP subslots.

Figure 2-1 Single-height and Double-height SPA Sizes

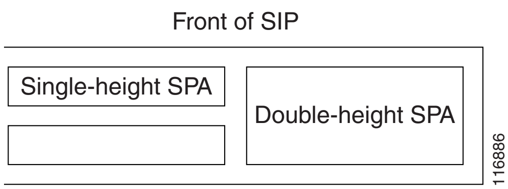
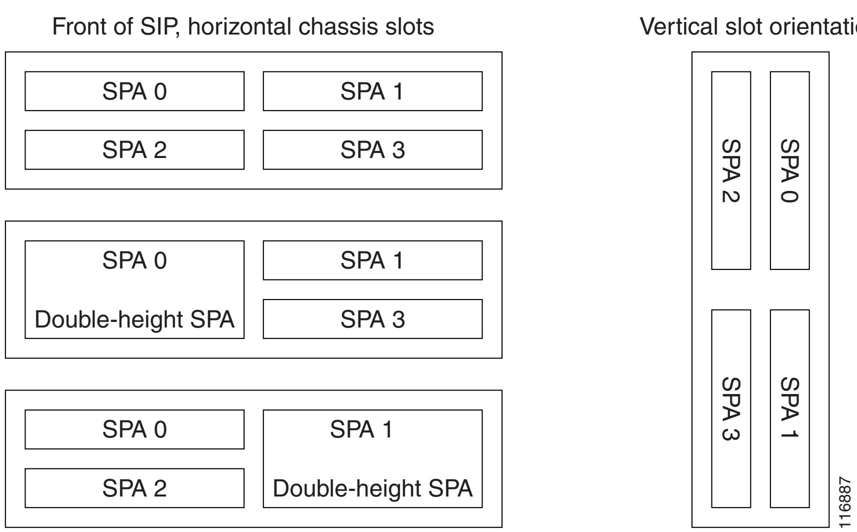


Figure 2-2 Horizontal and Vertical Chassis Slot Orientation for SPAs



- Each SPA provides a certain number of connectors, or ports, that are the interfaces to one or more networks. These interfaces can be individually configured within the Cisco IOS command-line interface (CLI).
- Either a blank filler panel or a functional SPA should reside in every subslot of an SIP during normal operation.
- SPAs support online insertion and removal (OIR). They can be inserted or removed independently from the SIP. OIR of a SIP with installed SPAs is also supported.

SFP and XFP Optics Modules

For more detailed information about the SFP and XFP optics modules, please refer to applicable SPA section in the *Cisco 7600 Series Router SIP, SSC, and SPA Hardware Installation Guide*.

Table 2-1 shows the SFP Modules and their descriptions.

Table 2-1 SFP Modules

SPA	SFP Module Product Number	SFP Module	Description
5-Port Gigabit Ethernet SPA	SFP-GE-S	Short wavelength (1000BASE-SX)	Contains a Class 1 laser of 850 nm for 1000BASE-SX (short wavelength) applications.
5-Port Gigabit Ethernet SPA	SFP-GE-L	Long wavelength/long haul (1000BASE-LX/LH)	Contains a Class 1 laser of 1310 nm for 1000BASE-LX/LH (long wavelength) applications.
5-Port Gigabit Ethernet SPA	SFP-GE-Z	Extended distance (1000BASE-ZX)	Contains a Class 1 laser of 1550 nm for 1000BASE-ZX (extended wavelength) applications.
1-Port 10-Gigabit Ethernet SPA	XFP-10GLR	XFP-10GLR-OC192SR	Contains a Class 1 laser of 1310 nm for 1000BASE-LX/LH (long wavelength) applications.
1-Port 10-Gigabit Ethernet SPA	XFP-10GER	XFP-10GER-OC192IR	Contains a Class 1 laser of 1550 nm for 1000BASE-ZX (extended wavelength) applications.

SPA Optics Compatibility

Table 2-2 shows the types of optics modules that have been qualified for use with a SPA:

Table 2-2 SPA Optics Compatibility

SPA	Qualified Optics Modules
2-Port T3/E3 Serial SPA	None.
4-Port Clear Channel T3/E3 SPA	None.
2-Port Channelized T3 SPA	None.
4-Port Channelized T3 SPA	None.
1-Port 10-Gigabit Ethernet SPA	XFP-10GLR-OC192SR XFP-10GER-OC192IR
5-Port Gigabit Ethernet SPA	SFP-GE-S SFP-GE-L SFP-GE-Z
10-Port Gigabit Ethernet SPA	SFP-GE-S SFP-GE-L SFP-GE-Z

Table 2-2 SPA Optics Compatibility (continued)

SPA	Qualified Optics Modules
1-Port OC-192c/STM-64 POS/RPR SPA	None.
2-Port OC48-POS/RPR SPA	SFP-OC48-SR OC48/STM16c SFP, Short Reach SFP-OC48-IR1 OC48/ STM16c SFP, Intermediate Reach SFP-OC48-LR2 OC48/STM16c SFP, Long Reach (80km)
2-Port, 4-Port, and 8-Port OC-3c/STM-1 and OC-12c/STM-4 POS SPA	SFP-OC3-SR OC3c/STM1 SFP, Short Reach SFP-OC3-IR1 OC3c/STM1 SFP, Intermediate Reach SFP-OC3-LR2 OC3c/STM1 SFP, Long Reach (80km) SFP-OC12-SR OC12c/STM4 SFP, Short Reach SFP-OC12-IR1 OC12c/STM4 SFP, Intermediate Reach SFP-OC12-LR2 OC12c/STM4 SFP, Long Reach (80km)

SIP and SPA Compatibility

Table 2-3 shows the SIPs that are supported in the Cisco 12000 Series Router and the SPAs that each SIP supports:

Table 2-3 SIP and SPA Compatibility on the Cisco 12000 Series Router

	SIP Type		SIP Type		
SPA	2.5G ISE SIP 400	10G SIP 600	2.5G SIP 401	5G SIP 501	10G SIP 601
2-Port T3/E3 Serial SPA	X		X	X	X
4-Port Clear Channel T3/E3 SPA	X		X	X	X
2-Port Channelized T3 SPA	X		X	X	X
4-Port Channelized T3 SPA	X		X	X	X
8-Port Fast Ethernet SPA			X	X	X
1-Port 10-Gigabit Ethernet SPA		X			X
5-Port Gigabit Ethernet SPA		X		X	X
10-Port Gigabit Ethernet SPA		X			X
1-Port OC-192c/STM-64 POS/RPR SPA		X			X
2-Port OC48-POS/RPR SPA		X		X	X
2-Port, 4-Port, and 8-Port OC-3c/STM-1 and OC-12c/STM-4 POS SPA			X	X	X

CHAPTER 3

Overview of the Cisco 12000 Series Router SIPs

This chapter provides an overview of the release history, and feature and Management Information Base (MIB) support for the SIPs supported on the Cisco 12000 Series Routers.

This chapter includes the following sections:

Release History

Release	Modification
Cisco IOS Release 12.0(31)S	Support for the following SPA interface processor (SIP) hardware was introduced on the Cisco 12000 series routers: • Cisco 12000 SIP-400 • Cisco 12000 SIP-600
Cisco IOS Release 12.0(32)S	Support for the following SPA interface processor (SIP) hardware was introduced on the Cisco 12000 series routers: • Cisco 12000 SIP-401 • Cisco 12000 SIP-501 • Cisco 12000 SIP-601

Supported Features

This section provides a list of some of the primary features supported by the SIP hardware and software.

Cisco 12000 SIP-401, Cisco 12000 SIP-501, Cisco 12000 SIP-600, and Cisco 12000 SIP-601 Features

The Cisco 12000 SIP-401, Cisco 12000 SIP-501, Cisco 12000 SIP-600, and Cisco 12000 SIP-601 provide a common 10 Gbps forwarding and queuing engine responsible for packet classification, forwarding, queuing, and accounting without compromising performance. The Cisco 12000 SIP-401, Cisco 12000 SIP-501, Cisco 12000 SIP-600, and Cisco 12000 SIP-601 have two forwarding engines, one for ingress and one for egress. This allows the user to implement different features and QoS policies for the ingress and egress interfaces. The multicast replication is done by the egress forwarding engine, hence a very scalable multicast with built-in QoS.

The Modular Physical Layer Interface Module (PLIM) front end hosts up to 2 SPAs. Each SPA has a dedicated 10 Gbps interface to the SPA controller. The SPA controller uses a fair bandwidth allocation algorithm to share available and excess bandwidth between the 2 SPAs. The oversubscribed SPA does not cause any packet-drop on the nonoversubscribed SPA, and any unused bandwidth from one SPA is used by the other SPA.

The Cisco 12000 SIP-401, Cisco 12000 SIP-501, Cisco 12000 SIP-600, and Cisco 12000 SIP-601 support any combination of the following pluggable SPAs and Layer 2 encapsulations:

- Concatenated OC-192 and OC-48
- Gigabit Ethernet and 10 Gigabit Ethernet Interfaces
- Point to Point Protocol (PPP)
- High Level Data Link Control (HDLC)
- Frame Relay
- Dynamic Packet Transport (DPT)
- Resilient Packet Ring (RPR)
- 802.17
- VLANs

The SPA controller adapts the user traffic flowing between the SPA interfaces for the Layer 3 forwarding engine. The SPA controller has two levels of priority queuing with Deficit Round Robin (DRR) and Strict Priority Servicing. Strict Priority Servicing protects higher-priority packets by dropping lower priority packets first, in an oversubscribed configuration (persistent incoming traffic rate of 20 Gbps.)

The Cisco 12000 SIP-401, Cisco 12000 SIP-501, Cisco 12000 SIP-600, and Cisco 12000 SIP-601 provide the following key features:

- Dynamic allocation of 4096 input-shaped queues to any interface, subinterface, Frame Relay connection, VLAN.
- Ingress Queuing:
  - 2048 unicast Modified DRR (MDRR) queues
  - 16 high priority queues
  - 8 multicast queues
  - 2 fabric priority queues
- Egress Queuing:
  - 8192 Modified DRR (MDRR) queues dynamically shared across 4096 interfaces;
  - Hierarchical shaping (interface, queue)

- High number of IPv4, IPv6, Multiprotocol Label Switching (MPLS), and MPLS VKPN unicast and multicast routes: Up to 1M IPv4/MPLS routes and up to 512,000 IPv6 prefixes.
- Per-VLAN/source-destination MAC address filtering, trunking, accounting, QoS, match VLAN QoS, Hot Standby Router Protocol (HSRP)/Virtual Router Redundancy Protocol (VRRP) hierarchical rate limiting and policing, dynamic queuing, and traffic shaping.
- Input and output full NetFlow Version 8 in hardware.
- Input and output Sampled NetFlow, Versions 5, 8, and 9 in hardware.
- Building Integrated Timing Supply (BITS)
- Online Insertion Removal (OIR) of SPAs; OIR of one SPA does not effect the traffic on other SPA interfaces.
- Multi-router Automatic Protection Switching (MR-APS)
- Layer 2 VPNs over MPLS (Any transport over MPLS (AToM)) and Over IP Layer 2 Tunneling Protocol Version 3 (L2TPv3)

The Cisco 12000 SIP-401, Cisco 12000 SIP-501, and Cisco 12000 SIP-601 provide the following key features not available on the Cisco 12000 SIP-400 and Cisco 12000 SIP-600:

- Finer control over power supply voltages

  The 12.0(32)S release allows you to specify the percentage of voltage increase. If you don’t specify a percentage, the value used is the default percentage, which is 5%.

  The output is enhanced to show nominal supply voltage, percentage margin, and actual read-back voltage, to validate that the expected values were written and actually applied successfully.

Note High speed SPAs are only supported in bay 0 and 1 in routers with the Cisco 12000 SIP-401, Cisco 12000 SIP-501, or Cisco 12000 SIP-601 SIP installed.

Cisco 12000 SIP-400 Features

The Cisco 12000 SIP-400 is a 2.5 Gbps IP Services Engine (ISE) SIP that hosts SPAs used for applications that require a high level of performance, scalable physical and logical connections, and high-touch QoS and security features. The Cisco 12000 SIP-400 enhances and scales functionality with benefits previously available on the 2.5 G ISE line card, allowing carriers to offer services such as VoIP, MPLS VPN, Internet Access, and Low-speed Leased Line Aggregation (DS3, E3, CT3, n x T1, and n x DS0).

The Cisco 12000 SIP-400 provides a common 10 Gbps forwarding and queuing engine that handles packet classification, forwarding, queuing, and accounting without compromising performance. The forwarding engine, based on the 12000 Series ISE technology, features a unique edge-optimized, programmable adaptive network processor that combines the hardware performance of Application-Specific Integrated Circuits (ASICs) with the flexibility of software.

The Modular Physical Layer Interface Module (PLIM) front end hosts up to 4 SPAs. Each SPA has a dedicated 2.5 Gbps interface to the SPA controller. The Cisco 12000 SIP-400 supports any combination of the following pluggable SPAs and Layer 2 encapsulation:

- T3
- E3
- CT3

- PPP/HDLC/FR
- MLPPP
- MLFR

The SPA controller adapts the traffic flowing between the SPA interfaces for the Layer 3 forwarding engine. The SPA controller has two levels of priority queuing with Deficit Round Robin (DRR) and Strict Priority Servicing. Strict Priority Servicing protects high priority traffic.

Key Features

The Cisco 12000 SIP-400 provides the following key features and benefits:

- QoS
- Provider Edge
- Security
- Accounting
- High Availability

QoS

Traffic Shaping

Traffic Shaping offers additional value to service providers that want to build tiered service models. With traffic shaping, the Cisco 12000 SIP-400 can absorb bursts of traffic in both the ingress and egress directions. The Cisco 12000 SIP-400 supports up to 2048 input shaped queues and up to 1024 output shaped queues dynamically allocated to any interface or subinterface. Traffic can be shaped down to 64 kbps.

Traffic Rate Limiting and Marking

Traffic Rate Limiting and Marking, using Committed Access Rate (CAR) or Modular QoS CLI (MQC), allows service providers to control access to internal network resources. These features can be used to protect against Denial of Service (DoS) attacks or to deliver tiered services.

Traffic Prioritization through MDRR with Low Latency Queuing (LLQ)

Traffic Prioritization through MDRR with Low Latency Queuing (LLQ) offers class-based packet queuing that controls the packet dequeuing process to assure transit latency for differentiated flows. The Cisco 12000 SIP-400 supports the following queues:

- 2048 unicast MDRR queues
- 16 high priority queues
- 1 multicast queue in the ingress direction
- 4096 MDRR queues dynamically shared across 1024 interfaces in the egress direction

Congestion Control through WRED and Query Management

Congestion Control through WRED and Query Management allows selective discard of low-priority flows before dropping packets from higher-priority flows.

Provider Edge

The Cisco 12000 SIP-400 provides the following comprehensive MPLS capabilities that support the development of service-optimized networks and can accelerate migration from circuit-based networks to packet-based networks:

- Layer 2 VPNs over MPLS (any transport over MPLS) and over IP (L2TPv3)
- Layer 3 VPNs over MPLS and over IP, Multicast VPNs
- Multilink Point-to-point Protocol (MLPPP)
- Multilink Frame Relay (MLFR)
- Link Fragmentation And Interleaving (LFI) over Frame Relay
- IPv6 Unicast/Multicast
- 6PE

Security

Access Control Lists (ACLs) and Unicast Reverse Packet Check (uRPF) provide security and access control by checking and filtering unwanted packets on specific interfaces. With ACLs, filtering can be done on source and destination IP addresses, transport protocols, and input and output interfaces.

Accounting

ISE accounting tools provide data for end-customer billing and network utilization monitoring. The Cisco 12000 SIP-400 provides the following accounting tools:

- Input and output Full Netflow v8 in Hardware
- Input and output Sampled NetFlow v5/v8/v9 in Hardware
- BGP Policy accounting per interface, protocol, or Class of Service account

High Availability

The Cisco 12000 SIP-400 supports Online Insertion Removal (OIR) of SPAs; OIR of one SPA does not effect the traffic on other SPA interfaces.

The Cisco 12000 SIP-400 also supports Layer 3 NSF/SSO.

Supported MIBs

The following MIBs are supported in Cisco IOS Release 12.0(32)S for the Cisco 12000 SIP-600 on a Cisco 12000 series router:

- IPv6 MIB

- ICMPv6 MIB
- IPv6 TCP MIB
- IPv6 UDP MIB
- SNMP v1, v2c, v3 (RFC 1157, 1901-07)
- MIB II, including interface extensions (RFC 1213, 2011-13, 2233)
- Cisco GSR Manager
- CiscoView
- ifIndex persistence
- 64-bit counters
- APS Extensions MIB
- ATM CON MIB
- ATM Forum Address MIB
- ATM Forum MIB
- ATM MIB
- BGP-4 MIB
- CAR MIB
- Cisco AAL5 MIB
- Cisco APS MIB
- Cisco ATM Extensions MIB
- Cisco BGP Policy Accounting MIB
- Cisco Bulk File MIB
- Cisco CAR MIB
- Cisco CDP MIB
- Cisco Class-Based QoS MIB) aka MQC MIB)
- Cisco Config Copy MIB
- Cisco Config Man MIB
- Cisco Enhanced MemPool MIB
- Cisco EnvMon MIB
- Cisco Flash MIB
- Cisco Frame Relay MIB
- Cisco FRU MIB
- Cisco FTP Client MIB
- Cisco HSRP Extensions MIB
- Cisco HSRP MIB
- Cisco IETF ATM2 PVCTRAP MIB
- Cisco Image MIB
- Cisco IP Statistics MIB
- Cisco IP Mroute MIB

- Cisco MDRR MIB
- Cisco Memory Pool MIN
- Cisco Optical Monitoring MIB
- Cisco PIM MIB
- Cisco Ping MIB
- Cisco Process MIB
- Cisco Queue MIB
- Cisco RTT Monitor MIB (SAA)
- Cisco SRP MIB
- Cisco Syslog MIB
- Cisco TCP MIB
- Cisco VLAN IFTABLE Relationship MIB
- Cisco WRED MIB
- DPT MIB
- DS1/E1 MIB
- DS3/E3 MIB
- Entity MIB
- Entity II MIB
- Ethernet MIB
- Ethernet RMON MIB
- Ether-like MIB
- Event MIB
- Expression MIB
- Fabric MIB
- Frame Relay MIB (IETF)
- Frame Relay DTE MIB
- HSRP MIB
- IF MIB
- IF MIB for VLANs
- IGMP MIB
- Interfaces MIB
- Int-Serv MIB
- Int-Serv Guaranteed MIB
- IP Mroute MIB
- MPLS MIB
- MPLS LDP MIB
- MPLS LSR MIB
- MPLS-TE MIB

- MPLS-TE Topo MIB
- MPLS-VPN MIB
- MPLS-DE-TE MIB
- MQC MIB
- MSDP MIB
- Old Cisco Chassis MIB
- Old Cisco CPU MIB
- Old Cisco Interfaces MIB
- Old Cisco IP MIB
- Old Cisco Memory MIB
- Old Cisco System MIB
- Old Cisco TCP MIB
- Old Cisco TS MIB
- OSPFv2 MIB
- PIM MIB
- PSA Microcode MIB
- RFC1213 MIB
- RFC1253 MIB
- RFC1315 MIB
- RFC1406 MIB
- RFC1407 MIB
- RFC1398 MIB
- RFC1595 MIB
- RMON MIB
- RS232C MIB
- RSVP MIB
- SNMP Framework MIB
- SNMP Target MIB
- SNMP USM MIB
- SNMP VACM MIB
- SNMPv2 MIB
- SNMP v3 MIB
- SONET/SDH MIB
- SONET Traps
- Syslog Trap Alert on DLCI loss
- TCP MIB
- UDP MIB
- WRED 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

If Cisco MIB Locator does not support the MIB information that you need, you can also obtain a list of supported MIBs and download MIBs from the Cisco MIBs page at the following URL:

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

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

http://www.cisco.com/register

Displaying the SPA Hardware Type

To verify the SPA hardware type that is installed in your Cisco 12000 Series Router, you can use the **show gsr** command.

Table 3-1 shows the hardware description that appears in the **show** command output for each type of SPA that is supported on the Cisco 12000 Series Router.

Table 3-1 SPA Hardware Descriptions in show Commands

SPA	Description in show gsr Command
2-Port T3/E3 Serial SPA	SPA-2XT3/E3
4-Port T3/E3 Serial SPA	SPA-4XT3/E3
1-Port Channelized OC-3/STM-1 SPA	SPA-1XCOC3
8-Port Channelized T1/E1 SPA	SPA-8XCT1/E1
2-Port Clear Channel T3/E3 SPA	SPA-2XT3/E3
2-Port and 4-Port Clear Channel T3/E3 SPA	SPA-4XT3/E3
2-Port Channelized T3 SPA	SPA-2XCT3/DS0
4-Port Channelized T3 to DS0 SPA	SPA-4XCT3/DS0
8-Port FastEthernet SPA	SPA-8XFE, SPA-8x1FE-TX-V2
2-Port Gigabit Ethernet SPA	SPA-2XGE, SPA-2X1GE-V2
5-Port Gigabit Ethernet SPA	SPA-5XGE, SPA-5x1GE-V2
1-Port 10-Gigabit Ethernet SPA	SPA-1XTENGE-XFP, SPA-1X10GE-L-V2
10-Port Gigabit Ethernet SPA	SPA-10XGE-XFP, SPA-10X1GE-V2
1-Port OC-192c/STM-64 POS SPA	SPA-OC192POS
2-Port OC48-POS/RPR SPA	SPA-2XOC48POS
2-Port OC-3c/STM-1 and OC-12c/STM-4 POS SPA	SPA-2XOC12-POS
4-Port OC-3c/STM-1 and OC-12c/STM-4 POS SPA	SPA-4XOC12-POS

Table 3-1 SPA Hardware Descriptions in show Commands (continued)

SPA	Description in show gsr Command
8-Port OC-3c/STM-1 and OC-12c/STM-4 POS SPA	SPA-8XOC12-POS
4-Port OC-3c/STM-1 POS SPA	SPA-4XOC3-POS
8-Port OC-3c/STM-1 POS SPA	SPA-8XOC3-POS

Example of the show gsr Command

The following example shows output from the **show gsr** command on a Cisco 12000 Series Router with a Cisco 12000 SIP-400 installed in slot 1 and a Cisco 12000 SIP-600 installed in slot 3:

```
Router# show gsr
hdm-193#show gsr
Slot 0  type  = ISE 2.5G SPA Interface Card
        state = IOS RUN   Line Card Enabled
        subslot 0/0: SPA-4XT3/E3 (0x40B), status is ok
        subslot 0/1: SPA-4XT3/E3 (0x40B), status is ok
        subslot 0/2: SPA-4XT3/E3 (0x40B), status is ok
        subslot 0/3: SPA-2XCT3/DS0 (0x43C), status is ok
Slot 1  type  = ISE 2.5G SPA Interface Card
        state = IOS RUN   Line Card Enabled
        subslot 1/0: SPA-4XT3/E3 (0x40B), status is ok
        subslot 1/1: SPA-2XT3/E3 (0x40C), status is ok
        subslot 1/2: SPA-4XT3/E3 (0x40B), status is ok
        subslot 1/3: SPA-2XT3/E3 (0x40C), status is ok
Slot 2  type  = ISE 2.5G SPA Interface Card
        state = IOS RUN   Line Card Enabled
        subslot 2/0: SPA-4XT3/E3 (0x40B), status is ok
        subslot 2/1: SPA-4XT3/E3 (0x40B), status is ok
        subslot 2/2: SPA-2XT3/E3 (0x40C), status is ok
        subslot 2/3: SPA-4XT3/E3 (0x40B), status is ok
Slot 3  type  = ISE 2.5G SPA Interface Card
        state = IOS RUN   Line Card Enabled
        subslot 3/0: SPA-4XT3/E3 (0x40B), status is out of service
        subslot 3/1: SPA-4XT3/E3 (0x40B), status is ok
        subslot 3/2: Empty
        subslot 3/3: Empty
Slot 4  type  = ISE 2.5G SPA Interface Card
        state = IOS RUN   Line Card Enabled
        subslot 4/0: Empty
        subslot 4/1: Empty
        subslot 4/2: Empty
        subslot 4/3: Empty
Slot 9  type  = Performance Route Processor
        state = ACTV RP   IOS Running  ACTIVE
Slot 16 type  = Clock Scheduler Card(10) OC-192
        state = Card Powered
Slot 17 type  = Clock Scheduler Card(10) OC-192
        state = Card Powered  PRIMARY CLOCK
Slot 18 type  = Switch Fabric Card(10) OC-192
        state = Card Powered
Slot 19 type  = Switch Fabric Card(10) OC-192
        state = Card Powered
Slot 20 type  = Switch Fabric Card(10) OC-192
        state = Card Powered
Slot 21 type  = Switch Fabric Card(10) OC-192
        state = Card Powered
```

```
Slot 22 type  = Switch Fabric Card(10) OC-192
        state = Card Powered
Slot 24 type  = Alarm Module(10)
        state = Card Powered
Slot 25 type  = Alarm Module(10)
        state = Card Powered
Slot 29 type  = Blower Module(16)
        state = Card Powered
```

Part 2

Gigabit Ethernet Shared Port Adapters

CHAPTER 4

Overview of the Gigabit Ethernet SPAs

This chapter provides an overview of the release history, and feature and Management Information Base (MIB) support for the Gigabit Ethernet SPAs on the Cisco 12000 series router.

This chapter includes the following sections:

Release History

Table 4-1 provides the release and modification history for Ethernet SPA-related features and enhancements on the Cisco 12000 series router.

Table 4-1 Release Historyfor Ethernet SPAs

Release	Modification
Cisco IOS Release 12.0(31)S	Support for the following SPAs was introduced on Cisco 12000 series routers: • 1-Port 10-Gigabit Ethernet SPA • 5-Port Gigabit Ethernet SPA • 10-Port Gigabit Ethernet SPA
Cisco IOS Release 12.0(32)S	Support for the following SPAs with the SIP 401/501/601 was introduced on Cisco 12000 series routers: • 1-Port 10-Gigabit Ethernet SPA • 8-Port FastEthernet SPA • 10-Port Gigabit Ethernet SPA

Cisco IOS Release 12.0(32)SY	Support for the following SPAs with the SIP 401/501/601 was introduced on Cisco 12000 series routers: • 1-Port 10-Gigabit Ethernet SPA Version 2 • 8-Port FastEthernet SPA Version 2 • 5-Port Gigabit Ethernet SPA Version 2 • 10-Port Gigabit Ethernet SPA Version 2
Cisco IOS Release 12.0(32)SY4	Support for the following SPA with the SIP 401/501/601 was introduced on Cisco 12000 series routers: • 2-Port Gigabit Ethernet SPA Version 2

Supported Features

This section provides a list of some of the primary features supported with the Gigabit Ethernet.

Gigabit Ethernet SPA Features

The following is a list of some of the significant hardware and software features supported by the Gigabit Ethernet SPAs on the Cisco 12000 series routers:

- Auto negotiation
- Full-duplex operation
- 802.1Q VLAN termination
- Jumbo frames support (9188 bytes)
- Support for command-line interface (CLI) controlled OIR
- 802.3x flow control
- Up to 4K VLAN per SPA
- Up to 5K Mac Accounting Entries per SPA (Source Mac Accounting on the ingress and Destination Mac Accounting on the egress)
- Up to 2K MAC address entries for destination MAC address filtering per SPA, and up to 1K MAC address filtering entries per port
- Per port byte and packet counters for policy drops, oversubscription drops, CRC error drops, packet sizes, Unicast, multicast, and broadcast packets
- Per VLAN byte and packet counters for policy drops, oversubscription drops, Unicast, multicast, and broadcast packets
- Per-port byte counters for good bytes and dropped bytes
- Ethernet over Multi-protocol Label Switching (EoMPLS)
- Quality of service (QoS)
- Hot Standby Router Protocol (HSRP)
- Virtual Router Redundancy Protocol (VRRP)

Supported MIBs

The following MIBs are supported by the Gigabit Ethernet SPAs on the Cisco 12000 series routers:

- Entity-MIB (RFC 2737)
- Cisco-entity-asset-MIB
- Cisco-entity-field-replaceable unit (FRU)-control-MIB
- Cisco-entity-alarm-MIB
- Cisco-entity-sensor-MIB
- IF-MIB
- Etherlike-MIB (RFC 2665)
- Remote Monitoring (RMON)-MIB (RFC 1757)
- Cisco-class-based-QoS-MIB
- MPLS-related MIBs
- Ethernet MIB/RMON

To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL:

http://tools.cisco.com/ITDIT/MIBS/servlet/index

If Cisco MIB Locator does not support the MIB information that you need, you can also obtain a list of supported MIBs and download MIBs from the Cisco MIBs page at the following URL:

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

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

http://www.cisco.com/register

SPA Architecture

This section provides an overview of the architecture of the Gigabit Ethernet SPAs and describes the path of a packet in the ingress and egress directions. Some of these areas of the architecture are referenced in the SPA software and can be helpful to understand when troubleshooting or interpreting some of the SPA CLI and **show** command output.

Every incoming and outgoing packet on the Gigabit Ethernet SPAs goes through the physical (PHY) SFP optics, Media Access Control (MAC), and ASIC devices.

Path of a Packet in the Ingress Direction

The following steps describe the path of an ingress packet through the Gigabit Ethernet SPAs:

1. The PHY SFP optics device receives incoming frames on a per-port basis from one of the laser optic interface connectors.
2. The PHY laser optics device processes the frame and sends it over the XAUI path to the MAC device.
3. The MAC device receives the frame, strips the CRCs, and sends the packet via the SPI 4.2 bus to the ASIC.
4. The ASIC takes the packet from the MAC devices and classifies the ethernet information. CAM lookups based on etype, port, VLAN, and source and destination address information determine whether the packet is dropped or forwarded to the SPA interface. If the packet is forwarded to the SPA interface, an 8-byte SHIM header that is used for additional downstream packet processing is prepended to the packet.

Path of a Packet in the Egress Direction

The following steps describe the path of an egress packet from the SIP through the Gigabit Ethernet SPA:

1. The packet is sent to the ASIC using the SPI 4.2 Bus. The packets are received with layer 2 and layer 3 headers in addition to the packet data.
2. The ASIC uses port number, destination MAC address, destination address type, and VLAN ID to perform parallel CAM lookups. If the packet is forwarded, it is forwarded via the SPI 4.2 Bus to the MAC device.
3. The MAC device forwards the packets to the PHY laser optic interface, which transmits the packet.

Displaying the SPA Hardware Type

To verify the SPA hardware type that is installed in your Cisco 12000 series router, you can use the **show interfaces** command. For more information about these commands, see Chapter 19, "SIP and SPA Command Reference."

Table 4-2 shows the hardware description that appears in the **show** command output for each type of Gigabit Ethernet SPA that is supported on Cisco 12000 series routers.

Table 4-2 SPA Hardware Descriptions in show Commands

SPA	Description in show interfaces and show controllers commands
1-Port 10-Gigabit Ethernet SPA	Hardware is GigMac 1 Port 10 GigabitEthernet
5-Port Gigabit Ethernet SPA	Hardware is FiveGigE
10-Port Gigabit Ethernet SPA	Hardware is TenGigE

Example of the show interfaces Command

The following example shows output from the **show interfaces fastethernet** command on a Cisco 12000 series router with a 1-Port 10-Gigabit Ethernet SPA installed in slot 3:

```
Router# show interfaces gigabitethernet 3/0/0
GigabitEthernet3/0/0 is up, line protocol is up
  Hardware is GigMac 1 Port 10 GigabitEthernet, address is 0008.7db3.8dfe (bia )
  Internet address is 10.0.0.2/24
  MTU 1500 bytes, BW 10000000 Kbit, DLY 10 usec, rely 255/255, load 1/255
  Encapsulation ARPA, loopback not set
.
.
.
```

CHAPTER 5

Configuring the Fast Ethernet and Gigabit Ethernet SPAs

This chapter provides information about configuring the Cisco 1-port 10 Gigabit Ethernet SPA, 5-Port Gigabit Ethernet SPA, 8-Port Fast Ethernet SPA,and Cisco 10-port Gigabit Ethernet SPA on Cisco 12000 series routers. It includes the following sections:

For information about managing your system images and configuration files, refer to the *Cisco IOS Configuration Fundamentals Configuration Guide, Release 12.0* and *Cisco IOS Configuration Fundamentals Command Reference, Release 12.0* publications.

For more information about the commands used in this chapter, first see Chapter 19, "SIP and SPA Command Reference," which documents new and modified commands. Also refer to the related Cisco IOS Release 12.0 software command reference and master index publications. For more information about accessing these publications, see the "Related Documentation" section on page -xviii.

Configuration Tasks

This section describes how to configure the Cisco 1-port 10 Gigabit Ethernet SPA, 5-Port Gigabit Ethernet SPA, 8-Port Fast Ethernet, and the Cisco 10-port Gigabit Ethernet SPA and includes information about verifying the configuration.

This section includes the following topics:

Required Configuration Tasks

This section lists the required configuration steps to configure the Gigabit Ethernet SPAs. Some of the required configuration commands implement default values that might be appropriate for your network. If the default value is correct for your network, then you do not need to configure the command. These commands are indicated by "(As Required)" in the purpose column.

Required Configuration Tasks for the Fast Ethernet SPA

To configure the 8-Port Fast Ethernet SPA, complete the following steps:

	Command	Purpose
Step 1	Router# **configure terminal**	Enters global configuration mode.
Step 2	Router(config)# **interface fastethernet** *slot/subslot/port*[**.***subinterface-number*]	Specifies the Fast Ethernet interface to configure, where: • *slot/subslot/port*—Specifies the location of the interface. See the "Specifying the Interface Address" section on page 5-4. • **.***subinterface-number*—(Optional) Specifies a secondary interface (subinterface) number.
Step 3	Router(config-if)# **ip address** *ip-address mask* [**secondary**]	Sets a primary or secondary IP address for an interface, where: • *ip-address*—Specifies the IP address for the interface. • *mask*—Specifies the mask for the associated IP subnet. • **secondary**—(Optional) Specifies that the configured address is a secondary IP address. If this keyword is omitted, the configured address is the primary IP address.
Step 4	Router(config-if)# **duplex** {**full** | **half**}	(As Required) Configures the duplex operation on an interface. The default is **full**.
Step 5	Router(config-if)# **speed** {**10** | **100**}	(As Required) Configures the speed of an interface (Mbps).
Step 6	Router(config-if)# **mtu** *bytes*	(As Required) Specifies the maximum packet size for an interface, where: • *bytes*—Specifies the maximum number of bytes for a packet. The default is 1500 bytes.
Step 7	Router(config-if)# **no shutdown**	Enables the interface.

Required Configuration Tasks for the Gigabit Ethernet SPA

To configure the Cisco 1-port 10 Gigabit Ethernet SPA, 5-Port Gigabit Ethernet SPA, and Cisco 10-port Gigabit Ethernet SPA, complete the following steps:

	Command	Purpose
Step 1	Router# **configure terminal**	Enters global configuration mode.
Step 2	Router(config)# **interface gigabitethernet** *slot/subslot/port*[**.***subinterface-number*] or Router(config)# **interface tengigabitethernet** *slot/subslot/port*[**.***subinterface-number*]	Specifies the Gigabit Ethernet or Ten Gigabit Ethernet interface to configure, where: • *slot/subslot/port*—Specifies the location of the interface. See the "Specifying the Interface Address" section on page 5-4. • **.***subinterface-number*—(Optional) Specifies a secondary interface (subinterface) number.
Step 3	Router(config-if)# **ip address** *ip-address mask* [**secondary**]	For IPv4: Sets a primary or secondary IP address for an interface that is using IPv4, where: • *ip-address*—Specifies the IP address for the interface. • *mask*—Specifies the mask for the associated IP subnet. • **secondary**—(Optional) Specifies that the configured address is a secondary IP address. If this keyword is omitted, the configured address is the primary IP address.
Step 4	Router(config)# **ip accounting mac-address** {**input** | **output**}	(Optional) Enables MAC address accounting. MAC address accounting provides accounting information for IP traffic based on the source and destination MAC addresses of the LAN interfaces, where: • **input**—specifies MAC address accounting for traffic entering the interface. • **output**—specifies MAC address accounting for traffic leaving the interface.
Step 5	Router(config-if)# **mtu** *bytes*	(As Required) Specifies the maximum packet size for an interface, where: • *bytes*—Specifies the maximum number of bytes for a packet. The default is 1500 bytes.

	Command	Purpose
Step 6	Router(config-if)# **standby** [*group-number*] **ip** [*ip-address* [**secondary**]]	(Required for HSRP Configuration Only) Creates (or enables) the HSRP group using its number and virtual IP address. • (Optional) *group-number*—The group number on the interface for which HSRP is being enabled. The range is 0 to 255; the default is 0. If there is only one HSRP group, you do not need to enter a group number. • (Optional on all but one interface if configuring HSRP) *ip-address*—The virtual IP address of the hot standby router interface. You must enter the virtual IP address for at least one of the interfaces; it can be learned on the other interfaces. • (Optional) **secondary**—The IP address is a secondary hot standby router interface. If neither router is designated as a secondary or standby router and no priorities are set, the primary IP addresses are compared and the higher IP address is the active router, with the next highest as the standby router. This command enables HSRP but does not configure it further. For additional information on configuring HSRP, see the "*Configuring Hot Standby Routing Protocol*" section of the *Cisco IOS Release 12.2 IP Configuration Guide*.
Step 7	Router(config-if)# **no shutdown**	Enables the interface.

Specifying the Interface Address

The interface address format when using SPAs is *slot*/*subslot*/*port*:

- *slot*—Specifies the slot number in the Cisco 12000 series router in which the SIP that contains the SPA is installed.
- *subslot*—Specifies the secondary slot on the MSC where the SPA that you want to select is installed.
- *port*—Specifies the interface number that you want to select on the SPA:
  - For the Cisco 1-port 10 Gigabit Ethernet SPA, 0 is the only option.
  - For the 5-Port Gigabit Ethernet SPA, 0 through 4 are the options.
  - For the 8-Port Fast Ethernet SPA, 0 through 7 are the options.
  - For the Cisco 10-port Gigabit Ethernet SPA, 0 through 9 are the options.

Figure 5-1 shows the slot, subslot, and interface port locations of the Cisco 10-port Gigabit Ethernet SPA on a Cisco 12000 series router.

Figure 5-1 Slot, Subslot, and Port Locations for the Cisco 10-port Gigabit Ethernet SPA and the 1-Port 10-Gigabit Ethernet SPA.

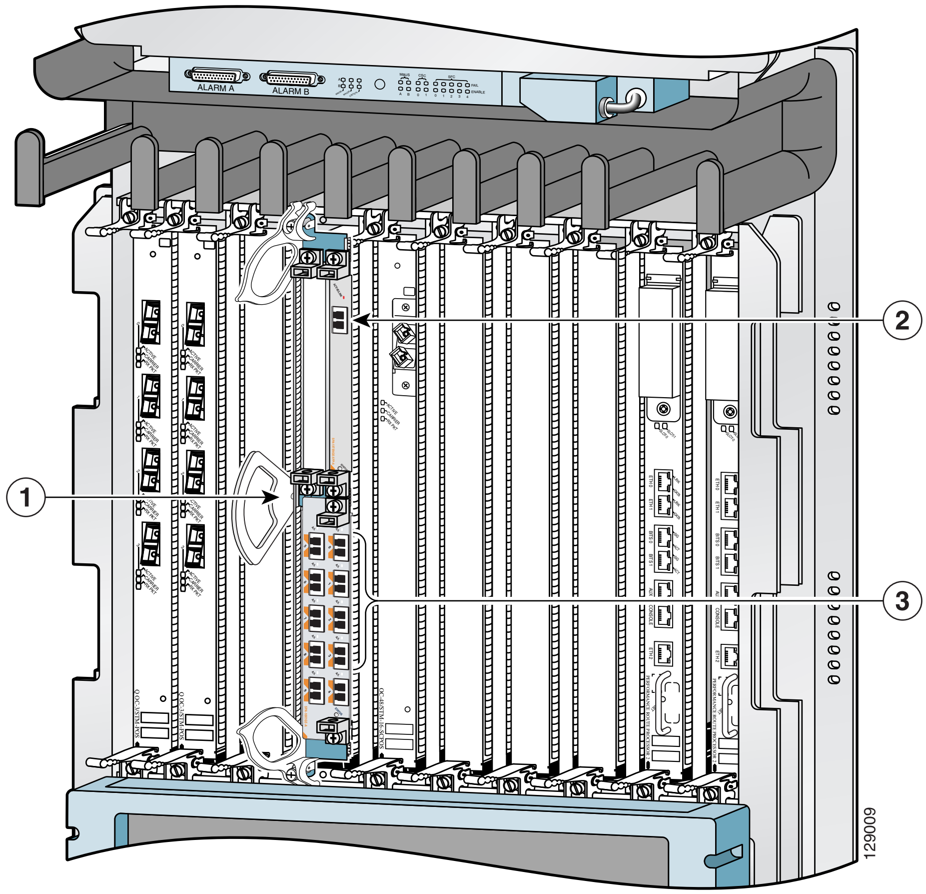


Table 5-1 Slot and Port Locations for the Gigabit Ethernet SPAs

Call Out Number	Description
1	Slot 3
2	Subslot 0, Port 3/0/0
3	Subslot 1, Ports 3/1/0 to 3/1/9

For more information about the installation of cards on the Cisco 12000 router, refer to the *Cisco 12000 SIP and SPA Hardware Installation Guide*.

Modifying the MAC Address on the Interface

The Fast Ethernet and Gigabit Ethernet SPAs use a default MAC address for each port that is derived from the base address that is stored in the electrically erasable programmable read-only memory (EEPROM) on the backplane of the Cisco 12000 series router.

To modify the default MAC address of an interface to some user-defined address, use the following command in interface configuration mode:

Command	Purpose
Router(config-if)# **mac-address** *ieee-address*	Modifies the default MAC address of an interface to some user-defined address, where: • *ieee-address*—Specifies the 48-bit Institute of Electrical and Electronics Engineers (IEEE) MAC address written as a dotted triple of four-digit hexadecimal numbers (*xxxx.yyyy.zzzz*).

To return to the default MAC address on the interface, use the **no** form of the command.

Verifying the MAC Address

To verify the MAC address of an interface, use the **show interfaces gigabitethernet** privileged EXEC command and observe the value shown in the "address is" field.

The following example shows that the MAC address is 0008.7db3.8dfe for interface 0 on the SPA installed in slot 3 of the Cisco 12000 series router:

```
Router# show interfaces gigabitethernet 3/0/0
GigabitEthernet3/0/0 is up, line protocol is up
  Hardware is GigMac 1 Port 10 GigabitEthernet, address is 0008.7db3.8dfe (bia )
  Internet address is 10.0.0.2/24
  MTU 1500 bytes, BW 10000000 Kbit, DLY 10 usec, rely 255/255, load 1/255
  Encapsulation ARPA, loopback not set
.
.
.
```

Gathering MAC Address Accounting Statistics

The **ip accounting mac-address** [**input** | **output**] command can be entered to enable MAC Address Accounting on an interface.

After enabling MAC Address Accounting, MAC address statistics can be gathered by entering the **show interface mac** command.

Configuring HSRP

Hot Standby Router Protocol (HSRP) is available for Fast Ethernet and Gigabit Ethernet SPAs. HSRP provides high network availability because it routes IP traffic from hosts without relying on the availability of any single router. HSRP is used in a group of routers for selecting an active router and a standby router. (An active router is the router of choice for routing packets; a standby router is a router that takes over the routing duties when an active router fails, or when preset conditions are met).

HSRP is enabled on an interface by entering the **standby** [*group-number*] **ip** [*ip-address* [**secondary**]] command. The **standby** command is also used to configure various HSRP elements. This document does not discuss more complex HSRP configurations. For additional information on configuring HSRP, see the *Configuring Hot Standby Routing Protocol* section of the *Cisco IOS Release 12.2 IP Configuration Guide*.

In the following HSRP configuration, standby group 2 on GigabitEthernet port 2/1/0 is configured at a priority of 110 and is also configured to have a preemptive delay should a switchover to this port occur.

```
Router(config)# interface GigabitEthernet 2/1/0
Router(config-if)# standby 2 ip 120.12.1.200
Router(config-if)# standby 2 priority 110
Router(config-if)# standby 2 preempt
```

Modifying the Interface MTU Size

The Cisco IOS software supports three different types of configurable maximum transmission unit (MTU) options at different levels of the protocol stack:

- Interface MTU—Checked by the SPA on traffic coming in from the network. Different interface types support different interface MTU sizes and defaults. The interface MTU defines the maximum packet size allowable (in bytes) for an interface before drops occur. If the frame is smaller than the interface MTU size, but is not smaller than the minimum frame size for the interface type (such as 64 bytes for Ethernet), then the frame continues to process.
- IP MTU—Can be configured on a subinterface and is used by the Cisco IOS software to determine whether fragmentation of a packet takes place. If an IP packet exceeds the IP MTU size, then the packet is fragmented.
- Tag or Multiprotocol Label Switching (MPLS) MTU—Can be configured on a subinterface and allows up to six different labels, or tag headers, to be attached to a packet. The maximum number of labels is dependent on your Cisco IOS software release.

Different encapsulation methods and the number of MPLS MTU labels add additional overhead to a packet. For example, Subnetwork Access Protocol (SNAP) encapsulation adds an 8-byte header, dot1q encapsulation adds a 2-byte header, and each MPLS label adds a 4-byte header (*n* labels x 4 bytes).

For the Fast Ethernet and Gigabit Ethernet SPAs on the Cisco 12000 series router, the default MTU size is 1500 bytes. The maximum configurable MTU is 9216 bytes. The SPA automatically adds an additional 38 bytes to the configured MTU size to accommodate some of the additional overhead.

Interface MTU Configuration Guidelines

When configuring the interface MTU size on a Fast Ethernet or Gigabit Ethernet SPA on a Cisco 12000 series router, consider the following guidelines:

- The default interface MTU size accommodates a 1500-byte packet, plus 38 additional bytes to cover the following additional overhead:
  - Layer 2 header—14 bytes
  - SNAP header—8 bytes
  - Dot1q header—4 bytes
  - 2 MPLS labels—8 bytes
  - CRC—4 bytes

Note Depending on your Cisco IOS software release, a certain maximum number of MPLS labels are supported. If you need to support more than two MPLS labels, then you should increase the default interface MTU size on the SPA interface.

- If you are using MPLS, be sure that the **mpls mtu** command is configured for a value less than or equal to the interface MTU.
- If you are using MPLS labels, then you should increase the default interface MTU size to accommodate the number of MPLS labels. Each MPLS label adds 4 bytes of overhead to a packet.

Interface MTU Configuration Task

To modify the MTU size on an interface, use the following command in interface configuration mode:

Command	Purpose
Router(config-if)# **mtu** *bytes*	Configures the maximum packet size for an interface, where: • *bytes*—Specifies the maximum number of bytes for a packet. The default is 1500 bytes.

To return to the default MTU size, use the **no** form of the command.

Verifying the MTU Size

To verify the MTU size for an interface, use the **show interfaces fastethernet** or **show interfaces gigabitethernet**, or **show interfaces tengigabitethernet** privileged EXEC command and observe the value shown in the "MTU" field.

The following example shows an MTU size of 1500 bytes for interface port 0 (the first port) on the Gigabit Ethernet SPA installed in the top subslot (0) of the MSC that is located in slot 3 of the Cisco 12000 series router:

```
Router# show interfaces gigabitethernet 3/0/0
GigabitEthernet3/0/0 is up, line protocol is up
  Hardware is GigMac 1 Port 10 GigabitEthernet, address is 0008.7db3.8dfe (bia )
  Internet address is 10.0.0.2/24
  MTU 1500 bytes, BW 10000000 Kbit, DLY 10 usec, rely 255/255, load 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  Full Duplex, 10000Mbps, link type is autonegotiation, media type is T
  output flow-control is on, input flow-control is on
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 00:00:01, output 00:00:01, output hang never
  Last clearing of "show interface" counters never
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
        Available Bandwidth 10000000 kilobits/sec
  30 second input rate 0 bits/sec, 0 packets/sec
  30 second output rate 0 bits/sec, 0 packets/sec
     11 packets input, 1154 bytes, 0 no buffer
     Received 1 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
     0 watchdog, 0 multicast, 0 pause input
     67 packets output, 20951 bytes, 0 underruns
     0 output errors, 0 collisions, 1 interface resets
     0 babbles, 0 late collision, 0 deferred
     0 lost carrier, 0 no carrier, 0 pause output
     0 output buffer failures, 0 output buffers swapped out
```

Configuring the Encapsulation Type

By default, the interfaces on the Cisco 1-port 10 Gigabit Ethernet SPA, 5-Port Gigabit Ethernet SPA,8-Port Fast Ethernet SPA, and Cisco 10-port Gigabit Ethernet SPA support Advanced Research Projects Agency (ARPA) encapsulation. They do not support configuration of service access point (SAP) or SNAP encapsulation for transmission of frames; however, the interfaces will properly receive frames that use SAP and SNAP encapsulation.

The only other encapsulation supported by the SPA interfaces is IEEE 802.1Q encapsulation for virtual LANs (VLANs).

Configuring Autonegotiation on an Interface

Ethernet interfaces use a connection-setup algorithm called *autonegotiation.* Autonegotiation allows the local and remote devices to configure compatible settings for communication over the link. Using autonegotiation, each device advertises its transmission capabilities and then agrees upon the settings to be used for the link.

For the Fast Ethernet and Gigabit Ethernet interfaces on the Cisco 12000 series router, flow control is autonegotiated when autonegotiation is enabled. For the 10 Gigabit Ethernet interfaces, autonegotiation is not an option.

The following guidelines should be followed regarding autonegotiation:

- If autonegotiation is disabled on one end of a link, it has to be disabled on the other end of the link. If one end of a link has autonegotiation disabled while the other end of the link does not, the link will not come up properly on both ends.
- Flow control is enabled by default.
- Flow control will be on if autonegotiation is disabled on both ends of the link.

Disabling Autonegotiation

Autonegotiation is automatically enabled. During autonegotiation, advertisement for flow control is advertised. If the Fast Ethernet or Gigabit Ethernet interface is connected to a link that has autonegotiation disabled, autonegotiation should either be re-enabled on the other end of the link or disabled on the Fast Ethernet or Gigabit Ethernet SPA. Both ends of the link will not come up properly if only one end of the link has disabled autonegotiation.

To disable autonegotiation on a Fast Ethernet or Gigabit Ethernet interface, use the following command in interface configuration mode:

Command	Purpose
Router(config-if)# **no negotiation auto**	Disables autonegotiation on Gigabit Ethernet SPA interfaces. No advertisement of flow control occurs.

Enabling Autonegotiation

Autonegotiation is automatically enabled. During autonegotiation, advertisement and configuration of flow control occurs. To re-enable autonegotiation on a Fast Ethernet or Gigabit Ethernet interface, use the following command in interface configuration mode:

Command	Purpose
Router(config-if)# **negotiation auto**	Enables autonegotiation on Gigabit Ethernet SPA interfaces. Advertisement of flow control occurs.

Configuring a Subinterface on a VLAN

You can configure subinterfaces on the Cisco 1-port 10 Gigabit Ethernet SPA, 5-Port Gigabit Ethernet SPA, 8-Port Fast Ethernet SPA, and Cisco 10-port Gigabit Ethernet SPA on a VLAN using IEEE 802.1Q encapsulation.

Note The Cisco 10-port Gigabit Ethernet SPA does not support Inter-Switch Link (ISL) encapsulation.

To configure a SPA subinterface on a VLAN, use the following commands beginning in interface configuration mode:

	Command	Purpose
Step 1	Router(config)# **interface fastethernet** *slot***/***subslot***/***port***.***subinterface-number* or Router(config)# **interface gigabitethernet** *slot***/***subslot***/***port***.***subinterface-number* or Router(config)# **interface tengigabitethernet** *slot***/***subslot***/***port***.***subinterface-number*	Specifies the Fast Ethernet, Gigabit Ethernet, or Ten Gigabit Ethernet interface to configure, where: • *slot***/***subslot***/***port*—Specifies the location of the interface. See the "Specifying the Interface Address" section on page 5-4. • **.***subinterface-number*—Specifies a secondary interface (subinterface) number.
Step 2	Router(config-subif)# **encapsulation dot1q** *vlan-id*	Defines the encapsulation format as IEEE 802.1Q ("dot1q"), where *vlan-id* is the number of the VLAN (1–4095).
Step 3	Router(config-if)# **ip address** *ip-address mask* [**secondary**]	Sets a primary or secondary IP address for an interface, where: • *ip-address*—Specifies the IP address for the interface. • *mask*—Specifies the mask for the associated IP subnet. • **secondary**—(Optional) Specifies that the configured address is a secondary IP address. If this keyword is omitted, the configured address is the primary IP address.

Verifying Subinterface Configuration on a VLAN

To verify the configuration of a subinterface and its status on the VLAN, use the **show vlans** privileged EXEC command.

The following example shows the status of subinterface number 1 on port 0 on the SPA in VLAN number 200:

```
Router# show vlans
VLAN ID:200 (IEEE 802.1Q Encapsulation)

Protocols Configured:         Received:       Transmitted:
          IP                  0                  14

VLAN trunk interfaces for VLAN ID 200:

GigabitEthernet4/1/0.1 (200)

      IP:12.200.21.21

      Total 0 packets, 0 bytes input
      Total 2 packets, 120 bytes output
```

Configuring Flow Control Support on the Link

Flow control is turned on or off based on the result of the autonegotiation. For information on this process, see "Configuring Autonegotiation on an Interface" section on page 5-9.

Verifying Flow Control Status

To verify flow control status on a Fast Ethernet or Gigabit Ethernet interface on a SPA, use the **show interfaces fastethernet**, **show interfaces gigabitethernet** ,or **show interfaces tengigabitethernet** privileged EXEC command and view the "output flow-control is" and " input flow-control is" output lines to see if input and output flow control is on or off. The "pause input" and "pause output" counters of the output of this command can be used to view the number of pause frames sent or received by the interface.

The following example shows that zero pause frames have been transmitted and received by the MAC device for interface port 3 (the fourth port) on the SPA located in subslot 0 of the MSC that is installed in slot 3 of the Cisco 12000 series router:

```
Router# show interfaces gigabitethernet 3/0/3
GigabitEthernet3/0/3 is up, line protocol is up
  Hardware is GigabitEthernet, address is 0008.7db3.8e01 (bia 0008.7db3.8e01)
  Internet address is 13.0.0.2/24
  MTU 1500 bytes, BW 1000000 Kbit, DLY 10 usec, rely 255/255, load 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  Full Duplex, 1000Mbps, link type is autonegotiation, media type is T
  output flow-control is on, input flow-control is on
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 00:00:09, output 00:00:09, output hang never
  Last clearing of "show interface" counters never
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
        Available Bandwidth 1000000 kilobits/sec
  30 second input rate 0 bits/sec, 0 packets/sec
  30 second output rate 0 bits/sec, 0 packets/sec
     5 packets input, 520 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
     0 watchdog, 0 multicast, 0 pause input
     26 packets output, 8286 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
```

```
0 babbles, 0 late collision, 0 deferred
0 lost carrier, 0 no carrier, 0 pause output
0 output buffer failures, 0 output buffers swapped out
```

Saving the Configuration

To save your running configuration to nonvolatile random-access memory (NVRAM), use the following command in privileged EXEC configuration mode:

Command	Purpose
Router# **copy running-config startup-config**	Writes the new configuration to NVRAM.

For more information about managing configuration files, refer to the *Cisco IOS Configuration Fundamentals Configuration Guide, Release 12.0* and *Cisco IOS Configuration Fundamentals Command Reference, Release 12.0* publications.

Shutting Down and Restarting an Interface on a SPA

You can shut down and restart any of the interface ports on a SPA independently of each other. Shutting down an interface stops traffic and enters the interface into an "administratively down" state.

If you are preparing for an OIR of a SPA, it is not necessary to independently shut down each of the interfaces prior to deactivation of the SPA. The **hw-module subslot shutdown** command automatically stops traffic on the interfaces and deactivates them along with the SPA in preparation for OIR.

In similar fashion, you do not need to independently restart any interfaces on a SPA after OIR of a SPA or MSC.

To shut down an interface on a SPA, use the following command in interface configuration mode:

Command	Purpose
Router(config-if)# **shutdown**	Disables an interface.

To restart an interface on a SPA, use the following command in interface configuration mode:

Command	Purpose
Router(config-if)# **no shutdown**	Restarts a disabled interface.

Verifying the Interface Configuration

Besides using the **show running-configuration** command to display your router configuration settings, you can use the **show interfaces gigabitethernet** command to get detailed information on a per-port basis for your Cisco 1-port 10 Gigabit Ethernet SPA, 5-Port Gigabit Ethernet SPA, and Cisco 10-port Gigabit Ethernet SPA. For the 8-Port Fast Ethernet SPA, **show interfaces fastethernet** can be entered to gather detailed per-port information.

Verifying Per-Port Interface Status

To find detailed interface information on a per-port basis for the Fast Ethernet or Gigabit Ethernet SPAs, use the **show interfaces fastethernet**, **show interfaces gigabitethernet** , or **show interfaces tengigabitethernet** command. For a description of the command output, see Chapter 19, "SIP and SPA Command Reference."

The following example provides sample output for interface port 0 on the Gigabit Ethernet SPA located in the top subslot (0) of the MSC that is installed in slot 3 of the Cisco 12000 series router:

```
Router# show interfaces gigabitethernet 3/0/0
GigabitEthernet3/0/0 is up, line protocol is up
  Hardware is GigMac 1 Port 10 GigabitEthernet, address is 0008.7db3.8dfe (bia )
  Internet address is 10.0.0.2/24
  MTU 1500 bytes, BW 10000000 Kbit, DLY 10 usec, rely 255/255, load 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  Full Duplex, 10000Mbps, link type is autonegotiation, media type is T
  output flow-control is on, input flow-control is on
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 00:00:01, output 00:00:01, output hang never
  Last clearing of "show interface" counters never
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
        Available Bandwidth 10000000 kilobits/sec
  30 second input rate 0 bits/sec, 0 packets/sec
  30 second output rate 0 bits/sec, 0 packets/sec
     11 packets input, 1154 bytes, 0 no buffer
     Received 1 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
     0 watchdog, 0 multicast, 0 pause input
     67 packets output, 20951 bytes, 0 underruns
     0 output errors, 0 collisions, 1 interface resets
     0 babbles, 0 late collision, 0 deferred
     0 lost carrier, 0 no carrier, 0 pause output
     0 output buffer failures, 0 output buffers swapped out
```

The following example provides sample output for interface port 0 on the Fast Ethernet SPA located in the top subslot (0) of the MSC that is installed in slot 7 of the Cisco 12000 series router:

```
Router# show interfaces fastethernet 7/0/0
FastEthernet7/0/0 is administratively down, line protocol is down
  Hardware is FastEthernet, address is 0000.001c.a400 (bia 0000.001c.a400)
  MTU 1500 bytes, BW 100000 Kbit, DLY 1000 usec, rely 255/255, load 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  Full Duplex, 100Mbps, link type is autonegotiation, media type is 100BaseTx
  output flow-control is unsupported, input flow-control is unsupported
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input never, output never, output hang never
  Last clearing of "show interface" counters never
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
        Available Bandwidth 100000 kilobits/sec
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     0 packets input, 0 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
     0 watchdog, 0 multicast, 0 pause input
     0 packets output, 0 bytes, 0 underruns
     Transmitted 0 broadcasts
     0 output errors, 0 collisions, 0 interface resets
```

```
     0 babbles, 0 late collision, 0 deferred
     0 lost carrier, 0 no carrier, 0 pause output
     0 output buffer failures, 0 output buffers swapped out
```

Configuration Examples

This section includes the following configuration examples:

- Basic Interface Configuration Example, page 5-14
- MAC Address Configuration Example, page 5-15
- MTU Configuration Example, page 5-15
- VLAN Configuration Example, page 5-16

Basic Interface Configuration Example

The following example shows how to enter global configuration mode to specify the interface that you want to configure, configure an IP address for the interface, and save the configuration. This example configures interface port 1 on the SPA that is located in subslot 0 of the MSC, that is installed in slot 3 of the Cisco 12000 series router:

```
!Enter global configuration mode
!
Router# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
!
! Specify the interface address
!
Router(config)# interface gigabitethernet 3/0/1
!
! Configure an IP address
!
Router(config-if)# ip address 192.168.50.1 255.255.255.0
!
! Start the interface
!
Router(config-if)# no shut
!
! Save the configuration to NVRAM
!
Router(config-if)# exit
Router# copy running-config startup-config
```

The following example shows the same configuration on a port, but with an IPv6 address:

```
!Enter global configuration mode
!
Router# configure terminal
```

```
Enter configuration commands, one per line. End with CNTL/Z.
!
!Enable IPv6 Routing
!
Router(config)#
!
! Specify the interface address
!
Router(config)# interface gigabitethernet 3/0/1
!
! Configure an IP address
!
Router(config-if)# ipv6 address 2001:10::1/64
Router(config-if)# ipv6 address FEC0:11:1001:11::1/64
!
! Start the interface
!
Router(config-if)# no shut
!
! Save the configuration to NVRAM
!
Router(config-if)# exit
Router# copy running-config startup-config
```

MAC Address Configuration Example

The following example changes the default MAC address on the interface to 1111.2222.3333:

```
!Enter global configuration mode
!
Router# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
!
! Specify the interface address
!
Router(config)# interface gigabitethernet 3/0/1
!
! Modify the MAC address
!
Router(config-if)# mac-address 1111.2222.3333
```

MTU Configuration Example

The following example sets the interface MTU to 9216 bytes:

Note The SPA automatically adds an additional 36 bytes to the configured interface MTU size.

```
!Enter global configuration mode
!
Router# configure terminal
```

```
Enter configuration commands, one per line. End with CNTL/Z.
!
! Specify the interface address
!
Router(config)# interface gigabitethernet 3/0/1
!
! Configure the interface MTU
!
Router(config-if)# mtu 9216
```

VLAN Configuration Example

The following example creates subinterface number 268 on SPA interface port 2 (the third port), and configures the subinterface on the VLAN with ID number 269 using IEEE 802.1Q encapsulation:

Note The SPA does not support ISL encapsulation.

```
!Enter global configuration mode
!
Router# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
!
! Specify the interface address
!
Router(config)# interface gigabitethernet 3/0/1.268
!
! Configure dot1q encapsulation and specify the VLAN ID
!
Router(config-subif)# encapsulation dot1q 268
```

CHAPTER 6

Troubleshooting the Gigabit Ethernet SPA

This chapter describes techniques that you can use to troubleshoot the operation of your GigabitEthernet SPAs.

It includes the following sections:

The first section provides information about basic interface troubleshooting. If you are having a problem with your SPA, use the steps in the "Performing Basic Interface Troubleshooting" section to begin your investigation of a possible interface configuration problem.

To perform more advanced troubleshooting, see the other sections in this chapter.

General Troubleshooting Information

This section describes general information for troubleshooting SIPs and SPAs. It includes the following sections:

Using Debug Commands

Along with the other **debug** commands supported on the Cisco 12000 Series Router, you can obtain specific debug information for SPAs on the Cisco 12000 Series Router using the **debug hw-module subslot** privileged exec command.

The **debug hw-module subslot** command is intended for use by Cisco Systems technical support personnel. For more information about the **debug hw-module subslot** command, see Chapter 19, "SIP and SPA Command Reference."

Caution Because debugging output is assigned high priority in the CPU process, it can render the system unusable. For this reason, use **debug** commands only to troubleshoot specific problems or during troubleshooting sessions with Cisco technical support staff. Moreover, it is best to use **debug** commands during periods of lower network traffic and fewer users. Debugging during these periods decreases the likelihood that increased **debug** command processing overhead will affect system use.

For information about other **debug** commands supported on the Cisco 12000 Series Router, refer to the *Cisco IOS Debug Command Reference* and any related feature documents for the applicable Cisco IOS Release.

Using show Commands

There are several **show** commands that you can use to monitor and troubleshoot the SIPs and SPAs on the Cisco 12000 Series Router. This chapter describes using the **show interfaces** and **show controllers** commands to perform troubleshooting of your SPA.

For more information about **show** commands to verify and monitor SIPs and SPAs, see the following chapters of this guide:

- Chapter 5, "Configuring the Fast Ethernet and Gigabit Ethernet SPAs"
- Chapter 7, "Command Summary for Gigabit Ethernet SPAs"
- Chapter 19, "SIP and SPA Command Reference"

Performing Basic Interface Troubleshooting

You can perform most of the basic interface troubleshooting using the **show interfaces gigabitethernet** command and examining several areas of the output to determine how the interface is operating.

The following example shows output from the **show interfaces gigabitethernet** command with some of the significant areas of the output to observe shown in bold:

```
Router# show interfaces gigabitethernet 3/0/0
GigabitEthernet3/0/0 is up, line protocol is up
  Hardware is GigMac 1 Port 10 GigabitEthernet, address is 0008.7db3.8dfe (bia )
  Internet address is 10.0.0.2/24
  MTU 1500 bytes, BW 10000000 Kbit, DLY 10 usec, rely 255/255, load 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  Full Duplex, 10000Mbps, link type is autonegotiation, media type is T
  output flow-control is on, input flow-control is on
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 00:00:01, output 00:00:01, output hang never
  Last clearing of "show interface" counters never
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
        Available Bandwidth 10000000 kilobits/sec
  30 second input rate 0 bits/sec, 0 packets/sec
  30 second output rate 0 bits/sec, 0 packets/sec
     11 packets input, 1154 bytes, 0 no buffer
     Received 1 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
     0 watchdog, 0 multicast, 0 pause input
     67 packets output, 20951 bytes, 0 underruns
```

```
0 output errors, 0 collisions, 1 interface resets
0 babbles, 0 late collision, 0 deferred
0 lost carrier, 0 no carrier, 0 pause output
0 output buffer failures, 0 output buffers swapped out
```

To verify that your interface is operating properly, complete the steps in Table 6-1:

Table 6-1 Basic Interface Troubleshooting Steps

	Action	Example
Step 1	From global configuration mode, enter the **show interfaces gigabitethernet** command.	`Router# show interfaces gigabitethernet 2/1/1`
Step 2	Verify that the interface is up.	`Router# show interfaces gigabitethernet 2/1/1` `GigabitEthernet2/1/1 is up, line protocol is up`
Step 3	Verify that the line protocol is up.	`Router# show interfaces gigabitethernet 2/1/1` `GigabitEthernet2/1/1 is up, line protocol is up`

Step 4	Verify that the interface duplex mode matches the remote interface configuration.	The following example shows that the local interface is currently operating in full-duplex mode:
		`Router# show interfaces gigabitethernet 2/1/1`
		`[text omitted]`
		
		`  Keepalive set (10 sec)`
		`  Full-duplex, 100Mb/s, 100BaseTX/FX`

Step 5	Verify that the interface speed matches the speed on the remote interface.	The following example shows that the local interface is currently operating at 100Mbps:
		`Router# show interfaces gigabitethernet 2/1/1`
		`.`
		`.`
		`.`
		`  Keepalive set (10 sec)`
		`  Full-duplex, 100Mb/s, 100BaseTX/FX`
		`.`
		`.`
		`.`

Step 6	Observe the output hang status on the interface.	`Router# show interfaces gigabitethernet 2/1/1`
		`.`
		`.`
		`.`
		`  ARP type: ARPA, ARP Timeout 04:00:00`
		`  Last input 00:00:22, output 00:00:02, output hang never`
		`.`
		`.`
		`.`

Step 7	Observe the CRC counter.	`Router# show interfaces gigabitethernet 2/1/1`
		`.`
		`.`
		`.`
		`     5 minute output rate 0 bits/sec, 0 packets/sec`
		`     5 packets input, 320 bytes`
		`     Received 1 broadcasts (0 IP multicast)`
		`     0 runts, 0 giants, 0 throttles`
		`     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored`
		`.`
		`.`
		`.`

Table 6-1 Basic Interface Troubleshooting Steps

	Action	Example

Step 8	Observe the late collision counter.	`Router# show interfaces gigabitethernet 2/1/1`
		.
		.
		.
		`0 input packets with dribble condition detected`
		`8 packets output, 529 bytes, 0 underruns`
		`0 output errors, 0 collisions, 2 interface resets`
		`0 babbles, 0 late collision, 0 deferred`
		.
		.
		.

Step 9	Observe the carrier signal counters.	`Router# show interfaces gigabitethernet 2/1/1`
		.
		.
		.
		`0 output errors, 0 collisions, 2 interface resets`
		`0 babbles, 0 late collision, 0 deferred`
		`2 lost carrier, 0 no carrier`
		.
		.
		.

For more information about the verification steps in and possible responses to correct detected problems, see the following sections:

- Verifying the Interface is Up, page 6-4
- Verifying the Line Protocol is Up, page 6-5
- Verifying Output Hang Status, page 6-5
- Verifying the CRC Counter, page 6-5
- Verifying Late Collisions, page 6-5
- Verifying the Carrier Signal, page 6-5

Verifying the Interface is Up

In the output from the **show interfaces gigabitethernet** command, verify that the interface is up. If the interface is down, perform the following corrective actions:

- If the interface is *administratively down*, use the **no shutdown** interface configuration command to enable the interface.
- Be sure that the cable is fully connected.
- Verify that the cable is not bent or damaged. If the cable is bent or damaged, the signal will be degraded.
- Verify that a hardware failure has not occurred. Observe the LEDs to confirm the failure. See the other troubleshooting sections of this chapter, and refer to the *Cisco 12000 Series Router SIP and SPA Hardware Installation Guide*. If the hardware has failed, replace the SPA as necessary.

Verifying the Line Protocol is Up

In the output from the **show interfaces gigabitethernet** command, verify that the line protocol is up. If the line protocol is down, the line protocol software processes have determined that the line is unusable.

Perform the following corrective actions:

- Swap the cable.
- Check the local and remote interface for misconfiguration.
- Verify that a hardware failure has not occurred. Observe the LEDs to confirm the failure. See the other troubleshooting sections of this chapter, and refer to the *Cisco 12000 Series Router SIP and SPA Hardware Installation Guide*. If the hardware has failed, replace the SPA as necessary.

Verifying Output Hang Status

In the output from the **show interfaces gigabitethernet** command, observe the value of the output hang field.

The output hang provides the number of hours, minutes, and seconds since the last reset caused by a lengthy transmission. When the number of hours the field exceeds 24 hours, the number of days and hours is shown. If the field overflows, asterisks are printed. The field shows a value of *never* if no output hangs have occurred.

Verifying the CRC Counter

In the output from the **show interfaces gigabitethernet** command, observe the value of the CRC counter. Excessive noise will cause high CRC errors accompanied by a low number of collisions.

Perform the following corrective actions if you encounter high CRC errors:

- Check the cables for damage.
- Verify that the correct cables are being used for the SPA interface.

Verifying Late Collisions

In the output from the **show interfaces gigabitethernet** command, observe the value of the late collision counter.

Perform the following corrective actions if you encounter late collisions on the interface:

- Verify that the duplex mode on the local and remote interface match. Late collisions occur when there is a duplex mode mismatch.
- Verify the length of the Ethernet cables. Late collisions result from cables that are too long.

Verifying the Carrier Signal

In the output from the **show interfaces gigabitethernet** command, observe the value of the carrier signal counters. The lost carrier counter shows the number of times that the carrier was lost during transmission. The no carrier counter shows the number of times that the carrier was not present during transmission.

Carrier signal resets can occur when an interface is in loopback mode or shut down.

Perform the following corrective actions if you observe the carrier signal counter incrementing outside of these conditions:

- Check the interface for a malfunction.
- Check for a cable problem.

Understanding SPA Automatic Recovery

When the Gigabit Ethernet SPAs encounter thresholds for certain types of errors and identifies a fatal error, the SPA initiates an automatic recovery process.

You do not need to take any action unless the error counters reach a certain threshold, and multiple attempts for automatic recovery by the SPA fail.

The GigabitEthernet SPAs might perform automatic recovery for the following types of errors:

- SPI4 TX/RX out of frame
- SPI4 TX train valid
- SPI4 TX DIP4
- SPI4 RX DIP2

Note These SPA error counters do not appear in the **show controllers gigabitethernet** command output until at least one SPI4 error occurs.

When Automatic Recovery Occurs

If the SPI4 errors occur more than 25 times within 10 milliseconds, the SPA automatically deactivates and reactivates itself. Error messages are logged on the console indicating the source of the error and the status of the recovery.

If Automatic Recovery Fails

If the SPA attempts automatic recovery more than five times in an hour, then the SPA deactivates itself and remains deactivated.

To troubleshoot automatic recovery failure for a SPA, perform the following steps:

Step 1 Use the **show hw-module subslot** *slot*/*subslot* **oir** command to verify the status of the SPA. The status is shown as "failed" if the SPA has been powered off due to five consecutive failures.

Step 2 If you verify that automatic recovery has failed, perform OIR of the SPA. For information about performing an OIR, see the "Preparing for Online Insertion and Removal of a SPA" section on page 6-8.

Step 3 If reseating the SPA after OIR does not resolve the problem, replace the SPA hardware.

Configuring the Interface for Internal Loopback

Loopback support is useful for testing the interface without connectivity to the network, or for diagnosing equipment malfunctions between the interface and a device. The Gigabit Ethernet SPAs supports both an internal and an external loopback mode. The external loopback mode requires the use of a loopback cable and implements a loopback through the transceiver on the SPA.

You can also configure an internal loopback without the use of a loopback cable that implements a loopback at the PHY device internally on a Gigabit Ethernet interface port, or at the MAC device internally on a Gigabit Ethernet interface port. By default, loopback is disabled.

Configuring the Interface for Internal Loopback

To enable internal loopback at the PHY device for an interface on a SPA, use the following commands beginning in interface configuration mode:

	Command or Action	Purpose
Step 10	Router(config-if)# **loopback internal**	Enables an interface for internal loopback on the Gigabit Ethernet SPA.

Configuring the Interface for External Loopback

Before beginning external loopback testing, remember that the external loopback mode requires the use of a loopback cable.

To enable external loopback, use the following commands beginning in interface configuration mode:

Command	Purpose
Router(config-if)# **loopback external**	Enables an interface for external loopback on the Gigabit Ethernet SPA.

Verifying Loopback Status

To verify whether loopback is enabled on an interface port on a SPA, use the **show interfaces gigabitethernet** privileged EXEC command and observe the value shown in the "loopback" field.

The following example shows that loopback is disabled for interface port 0 (the first port) on the SPA installed in the top (0) subslot of the SIP that is located in slot 3 of the Cisco 12000 Series Router:

```
Router# show interfaces gigabitethernet 3/0/0
GigabitEthernet3/0/0 is up, line protocol is up
  Hardware is GigMac 1 Port 10 GigabitEthernet, address is 0008.7db3.8dfe (bia )
  Internet address is 10.0.0.2/24
  MTU 1500 bytes, BW 10000000 Kbit, DLY 10 usec, rely 255/255, load 1/255
  Encapsulation ARPA, loopback not set
.
.
.
```

Using the Cisco IOS Event Tracer to Troubleshoot Problems

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

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

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

The SPAs currently support the “spa” component to trace SPA OIR-related events.

For more information about using the Event Tracer feature, refer to the following URL:

http://www.cisco.com/univercd/cc/td/doc/product/software/ios120/120newft/120limit/120s/120s18/evnttrcr.htm

Preparing for Online Insertion and Removal of a SPA

The Cisco 12000 Series Router supports online insertion and removal (OIR) of the SIP, in addition to each of the SPAs. Therefore, you can remove a SIP with its SPAs still intact, or you can remove a SPA independently from the SIP, leaving the SIP installed in the router.

This means that a SIP can remain installed in the router with one SPA remaining active, while you remove another SPA from one of the SIP subslots. If you are not planning to immediately replace a SPA into the SIP, then be sure to install a blank filler plate in the subslot. The SIP should always be fully installed with either functional SPAs or blank filler plates.

CHAPTER 7

Command Summary for Gigabit Ethernet SPAs

Table 7-1 provides an alphabetical list of the most significant commands that are needed to configure, monitor, and maintain the Gigabit Ethernet shared port adapter Shared Port Adapters (SPAs). For more information about the commands, see Chapter 19, "SIP and SPA Command Reference" in this book, and the Cisco IOS Release 12.2 command reference and master index publications.

Table 7-1 Command Summary

Command	Purpose
Router(config-subif)# **encapsulation dot1q** *vlan-id* [**native**]	Enables IEEE 802.1Q encapsulation of traffic on a specified subinterface in VLANs.
Router(config)# **ip accounting mac-address** {**input** | **output**}	Enables MAC address accounting. MAC address accounting provides accounting information for IP traffic based on the source and destination MAC addresses of the LAN interfaces.
Router(config-if)# **ip address** *ip-address mask* [**secondary**]	Sets a primary or secondary IP address for an interface.
Router(config-if)#**ipv6 address** *prefix-name ipv6-prefix/prefix-length*	Sets an IPv6 general prefix and enables IPv6 processing on an interface.
Router(config)# **interface gigabitethernet** *slot/subslot/port*[**.***subinterface-number*]	Specifies the Gigabit Ethernet interface to configure.
Router(config-if)# **loopback internal**	Enables internal loopback mode.
Router(config-if)# **loopback external**	Enables external loopback mode.
Router(config-if)# **mac-address** *ieee-address*	Modifies the default Media Access Control (MAC) address of an interface to some user-defined address.
Router(config-if)# **mtu** *bytes*	Configures the maximum packet size for an interface.
Router(config-if)# **negotiation auto**	Enables advertisement of flow control on a Gigabit Ethernet interface.
Router(config-if)# **no negotiation auto**	Disables advertisement of flow control on a Gigabit Ethernet interface. Autonegotiation is enabled by default, so this command is required if you want to change the configuration.
Router(config-if)# **no shutdown**	Enables an interface.
Router# **show interfaces gigabitethernet**	Displays various Gigabit Ethernet interface statistics.

Table 7-1 Command Summary (continued)

Command	Purpose
Router# **show vlans** [*vlan-id*]	Displays VLAN subinterfaces.
Router(config-if)# **standby** [*group-number*] **ip** [*ip-address* [**secondary**]]	Creates (or enables) the HSRP group using its number and virtual IP address.

PART 3

Serial Shared Port Adapters

CHAPTER 8

Overview of the Serial SPAs

This chapter provides an overview of the release history, and feature and MIB support for the Cisco 12000 SIP-400, Cisco 12000 SIP-401, Cisco 12000 SIP-501, and Cisco 12000 SIP-601with the 2-Port and 4-Port Clear Channel T3/E3 SPA, 2-Port and 4-Port Channelized T3 SPA, 1-Port Channelized OC-3/STM-1 SPA, and the 8-Port Channelized T1/E1 SPA.

This chapter includes the following sections:

- Release History, page 8-1
- Supported Features, page 8-1
- Supported MIBs, page 8-4
- Displaying the SPA Hardware Type, page 8-5

Release History

Release	Modification
Cisco IOS Release 12.0S	Support for the following hardware was introduced on the Cisco 12000 Series routers: • Cisco 12000 SIP-400 • Cisco 12000 SIP-401 • Cisco 12000 SIP-501 • Cisco 12000 SIP-601 • 2-Port and 4-Port Clear Channel T3/E3 SPA • 2-Port and 4-Port Channelized T3 SPA • 1-Port Channelized OC-3/STM-1 SPA • 8-Port Channelized T1/E1 SPA

Supported Features

This section provides a list of some of the primary features supported by the SIP and SPA hardware and software.

SIP-400 Features

The SIP-400 is a carrier card designed to process packets between different Shared Port Adapters (SPAs) and the Cisco 12000.

- Online insertion and removal (OIR)
- Supports up to four single-height or two double-height Shared Port Adaptors (SPAs).
- Field Programmable Gate Array (FPGA) upgrade support

  The SIP-400 supports the standard FPGA upgrade methods for the Cisco 12000 Series router.
- Compact Flash for code upgrade

SPA Features

The following is a list of some of the significant software features supported by the 2-Port and 4-Port Channelized T3 SPA, 2-Port and 4-Port Clear Channel T3/E3 SPA, 8-Port Channelized T1/E1 SPA, and 1-Port Channelized OC-3/STM-1 SPA:

- SONET and SDH multiplexing
- 24-hour history maintained for error statistics and failure counts, at 15-minute intervals
- Software selectable between E3 or T3 framing on each card (ports are configured as all T3 or E3). Applies to the 2 and 4-Port T3/E3 SPA.
- Layer 2 encapsulation support:
  - Point-to-Point Protocol (PPP)
  - High-level Data Link Control (HDLC)
  - Frame Relay
- Internal or network clock (selectable per port)
- Online insertion and removal (OIR)
- Hot standby router protocol (HSRP)
- Alarm reporting-24-hour history maintained, 15-minute intervals on all errors
- 16- and 32-bit cyclic redundancy checks (CRC) supported (16-bit default)
- Local and remote loopback
- Bit error rate testing (BERT) pattern generation and detection per port
- Dynamic provisioning— Dynamic provisioning allows for the addition of new customer circuits within a channelized interface without affecting other customers.
- FPD (field programmable device upgrades)

Channelized T1 Features

- All ports can be fully channelized down to DS0
- Data rates in multiples of 56Kbps or 64Kbps per channel
- Maximum 1.536Mbps for each T1 port
- D4 (SF) and ESF support for each T1 port

- ANSI T1.403 and AT&T TR54016 CI FDL Support
- Internal and receiver recovered clocking modes
- Short haul and long haul CSU support
- B8ZS and AMI line encoding
- J1 framing (2 and 4-Port CT3 SPA)
- Support for Multilink Point to Point Protocol (MLPPP) for full T1s on the same SPA (hardware based) and across SPAs (software based).
- Support for Multilink Frame Relay (MLFR)

Channelized T3 Features

- Binary 3-zero substitution (B3ZS) line coding
- Compliant with DS3 pulse mask per ANSI T1.102-1993
- DS3 far-end alarm and control (FEAC) channel support
- Full duplex connectivity at DS-3 rate (44.736 MHz)
- 672 DS0s per T3
- Loopback modes: DTE, local, dual, and network
- C-bit or M23 framing (software selectable)
- Line build-out: configured for up to 450 feet (135 m) of type 734A or equivalent coaxial cable
- DS-3 alarm/event detection (once per second polling)

  - Alarm indication signal (AIS)
  - Out of frame (OOF)
  - Far-end receive failure (FERF)
- Generation and termination of DS3 Maintenance Data Link (MDL) in C-bit framing
- Full FDL support and FDL performance monitoring
- Subrate and scrambling features for these DSU vendors:

  - Digital Link
  - ADC Kentrox
  - Adtran
  - Verilink
  - Larscom

Unchannelized E1 Features

- Maximum 1.984Mbps for each E1 port in framed mode and a 2.048Mbps in unframed E1 mode
- All ports can be fully channelized down to DS0
- Compliant with ITU G.703, G.704, ETSI and ETS300156
- Internal and receiver recovered clocking modes
- HDB3 and AMI line encoding

Unchannelized E3 Features

- Full duplex connectivity at E3 rate (34.368 MHz)
- Supports G.751 or G.832 framing (software selectable)
- Hi-density bipolar with three zones (HD3B) line coding
- Compliant with E3 pulse mask
- Line build-out: configured for up to 450 feet (135 m) of type 728A or equivalent coaxial cable
- Loopback modes: DTE, local, dual, and network
- E3 alarm/event detection (once per second polling)
- Subrate and scrambling features for these DSU vendors:
  - Digital Link
  - ADC Kentrox
  - Adtran
  - Verilink
  - Larscom

Restrictions

- The following features are supported only on channelized SPAs:
  - End-to-end FRF.12 fragmentation support
  - Link Fragmentation and Interleaving (LFI) support

Supported MIBs

The following MIBs are supported in Cisco IOS Release 12.2S for the serial SPAs on the Cisco 12000 Series routers:

All serial SPAs:

- CISCO-ENTITY-ALARM-MIB
- CISCO-CLASS-BASED-QOS-MIB
- CISCO-ENVMON-MIB (For NPEs, NSEs, line cards, and SIPs only)
- CISCO-ENTITY-ASSET-MIB
- CISCO-ENTITY-FRU-CONTROL-MIB
- CISCO-ENTITY-SENSOR-MIB
- ENTITY-MIB
- IF-MIB
- RMON-MIB
- MPLS-LDP-MIB
- MPLS-LSR-MIB

- MPLS-TE-MIB
- MPLS-VPN-MIB

2 and 4-Port T3/E3 SPAs:

- DS3/E3 MIB

8-Port Channelized T1/E1 SPA:

- DS1/E1 MIB

2 or 4-Port CT3 SPA

- DS1-MIB
- DS3-MIB
- CISCO-FRAME-RELAY-MIB
- IANAifType-MIB
- RFC1381-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://tools.cisco.com/ITDIT/MIBS/servlet/index

If Cisco MIB Locator does not support the MIB information that you need, you can also obtain a list of supported MIBs and download MIBs from the Cisco MIBs page at the following URL:

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

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

http://www.cisco.com/register

Displaying the SPA Hardware Type

To verify the SPA hardware type that is installed in your Cisco 12000 Series router, you can use the **show diagbus** command or the **show interfaces** command (can be used only if the interface has been configured). There are several other commands on the Cisco 12000 series routers that also provide SPA hardware information.

Table 8-1 shows the hardware description that appears in the **show** command output for each type of SPA that is supported on the Cisco 12000 series router.

Table 8-1 SPA Hardware Descriptions in show Commands

SPA	Description in show interfaces and show controllers commands
4-Port Clear Channel T3/E3 SPA	"Hardware is SPA-4XT3/E3"
2-Port Clear Channel T3/E3 SPA	"Hardware is SPA-2XT3/E3"
2-Port Channelized T3 SPA	"Hardware is 2 ports CT3 SPA"
4-Port Channelized T3 SPA	"Hardware is 4 ports CT3 SPA"

Example of the show interface Command

The following example shows output from the **show interface serial 0/0/0** command on a Cisco 12008 router with a 4-Port Channelized T3 SPA installed in slot 7:

```
Router#Show interface serial 7/0/0/1
Serial7/0/0/1:0 is down, line protocol is down
  Hardware is SPA-4XCT3/DS0
  MTU 1500 bytes, BW 1536 Kbit, DLY 20000 usec, rely 255/255, load 1/255
  Encapsulation FRAME-RELAY, crc 16, loopback not set
  Keepalive set (10 sec)
  LMI enq sent  0, LMI stat recvd 0,LMI upd recvd 0
  LMI enq recvd 0, LMI stat sent  0,LMI upd sent  0, DCE LMI down
  LMI DLCI 1023  LMI type is CISCO  frame relay DCE
  Broadcast queue 0/64, broadcasts sent/dropped 0/0, interface broadcasts 0
  Last input never, output never, output hang never
  Last clearing of "show interface" counters 1d17h
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
        Available Bandwidth 1536 kilobits/sec
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     0 packets input, 0 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     0 packets output, 0 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions no alarm present
  VC 1: timeslot(s): 1-24, Transmitter delay 0, non-inverted data
Router#


Router#show gsr
Slot 0  type  = Performance Route Processor
        state = ACTV RP   IOS Running  ACTIVE
Slot 3  type  = 12 Port Packet over DS3
        state = IOS RUN   Line Card Enabled
Slot 4  type  = 4 Port Packet Over SONET OC-12c/STM-4
        state = IOS RUN   Line Card Enabled
Slot 6  type  = 1 Port Packet Over SONET OC-192c/STM-64
        state = IOS RUN   Line Card Enabled
Slot 7  type  = ISE 2.5G SPA Interface Card
        state = IOS RUN   Line Card Enabled
        subslot 7/0: SPA-4XCT3/DS0 (0x43B), status is ok
        subslot 7/1: Empty
        subslot 7/2: SPA-1XCHSTM1/OC3 (0x463), status is out of service
        subslot 7/3: Empty
Slot 16 type  = Clock Scheduler Card 16XOC192
        state = Card Powered
Slot 17 type  = Clock Scheduler Card 16XOC192
        state = Card Powered  PRIMARY CLOCK
Slot 18 type  = Switch Fabric Card 16XOC192
        state = Card Powered
Slot 19 type  = Switch Fabric Card 16XOC192
        state = Card Powered
Slot 20 type  = Switch Fabric Card 16XOC192
        state = Card Powered
Slot 24 type  = Alarm Module(16)
        state = Card Powered
Slot 25 type  = Alarm Module(16)
        state = Card Powered
Slot 27 type  = Bus Board(16)
```

```
        state = Card Powered
Slot 28 type  = Blower Module(16)
        state = Card Powered
Slot 29 type  = Blower Module(16)
        state = Card Powered
```

CHAPTER 9

Configuring the 2-Port and 4-Port Channelized T3 SPA

This chapter provides information about configuring the 2-Port and 4-Port Channelized T3 Shared Port Adapters (SPAs) on the Cisco 12000 series routers. It includes the following sections:

For information about managing your system images and configuration files, refer to the *Cisco IOS Configuration Fundamentals Configuration Guide, Release 12.0* and *Cisco IOS Configuration Fundamentals Command Reference, Release 12.0* publications.

For more information about the commands used in this chapter, see Chapter 19, "SIP and SPA Command Reference," in this guide, which documents new and modified commands. Also refer to the related Cisco IOS Release 12.0 software command reference and master index publications. For more information about accessing these publications, see the Related Documentation section in the Preface.

Configuration Tasks

This section describes how to configure the serial SPAs for the Cisco 12000 series routers and includes information about verifying the configuration.

It includes the following topics:

Required Configuration Tasks

This section lists the required configuration steps to configure the 2-Port and 4-Port Channelized T3 SPA. Some of the required configuration commands implement default values that might be appropriate for your network.

- Configuring the T3 Controller, page 9-10
- Configuring the Logical T1 Interfaces, page 9-11
- Verifying T3 Controller Configuration, page 9-13
- Verifying Interface Configuration, page 9-14

Note To better understand the address format used to specify the physical location of the SPA Interface Processor (SIP), SPA, and interfaces, see the section Specifying the Interface Address on a SPA, page 9-15.

Configuring the T3 Controller

To configure the T3 controller for the 2-Port and 4-Port Channelized T3 SPA, complete these steps:

	Command	Purpose
Step 1	Router# **configure terminal**	Enters global configuration mode.
Step 2	Router(config)# **controller t3** *slot/subslot/port*	Selects the controller to configure and enters controller configuration mode. • *slot/subslot/port*—Specifies the location of the CT3 SPA port. See: "Specifying the Interface Address on a SPA" section on page 9-15.
Step 3	Router(config-controller)# [**no**] **channelized**	(Optional) Specifies the channelization mode. • **channelized**—In channelized mode, the T3 link can be channelized into 28 T1s, and each T1 can be further channelized into 24 DS0s. This is the default. • **no channelized**—In the unchannelized mode the T3 link provides a single high-speed data channel of 44210 kbps.

	Command	Purpose
Step 4	Router(config-controller)# **framing** {**auto-detect** | **c-bit** | **m23**}	(Optional) Specifies the framing type in subrate T3 mode. • **auto-detect**—Detects the framing type at the device at the end of the line and switches to that framing type. If both devices are set to auto-detect, c-bit framing is used. • **c-bit**—Specifies C-bit parity framing. This is the default. • **m23**—Specifies M23 framing. **Note** To set the framing type for an un-channelized T3, see: "Configuring T3 Framing" section on page 9-22.
Step 5	Router(config-controller)# **clock source** {**internal** | **line**}	(Optional) Specifies the clock source. • **internal**—Specifies that the internal clock source is used. Default for channelized mode. • **line**—Specifies that the network clock source is used. Default for un-channelized mode.
Step 6	Router(config-controller)# **cablelength** {**0 - 450**}	(Optional) Specifies the cable length. The default is 50 ft. • **0-450**—Cable length in feet.

Configuring the Logical T1 Interfaces

If channelized mode is configured for the T3 controller, use the following procedure to configure the logical T1 interfaces.

	Command	Purpose
Step 1	Router# **configure terminal**	Enters global configuration mode.
Step 2	Router(config)# **controller t3** *slot/subslot/port*	Selects the controller to configure and enters controller configuration mode. • *slot/subslot/port*—Specifies the location of the CT3 SPA port. See: "Specifying the Interface Address on a SPA" section on page 9-15

	Command	Purpose
Step 3	Router(config-controller)# **t1** *t1-number* **channel-group** *channel-number* **timeslots** *range* [**speed** {**56** | **64**}]	Specifies the T1 channel and timeslots to be mapped to each channel. • *t1-number*—T1 number from 1–28. • *channel-number*—Specifies a channel-group mapping(0–23) under the designated T1. • *range*—List of timeslots under the channel-group. Timeslots assigned to this T1 can be 1–24 or a combination of subranges within 1– 24. You can indicate a range using a hyphen, commas, or a combination of both. One timeslot equals one DS0. • **speed 56** or **64**— Specifies the speed of a timeslot as either 56 or 64 kbps. The default speed of 64 kbps is not mentioned in the config.
Step 4	Router(config-controller)# **t1** *t1-number* **framing** {**esf** | **sf** [**hdlc-idle** {**0x7e** | **0xff**}] [**mode** {**j1**}]}	(Optional) Specifies the T1 framing type using the **framing** command. • **sf**—Specifies Super Frame as the T1 frame type. **Note** If you select sf framing, you should consider disabling yellow alarm detection because the yellow alarm can be incorrectly detected with sf framing. • **esf**—Specifies Extended Super Frame as the T1 frame type. This is the default. • **hdlc-idle**— The hdlc-idle option allows you to set the idle pattern for the T1 interface to either **0x7e** (the default) or **0xff**.
Step 5	Router(config-controller)# **t1** *channel-number* **clock source** {**internal** | **line**}	(Optional) Specifies the T1 clock source. • **internal**—Specifies that the internal clock source is used. This is the default. • **line**—Specifies that the network clock source is used.

Step 6 Configure the serial interfaces.

Note After a T1 channel is configured, it appears to the Cisco IOS software as a serial interface; therefore, all the configuration commands for a serial interface are available. However, not all commands are applicable to the T1 interface. All the encapsulation formats, such as PPP, HDLC, and Frame Relay are applicable to the configured T1. Encapsulation can be set via the serial interface configuration commands.

For detailed interface configuration information, see the *Cisco IOS Interface Configuration Guide, Release 12.0*.

Verifying T3 Controller Configuration

Use the **show controllers** command to verify the controller configuration:

```
Router# show controllers t3
T3 3/1/0 is administratively down.
T3 3/1/1 is administratively down.
T3 3/1/2 is up.  Hardware is 4 ports CT3 SPA
  ATLAS FPGA version: 0, FREEDM336 version: 0
  TEMUX84(1) version: 0, TEMUX84(1) version: 0
  SUBRATE FPGA version: 0
  Applique type is Channelized T3
  No alarms detected.
  Framing is M23, Line Code is B3ZS, Clock Source is Internal
  Equipment customer loopback
  Data in current interval (746 seconds elapsed):
     0 Line Code Violations, 0 P-bit Coding Violation
     0 C-bit Coding Violation, 0 P-bit Err Secs
     0 P-bit Severely Err Secs, 0 Severely Err Framing Secs
     0 Unavailable Secs, 0 Line Errored Secs
     0 C-bit Errored Secs, 0 C-bit Severely Errored Secs
     0 Severely Errored Line Secs
     0 Far-End Errored Secs, 0 Far-End Severely Errored Secs
     0 CP-bit Far-end Unavailable Secs
     0 Near-end path failures, 0 Far-end path failures
     0 Far-end code violations, 0 FERF Defect Secs
     0 AIS Defect Secs, 0 LOS Defect Secs

  T1 1 is up
  timeslots: 1-24
  FDL per AT&T 54016 spec.
  No alarms detected.
  Framing is ESF, Clock Source is Internal
  Data in current interval (177 seconds elapsed):
     0 Line Code Violations, 0 Path Code Violations
     0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs
     0 Unavail Secs, 0 Stuffed Secs
     0 Near-end path failures, 0 Far-end path failures, 0 SEF/AIS Secs
  Total Data (last 2 15 minute intervals):
     0 Line Code Violations,0 Path Code Violations,
     0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins,
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs
     0 Unavail Secs, 0 Stuffed Secs
     0 Near-end path failures, 0 Far-end path failures, 0 SEF/AIS Secs

  T1 2
    Not configured.

  T1 3
    Not configured.
.
.
.
T3 3/1/3 is up.  Hardware is 4 ports CT3 SPA
  ATLAS FPGA version: 0, FREEDM336 version: 0
  TEMUX84(1) version: 0, TEMUX84(1) version: 0
  SUBRATE FPGA version: 0
  Applique type is Subrate T3
  No alarms detected.
  MDL transmission is disabled

  FEAC code received: No code is being received
```

```
  Framing is C-BIT Parity, Line Code is B3ZS, Clock Source is Line
  Equipment customer loopback
  Data in current interval (657 seconds elapsed):
     0 Line Code Violations, 0 P-bit Coding Violation
     0 C-bit Coding Violation, 0 P-bit Err Secs
     0 P-bit Severely Err Secs, 0 Severely Err Framing Secs
     0 Unavailable Secs, 0 Line Errored Secs
     0 C-bit Errored Secs, 0 C-bit Severely Errored Secs
     0 Severely Errored Line Secs
     0 Far-End Errored Secs, 0 Far-End Severely Errored Secs
     0 CP-bit Far-end Unavailable Secs
     0 Near-end path failures, 0 Far-end path failures
     0 Far-end code violations, 0 FERF Defect Secs
     0 AIS Defect Secs, 0 LOS Defect Secs
```

Verifying Interface Configuration

Use the **show interface serial** command to verify the interface configuration. The following example shows the ouput for the serial interface for an un-channelized T3:

```
Router# show interface serial3/0/0
Serial3/0/0 is down, line protocol is down
  Hardware is Channelized/ClearChannel CT3 SPA
  MTU 4470 bytes, BW 44210 Kbit, DLY 200 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation HDLC, crc 16, loopback not set
  Keepalive set (10 sec)
  Last input never, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     0 packets input, 0 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicast)
     0 runts, 0 giants, 0 throttles
              0 parity
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     0 packets output, 0 bytes, 0 underruns
     0 output errors, 0 applique, 2 interface resets
     0 output buffer failures, 0 output buffers swapped out
     1 carrier transitions alarm present
  DSU mode 0, bandwidth 44210 Kbit, scramble 0, VC 0
```

The following example shows the ouput for a serial interface for the first T1 on a channelized T3:

```
Router# show interface serial3/0/1/1:0
Serial3/0/1/1:0 is administratively down, line protocol is down
  Hardware is Channelized/ClearChannel CT3 SPA
  MTU 1500 bytes, BW 832 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation HDLC, crc 16, loopback not set
  Keepalive set (10 sec)
  Last input never, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     0 packets input, 0 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicast)
```

```
     0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     0 packets output, 0 bytes, 0 underruns
     0 output errors, 0 collisions, 1 interface resets
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions alarm present
  VC 1: timeslot(s): 2-14, Transmitter delay 0, non-inverted data
```

Specifying the Interface Address on a SPA

SPA interface ports begin numbering with "0" from left to right. Single-port SPAs use only the port number 0. To configure or monitor SPA interfaces, you need to specify the physical location of the SIP, SPA, and interface in the CLI. The interface address format is *slot*/*subslot*/*port*, where:

- *slot*—Specifies the chassis slot number in the Cisco 12000 series router where the SIP is installed.
- *subslot*—Specifies the secondary slot of the SIP where the SPA is installed.
- *port*—Specifies the number of the individual interface port on a SPA.

The following example shows how to specify the first interface (0) on a SPA installed in the first subslot of a SIP (0) installed in chassis slot 3:

```
Router(config)# interface serial 3/0/0
```

This command shows a serial SPA as a representative example, however the same *slot*/*subslot*/*port* format is similarly used for other SPAs (such as ATM and POS) and other non-channelized SPAs.

For the 4-Port Channelized T3 Serial SPA, the interface address format is *slot/subslot/port/t1-number*:*channel-group*, where:

- *t1-number*—Specifies the logical T1 number in channelized mode.
- *channel-group*—Specifies the logical channel group assigned to the timeslots within the T1 link.

Optional Configurations

There are several standard, but optional configurations that might be necessary to complete the configuration of your serial SPA.

Note For additional command output details, see Chapter 19, "SIP and SPA Command Reference".

Configuring the Data Service Unit Mode

Configure the SPA to connect with customer premise Data Service Units (DSUs) by setting the DSU mode. Subrating a T3 or E3 interface reduces the peak access rate by limiting the data transfer rate. To configure the Data Service Unit (DSU) mode, use the following commands.

	Command	Purpose
Step 1	Router# **configure terminal**	Enters global configuration mode.
Step 2	Router(config)# **interface serial** *slot/subslot/port*	Selects the controller to configure and enters controller configuration mode. • *slot/subslot/port*—Specifies the location of the controller. See: Specifying the Interface Address on a SPA, page 9-15
Step 3	Router(config-if)# **dsu mode** {**adtran** | **cisco** | **digital-link** | **kentrox** | **larscom** | **verilink**}	Specifies the interoperability mode used by the T3 controller. • **digital-link**—Connects a T3 controller to another T3 controller or to a Digital Link DSU. Bandwidth range is from 300 to 44210 kbps. This is the default. • **kentrox**—Connects a T3 controller to a Kentrox DSU. Bandwidth range is from 1500 to 35000, or 44210 kbps. **Note** If the bandwidth is set between 35000–44210 kbps, an error message is displayed. • **larscom**—Connects a T3 controller to a Larscom DSU. Bandwidth range is from 3100 to 44210 kbps. • **cisco**—Connects a T3 controller to a Cisco DSU. • **adtran**—Connects a T3 controller to an Adtran T3SU 300. Bandwidth range is from 75 to 44210 kbps. • **verilink**—Connects a T3 controller to a Verilink HDM 2182. Bandwidth range is from 1500 to 44210 kbps.
Step 4	Router(config-if)# **dsu bandwidth** *kbps*	Specifies the maximum allowable bandwidth. • *kbps*—Bandwidth range is from 1 to 44210 kbps.

Verifying DSU Mode

Use the **show controllers serial** command to display the DSU mode of the controller:

```
router# show controllers serial
Serial3/1/0 -
   Framing is c-bit, Clock Source is Internal
   Bandwidth limit is 44210, DSU mode 0, Cable length is 10
   rx FEBE since last clear counter 0, since reset 0
   Data in current interval (0 seconds elapsed):
     0 Line Code Violations, 0 P-bit Coding Violation
     0 C-bit Coding Violation
     0 P-bit Err Secs, 0 P-bit Sev Err Secs
     0 Sev Err Framing Secs, 0 Unavailable Secs
     0 Line Errored Secs, 0 C-bit Errored Secs, 0 C-bit Sev Err Secs
     0 Severely Errored Line Secs
     0 Far-End Errored Secs, 0 Far-End Severely Errored Secs
     0 CP-bit Far-end Unavailable Secs
     0 Near-end path failures, 0 Far-end path failures
     0 Far-end code violations, 0 FERF Defect Secs
```

```
      0 AIS Defect Secs, 0 LOS Defect Secs

   Transmitter is sending AIS.
.
..
```

Configuring Maintenance Data Link

MDL messages are used to communicate identification information between local and remote ports. The type of information included in MDL messages includes the equipment identification code (EIC), location identification code (LIC), frame identification code (FIC), unit, Path Facility Identification (PFI), port number, and Generator Identification numbers. To configure Maintenance Data Link (MDL), use the following commands:

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Router(config)# **controller t3** *slot/subslot/port*	Selects the controller to configure and enters controller configuration mode. • *slot/subslot/port*—Specifies the location of the interface. See: Specifying the Interface Address on a SPA, page 9-15
Router(config-controller)# **mdl** [**string** {**eic** | **fic** | **generator** | **lic** | **pfi** | **port** | **unit**} *string*}] | [**transmit** {**idle-signal** | **path** | **test-signal**}]	Configures the MDL message. • **string eic**—Specifies the Equipment Identification Code; can be up to 10 characters. • **string fic**—Specifies the Frame Identification Code; can be up to 10 characters. • **string generator**—Specifies the Generator number string sent in the MDL Test Signal message; can be up to 38 characters. • **string lic**— Specifies the Location Identification Code; can be up to 11 characters. • **string pfi**—Specifies the Path Facility Identification Code sent in the MDL Path message; can be up to 38 characters. • **string port**—Specifies the Port number string sent in the MDL Idle Signal message; can be up to 38 characters. • **string unit**—Specifies the Unit Identification Code; can be up to 6 characters. • **transmit idle-signal**—Enable MDL Idle-Signal message transmission • **transmit path**—Enable MDL Path message transmission. • **transmit test-signal**—Enable MDL Test-Signal message transmission.

Verifying MDL

Use the **show controller** command to display the MDL settings:

```
Router# show controller t3 3/0/0
T3 3/0/0 is down.  Hardware is 2 ports CT3 SPA
  ATLAS FPGA version: 0, FREEDM336 version: 0
  TEMUX84(1) version: 0, TEMUX84(1) version: 0
  SUBRATE FPGA version: 0
  Applique type is Subrate T3
  Receiver has loss of signal.
  MDL transmission is enabled
     EIC: new, LIC: US, FIC: 23, UNIT: myunit
     Path FI: test pfi
     Idle Signal PORT_NO: New-port
     Test Signal GEN_NO: test-message
  FEAC code received: No code is being received
  Framing is C-BIT Parity, Line Code is B3ZS, Clock Source is Line
  Equipment customer loopback
  Data in current interval (869 seconds elapsed):
     0 Line Code Violations, 0 P-bit Coding Violation
     0 C-bit Coding Violation, 0 P-bit Err Secs
     0 P-bit Severely Err Secs, 0 Severely Err Framing Secs
     869 Unavailable Secs, 0 Line Errored Secs
     0 C-bit Errored Secs, 0 C-bit Severely Errored Secs
     0 Severely Errored Line Secs
     0 Far-End Errored Secs, 0 Far-End Severely Errored Secs
     869 CP-bit Far-end Unavailable Secs
     0 Near-end path failures, 0 Far-end path failures
     0 Far-end code violations, 0 FERF Defect Secs
     0 AIS Defect Secs, 870 LOS Defect Secs
```

Configuring Encapsulation

When traffic crosses a WAN link, the connection needs a Layer 2 protocol to encapsulate traffic. To set the encapsulation method, use the following commands:

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Channelized: Router(config)# **interface serial** *slot/subslot/port/t1-number:channel-group* Un-channelized: Router(config)# **interface serial** *slot/subslot/port*	Selects the interface to configure and enters interface configuration mode. • Channelized: *slot/subslot/port/t1-number:channel-group*—Specifies the location of the interface. See: Specifying the Interface Address on a SPA, page 9-15 • Un-channelized: *slot/subslot/port*—Specifies the location of the interface. See: Specifying the Interface Address on a SPA, page 9-15
Router(config-if)# **encapsulation** {**hdlc** | **ppp** | **frame-relay**}	Set the encapsulation method on the interface. • **hdlc**—High-Level Data Link Control (HDLC) protocol for serial interface. This is the default. • **ppp**—Point-to-Point Protocol (PPP) (for serial interface). • **frame-relay**—Frame Relay (for serial interface).

Verifying Encapsulation

Use the **show interface serial** command to display the encapsulation method:

```
Router# show interface serial3/0/0
Serial3/0/0 is down, line protocol is down
  Hardware is Channelized/ClearChannel CT3 SPA
  MTU 4470 bytes, BW 44210 Kbit, DLY 200 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation HDLC, crc 16, loopback not set
  Keepalive set (10 sec)
  Last input never, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     0 packets input, 0 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicast)
     0 runts, 0 giants, 0 throttles
              0 parity
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     0 packets output, 0 bytes, 0 underruns
     0 output errors, 0 applique, 2 interface resets
```

```
     0 output buffer failures, 0 output buffers swapped out
     1 carrier transitions alarm present
  DSU mode 0, bandwidth 44210 Kbit, scramble 0, VC 0
```

Configuring T3 Framing

To set the T3 framing type, use the following commands:

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Router(config)# **interface serial** *slot/subslot/port*	Selects the interface to configure and enters interface configuration mode. • *slot/subslot/port*—Specifies the location of the interface. See: "Specifying the Interface Address on a SPA" section on page 9-15
Router(config-if)# **framing** {**auto-detect** | **c-bit** | **m23**}	Specifies the framing type in unchannelized mode. • **auto-detect**—Specifies auto-detect framing. • **c-bit**—Specifies C-bit parity framing. This is the default. • **m23**—Specifies DS3 Framing M23.

Verifying Framing

Use the **show controller** command to display the framing type:

```
Router# show controller t3 3/0/0
T3 3/0/0 is down.  Hardware is 2 ports CT3 SPA
  ATLAS FPGA version: 0, FREEDM336 version: 0
  TEMUX84(1) version: 0, TEMUX84(1) version: 0
  SUBRATE FPGA version: 0
  Applique type is Subrate T3
  Receiver has loss of signal.
  Framing is M13, Line Code is B3ZS, Clock Source is Line
  Equipment customer loopback
  Data in current interval (656 seconds elapsed):
     0 Line Code Violations, 0 P-bit Coding Violation
     0 C-bit Coding Violation, 0 P-bit Err Secs
     0 P-bit Severely Err Secs, 0 Severely Err Framing Secs
     666 Unavailable Secs, 0 Line Errored Secs
     0 C-bit Errored Secs, 0 C-bit Severely Errored Secs
     0 Severely Errored Line Secs
     0 Far-End Errored Secs, 0 Far-End Severely Errored Secs
     0 CP-bit Far-end Unavailable Secs
     0 Near-end path failures, 0 Far-end path failures
     0 Far-end code violations, 0 FERF Defect Secs
     0 AIS Defect Secs, 666 LOS Defect Secs
```

Configuring FDL

Facility Data Link (FDL) is a far-end performance reporting tool. In ansi mode, you can enable 1-second transmissions of performance reports on both ends of the T1 connection. To configure FDL, use the following commands:

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Router(config)# **controller t3** *slot/subslot/port*	Selects the controller to configure and enters controller configuration mode. • *slot/subslot/port*—Specifies the location of the interface. See: "Specifying the Interface Address on a SPA" section on page 9-15
Router(config-controller)# **t1** *number* **fdl** {**ansi**}	(Optional) Enables FDL. • *number*—Specifies the T1 channel number. • **ansi**—Specifies the FDL bit per the ANSI T1.403 specification.

Verifying FDL

Use the **show controller** command to display the FDL setting:

```
Router# show controller t3 3/0/1/1
T3 3/0/1 is down.  Hardware is 2 ports CT3 SPA
  ATLAS FPGA version: 0, FREEDM336 version: 0
  TEMUX84(1) version: 0, TEMUX84(1) version: 0
  SUBRATE FPGA version: 0
  Applique type is Channelized T3
  Receiver has loss of signal.
  Framing is M23, Line Code is B3ZS, Clock Source is Internal
  Equipment customer loopback
  Data in current interval (456 seconds elapsed):
     0 Line Code Violations, 0 P-bit Coding Violation
     0 C-bit Coding Violation, 0 P-bit Err Secs
     0 P-bit Severely Err Secs, 0 Severely Err Framing Secs
     456 Unavailable Secs, 0 Line Errored Secs
     0 C-bit Errored Secs, 0 C-bit Severely Errored Secs
     0 Severely Errored Line Secs
     0 Far-End Errored Secs, 0 Far-End Severely Errored Secs
     0 CP-bit Far-end Unavailable Secs
     0 Near-end path failures, 0 Far-end path failures
     0 Far-end code violations, 0 FERF Defect Secs
     0 AIS Defect Secs, 456 LOS Defect Secs

  T1 1 is down
  timeslots: 2-14
  FDL per ANSI T1.403 and AT&T 54016 spec.
  Configured for FDL remotely line looped (bell)
  Transmitter is sending LOF Indication.
  Receiver is getting AIS.
  Framing is ESF, Clock Source is Line
  BERT running on timeslots 2,3,4,5,6,7,8,9,10,11,12,13,14,
  BERT test result (running)
     Test Pattern : All 1's, Status : Not Sync, Sync Detected : 0
     Interval : 2 minute(s), Time Remain : 2 minute(s)
     Bit Errors (since BERT started): 0 bits,
```

```
     Bits Received (since BERT started): 0 Kbits
     Bit Errors (since last sync): 0 bits
     Bits Received (since last sync): 0 Kbits
  Data in current interval (703 seconds elapsed):
     0 Line Code Violations, 0 Path Code Violations
     0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs
     713 Unavail Secs, 0 Stuffed Secs
     357 Near-end path failures, 0 Far-end path failures, 0 SEF/AIS Secs
```

Configuring Scramble

T3 scrambling is used to assist clock recovery on the receiving end. Scrambling is designed to randomize the pattern of 1s and 0s carried in the physical layer frame. Randomizing the digital bits can prevent continuous, nonvariable bit patterns—in other words, long strings of all 1s or all 0s. Several physical layer protocols rely on transitions between 1s and 0s to maintain clocking.

Scrambling can prevent some bit patterns from being mistakenly interpreted as alarms by switches placed between the Data Service Units (DSUs).

To configure scrambling, use the following commands:

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Router(config)# **interface serial** *slot/subslot/port*	Selects the interface to configure and enters interface configuration mode. • *slot/subslot/port*—Specifies the location of the interface. See: "Specifying the Interface Address on a SPA" section on page 9-15
Router(config-if)# **scramble**	Enables scrambling. Scrambling is disabled by default.

Verifying Scrambling

Use the **show interface serial** command to display the scramble setting:

```
Router# show interface serial3/0/0
Serial3/0/0 is down, line protocol is down
  Hardware is Channelized/ClearChannel CT3 SPA
  MTU 4470 bytes, BW 44210 Kbit, DLY 200 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation HDLC, crc 16, loopback not set
  Keepalive set (10 sec)
  Last input never, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     0 packets input, 0 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicast)
     0 runts, 0 giants, 0 throttles
              0 parity
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     0 packets output, 0 bytes, 0 underruns
```

```
     0 output errors, 0 applique, 4 interface resets
     0 output buffer failures, 0 output buffers swapped out
     1 carrier transitions alarm present
  DSU mode 0, bandwidth 44210 Kbit, scramble 1, VC 0
```

Saving the Configuration

To save your running configuration to nonvolatile random-access memory (NVRAM), use the following command in privileged EXEC configuration mode:

Command	Purpose
Router# **copy running-config startup-config**	Writes the new configuration to NVRAM.

For more information about managing configuration files, refer to the *Cisco IOS Configuration Fundamentals Configuration Guide, Release 12.2* and *Cisco IOS Configuration Fundamentals Command Reference, Release 12.2* publications.

Verifying the Interface Configuration

Besides using the **show running-configuration** command to display your Cisco 12000 Series router configuration settings, you can use the **show interfaces serial** and the **show controllers serial** commands to get detailed information on a per-port basis for your 2-Port and 4-Port T3/E3 Serial SPA.

Verifying Per-Port Interface Status

To find detailed interface information on a per-port basis for the 2-Port and 4-Port Channelized T3 SPA, use the **show interfaces serial** command. For a description of the command output, see Chapter 19, "SIP and SPA Command Reference."

The following example provides sample output for the serial interface on an un-channelized T3:

```
Router# show interface serial3/0/0
Serial3/0/0 is down, line protocol is down
  Hardware is Channelized/ClearChannel CT3 SPA
  MTU 4470 bytes, BW 44210 Kbit, DLY 200 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation HDLC, crc 16, loopback not set
  Keepalive set (10 sec)
  Last input never, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     0 packets input, 0 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicast)
     0 runts, 0 giants, 0 throttles
              0 parity
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     0 packets output, 0 bytes, 0 underruns
     0 output errors, 0 applique, 4 interface resets
     0 output buffer failures, 0 output buffers swapped out
```

```
     1 carrier transitions alarm present
  DSU mode 0, bandwidth 44210 Kbit, scramble 1, VC 0
```

The following example provides sample output for the serial interface on a channelized T3:

```
Router# show interface serial3/0/1/1:0
Serial3/0/1/1:0 is down, line protocol is down
  Hardware is Channelized/ClearChannel CT3 SPA
  MTU 1500 bytes, BW 832 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation HDLC, crc 16, loopback not set
  Keepalive set (10 sec)
  Last input never, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     0 packets input, 0 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicast)
     0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     0 packets output, 0 bytes, 0 underruns
     0 output errors, 0 collisions, 2 interface resets
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions alarm present
  VC 1: timeslot(s): 2-14, Transmitter delay 0, non-inverted data
```

To find detailed status and statistical information on a per-port basis for the 2-Port and 4-Port T3/E3 Serial SPA, use the **show controllers serial** command. For a description of the command output, see Chapter 19, "SIP and SPA Command Reference."

The following example provides sample controller statistics for the third port on the SPA located in the first subslot of the SIP-200 that is installed in slot 5 of a Cisco 12008 router:

```
show controller serial 5/0/2
Serial5/0/2 -
   Framing is c-bit, Clock Source is Line
   Bandwidth limit is 44210, DSU mode 0, Cable length is 10
   rx FEBE since last clear counter 0, since reset 0
   Data in current interval (807 seconds elapsed):
     0 Line Code Violations, 0 P-bit Coding Violation
     0 C-bit Coding Violation
     0 P-bit Err Secs, 0 P-bit Sev Err Secs
     0 Sev Err Framing Secs, 306 Unavailable Secs
     500 Line Errored Secs, 0 C-bit Errored Secs, 0 C-bit Sev Err Secs
  Data in Interval 1:
     0 Line Code Violations, 0 P-bit Coding Violation
     0 C-bit Coding Violation
     0 P-bit Err Secs, 0 P-bit Sev Err Secs
     0 Sev Err Framing Secs, 0 Unavailable Secs
     564 Line Errored Secs, 0 C-bit Errored Secs, 0 C-bit Sev Err Secs
  Data in Interval 2:
     0 Line Code Violations, 0 P-bit Coding Violation
     0 C-bit Coding Violation
     0 P-bit Err Secs, 0 P-bit Sev Err Secs
     0 Sev Err Framing Secs, 0 Unavailable Secs
     564 Line Errored Secs, 0 C-bit Errored Secs, 0 C-bit Sev Err Secs
  Data in Interval 3:
     0 Line Code Violations, 0 P-bit Coding Violation
     0 C-bit Coding Violation
     0 P-bit Err Secs, 0 P-bit Sev Err Secs
     0 Sev Err Framing Secs, 0 Unavailable Secs
```

```
    562 Line Errored Secs, 0 C-bit Errored Secs, 0 C-bit Sev Err Secs
 Data in Interval 4:
    0 Line Code Violations, 0 P-bit Coding Violation
    0 C-bit Coding Violation
    0 P-bit Err Secs, 0 P-bit Sev Err Secs
    0 Sev Err Framing Secs, 0 Unavailable Secs
    560 Line Errored Secs, 0 C-bit Errored Secs, 0 C-bit Sev Err Secs
   .
   .
   .
   Total Data (last 44 15 minute intervals):
        0 Line Code Violations, 0 P-bit Coding Violation,
        0 C-bit Coding Violation,
        0 P-bit Err Secs, 0 P-bit Sev Err Secs,
        0 Sev Err Framing Secs, 0 Unavailable Secs,
        24750 Line Errored Secs, 0 C-bit Errored Secs, 0 C-bit Sev Err Secs

     Transmitter is sending AIS.

     Receiver has loss of signal.

      40434 Sev Err Line Secs, 0 Far-End Err Secs, 0 Far-End Sev Err Secs
      0 P-bit Unavailable Secs, 0 CP-bit Unavailable Secs
      0 CP-bit Far-end Unavailable Secs
      0 Near-end path failures, 0 Far-end path failures

     No FEAC code is being received
    MDL transmission is disabled
```

Configuration Examples

This section includes the following configuration examples:

- DSU Configuration Example, page 9-27
- MDL Configuration Example, page 9-28
- Encapsulation Configuration Example, page 9-28
- Framing - Unchannelized Mode Configuration Example, page 9-28
- Facility Data Link Configuration Example, page 9-29
- Scrambling Configuration Example, page 9-29

DSU Configuration Example

The following example sets the DSU mode on interface port 0 on slot 4, subslot 1.

```
! Specify the interface and enter interface configuration mode.
!
Router(config-int)# interface t3 4/1/0
!
!Specifies the interoperability mode used by the T3 interface.
!
Router(config-int)# dsu mode 2
!
!Specifies the maximum allowable bandwidth.

Router(config-int)# dsu bandwidth 23000
```

MDL Configuration Example

The following example configures the MDL strings on controller port 0 on slot 4, subslot 1.

```
! Enter controller configuration mode.
!
Router(config)# controller t3 4/1/0
!
! Specify the mdl strings.
!
Router(config-controller)# mdl string eic beic
Router(config-controller)# mdl string lic beic
Router(config-controller)# mdl string fic bfix
Router(config-controller)# mdl string unit bunit
Router(config-controller)# mdl string pfi bpfi
Router(config-controller)# mdl string port bport
Router(config-controller)# mdl string generator bgen
Router(config-controller)# mdl transmit path
Router(config-controller)# mdl transmit idle-signal
Router(config-controller)# mdl transmit test-signal
```

Encapsulation Configuration Example

The following example configures encapsulation on a channelized T1 interface.

```
! Specify the interface to configure and enter interface configuration mode.
!
Router(config)# interface serial 4/1/1/1:0
!
! Specify the encapsulation method.
!
Router(config-if)# encapsulation ppp
```

The following example configures encapsulation and framing on a un-channelized T3 interface.

```
! Specify the interface to configure and enter interface configuration mode.
!
Router(config)# interface serial 4/1/1
!
! Specify the encapsulation method.
!
Router(config-if)# encapsulation ppp
```

Framing - Unchannelized Mode Configuration Example

The following example configures framing on an un-channelized T3 interface.

```
! Specify the interface to configure and enter interface configuration mode.
!
Router(config)# interface serial 4/1/1
!
! Specify the framing type.
!
Router(config-if)# framing m13
```

Facility Data Link Configuration Example

The following example configures FDL on a channelized T1 interface.

```
! Specify the controller to configure and enter controller configuration mode.
!
Router(config)# controller t3 3/1/0
!
! Specify the T1 controller and set the FDL bit.
!
Router(config-controller)# t1 1 fdl ansi
```

Scrambling Configuration Example

The following example configures scrambling on the T3 interface:

```
! Enter global configuration mode.
!
Router# configure terminal
!
! Specify the interface to configure and enter interface configuration mode.
!
Router(config)# interface serial 4/1/3
!
! Enable scrambling.
!
Router(config-if)# scrambling
```

CHAPTER 10

Configuring the 2-Port and 4-Port T3/E3 SPAs

This chapter provides information about configuring the 2-Port and 4-Port T3/E3 Shared Port Adapters (SPAs) on the Cisco 12000 Series routers. It includes the following sections:

For information about managing your system images and configuration files, refer to the *Cisco IOS Configuration Fundamentals Configuration Guide, Release 12.0* and *Cisco IOS Configuration Fundamentals Command Reference, Release 12.0* publications.

For more information about the commands used in this chapter, see Chapter 19, "SIP and SPA Command Reference," in this guide, which documents new and modified commands. Also refer to the related Cisco IOS Release 12.0 software command reference and master index publications. For more information about accessing these publications, see the Related Documentation section in the "Preface".

Configuration Tasks

This section describes how to configure the 2-Port or 4-Port T3/E3 SPA for the Cisco12000 series routers and includes information about verifying the configuration.

It includes the following topics:

Required Configuration Tasks

This section lists the required configuration steps to configure the 2-Port or 4-Port T3/E3 SPA. Some of the required configuration commands implement default values that might be appropriate for your network. If the default value is correct for your network, then you do not need to configure the command.

- Setting the Card Type
- Configure the Interface

Note To better understand the address format used to specify the physical location of the SPA Interface Processor (SIP), SPA, and interfaces, see the: "Specifying the Interface Address on a SPA" section on page 10-3.

Setting the Card Type

The SPA is not functional until the card type is set. Information about the SPA is not indicated in the output of any show commands until the card type has been set. There is no default card type.

Note Mixing of interface types is not supported. All ports on a SPA will be the of the same type.

To set the card type for the 2-Port or 4-Port T3/E3 SPA, complete these steps:

	Command	Purpose
Step 1	Router# **configure terminal**	Enters global configuration mode.
Step 2	Router(config)# **card type** {**t3** | **e3**} *slot subslot*	Sets the serial mode for the SPA: • **t3**—Specifies T3 connectivity of 44210 kbps through the network, using B3ZS coding. • **e3**—Specifies a wide-area digital transmission scheme used predominantly in Europe that carries data at a rate of 34010 kbps. • *slot subslot*—Specifies the location of the SPA. See the: "Specifying the Interface Address on a SPA" section on page 10-3
Step 3	Router(config)# **exit**	Exit configuration mode and return to the EXEC command interpreter prompt.

Configure the Interface

To set the ip address for the 2-Port or 4-Port T3/E3 SPA, complete these steps:

	Command	Purpose
Step 1	Router(config)# **interface serial** *slot/subslot/port*	Selects the interface to configure and enters interface configuration mode. • *slot/subslot/port*—Specifies the location of the interface. See the: "Specifying the Interface Address on a SPA" section on page 10-3
Step 2	Router(config-if)# **ip address** *address mask*	Sets the IP address and subnet mask. • *address*—IP address • *mask*—Subnet mask
Step 3	Router(config-if)# **clock source** {**internal** | **line**}	Sets the clock source to internal. • **internal**—Specifies that the internal clock source is used. • **line**—Specifies that the network clock source is used. This is the default.
Step 4	Router(config-if)# **no shut**	Enables the interface.
Step 5	Router(config)# **exit**	Exits configuration mode and returns to the EXEC command interpreter prompt.

Verifying Interface Configuration

Use the **show interfaces** command to verify the interface configuration:

```
router# show interfaces serial 0/0/0
show interfaces serial 0/0/0
Serial0/0/0 is up, line protocol is up
  Hardware is SPA-4T3E3
  Internet address is 111.1.1.1/24
  MTU 4470 bytes, BW 44210 Kbit, DLY 200 usec, rely 255/255, load 1/255
  Encapsulation HDLC, crc 32, loopback not set
  Keepalive not set
  Last input 00:00:52, output 2d03h, output hang never
  Last clearing of "show interface" counters 11:07:23
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
        Available Bandwidth 44210 kilobits/sec
  30 second input rate 0 bits/sec, 0 packets/sec
  30 second output rate 0 bits/sec, 0 packets/sec
     1334 packets input, 510922 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
              0 parity
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     0 packets output, 0 bytes, 0 underruns
     0 output errors, 0 applique, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions
```

Specifying the Interface Address on a SPA

SPA interface ports begin numbering with "0" from left to right. Single-port SPAs use only the port number 0. To configure or monitor SPA interfaces, you need to specify the physical location of the SIP, SPA, and interface in the CLI. The interface address format is *slot/subslot/port*, where:

- *slot*—Specifies the chassis slot number in the Cisco 12000 Series Router where the SIP is installed.
- *subslot*—Specifies the secondary slot of the SIP where the SPA is installed.
- *port*—Specifies the number of the individual interface port on a SPA.

The following example shows how to specify the first interface (0) on a SPA installed in the first subslot of a SIP (0) installed in chassis slot 3:

```
Router(config)# interface serial 3/0/0
```

This command shows a serial SPA as a representative example, however the same *slot/subslot/port* format is similarly used for other SPAs (such as ATM and POS) and other non-channelized SPAs.

Optional Configurations

There are several standard, but optional configurations that might be necessary to complete the configuration of your serial SPA.

Note For additional command output details, see Chapter 19, "SIP and SPA Command Reference".

Configuring Data Service Unit Mode

Configure the SPA to connect with customer premise Data Service Units (DSUs) by setting the DSU mode. Subrating a T3 or E3 interface reduces the peak access rate by limiting the data transfer rate. To configure the DSU mode and bandwidth, use the following commands:

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Router(config)# **interface serial** *slot/subslot/port*	Selects the interface to configure and enters interface configuration mode. • *slot/subslot/port*—Specifies the location of the interface. See the: "Specifying the Interface Address on a SPA" section on page 10-3

Command	Purpose
T3: Router(config-if)# E3: Router(config-if)# **dsu mode {cisco | digital-link | kentrox | larscom}**	Specifies the interoperability mode used by a T3 controller. • **cisco**—Connects to Cisco DSU. • **digital-link**—Connects a T3/E3 controller to another T3/E3 controller or to a Digital Link DSU (DL3100 in T3 mode and DL3100E in E3 mode). This is the default. • **kentrox**—Connects a T3/E3 controller to a Kentrox DataSMART T3/E3 IDSU. • **larscom**—Connects a T3 controller to a Larscom Access-T45 DS3 DSU. This mode does not exist for the E3 card type.
Router(config-if)# **dsu bandwidth** *kbps*	Specifies the allowable bandwidth. • *kbps*—The bandwidth range and increment values are based on the specific DSU. Default for T3 mode is 44010 kbps and 34010 kbps for E3 mode. • Digital Link DL3100 – range: 300 to 44210 kbps – increments: 300 kbps • Digital Link DL3100E – range: 358 to 34010 kbps – increments: 358 kbps • Kentrox DataSMART T3/E3 IDSU – range: 1000 to 34000 kbps (E3 mode) – range: 1500 to 44210 kbps (T3 mode) – increments: 500 kbps • Larscom Access-T45 DS3 – range: 3100 to 44210 kbps – increments: 3100 kbps • Adtran T3SU 300 – range: 80 to 44210 kbps – increments: 80 kbps • Verilink HDM 2182 – range: 1600 to 31600 kbps – increments: 1600 kbps

Command	Purpose
Router(config-if)# **remote** {**accept** | **fullrate**}	Specifies where the DSU bandwidth is set. • **accept**—Accept incoming remote requests to reset the DSU bandwidth. • **fullrate**—Set far end DSU to its fullrate bandwidth.

Configuring Maintenance Data Link

MDL messages are used to communicate identification information between local and remote ports. The type of information included in MDL messages includes the equipment identification code (EIC), location identification code (LIC), frame identification code (FIC), unit, Path Facility Identification (PFI), port number, and Generator Identification numbers.

Note C-bit framing has to be enabled in order to transport MDL messages between source and destination T3 ports.

To configure Maintenance Data Link (MDL), use the following commands.

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Router(config)# **interface serial** *slot/subslot/port*	Selects the interface to configure. • *slot/subslot/port*—Specifies the location of the interface. See the: "Specifying the Interface Address on a SPA" section on page 10-3

Command	Purpose
Router(config-if)# **mdl** [**string** {**eic** | **fic** | **generator** | **lic** | **pfi** | **port** | **unit**} *string*}] | [**transmit** {**idle-signal** | **path** | **test-signal**}]	Configures the Maintenance Data Link (MDL) message. • **eic** *string*—Equipment identification code (up to 10 characters), which is a value used to describe a specific piece of equipment according to ANSI T1.107-1995. • **fic** *string*—Frame identification code (up to 10 characters), which is a value used to identify where the equipment is located within a building at a given location according to ANSI T1.107-1995. • **generator** *string*—Specifies the Generator number string sent in the MDL Test Signal message; can be up to 38 characters. • **lic** *string*—Location identification code (up to 11 characters), which is a value used to describe a specific location according to ANSI T1.107-1995. • **pfi** *string*—Specifies the Path Facility Identification Code sent in the MDL Path message; can be up to 38 characters. • **port** *string*—Specifies the Port number string sent in the MDL Idle Signal message; can be up to 38 characters. • **unit** *string*—Unit identification code (up to 6 characters), which is a value that identifies the equipment location within a subslot according to ANSI T1.107-1995. • **transmit idle-signal**—Enables transmission of the MDL idle signal message. An MDL idle signal message, as defined by ANSI T1.107, is distinguished from path and test signal messages in that it contains a port number as its final data element. • **transmit path**—Enables transmission of the MDL path message. An MDL path message, as defined by ANSI T1.107, is distinguished from idle and test signal messages in that it contains a facility identification code as its final data element. • **transmit test-signal**—Enables transmission of the MDL test signal message. An MDL test signal message, as defined by ANSI T1.107, is distinguished from path and idle signal messages in that it contains a generator number as its final data element.

Configuring Scramble

T3/E3 scrambling is used to assist clock recovery on the receiving end. Scrambling is designed to randomize the pattern of 1s and 0s carried in the physical layer frame. Randomizing the digital bits can prevent continuous, nonvariable bit patterns—in other words, long strings of all 1s or all 0s. Several physical layer protocols rely on transitions between 1s and 0s to maintain clocking.

Scrambling can prevent some bit patterns from being mistakenly interpreted as alarms by switches placed between the Data Service Units (DSUs).

To configure scrambling, use the following commands:

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Router(config)# **interface serial** *slot/subslot/port*	Selects the interface to configure. • *slot/subslot/port*—Specifies the location of the interface. See the: "Specifying the Interface Address on a SPA" section on page 10-3
Router(config-if)# [**no**] **scramble**	Enables scrambling. Scrambling is disabled by default. • **scramble**—Enable scramble. • **no scramble**—Disable scramble. **Note** When using framing bypass, **no scrambling** must be configured.

Configuring Framing

Framing is used to synchronize data transmission on the line. Framing allows the hardware to determine when each packet starts and ends. To configure framing, use the following commands.

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Router(config)# **interface serial** *slot/subslot/port*	Selects the interface to configure. • *slot/subslot/port*—Specifies the location of the T3/E3 interface. See the: "Specifying the Interface Address on a SPA" section on page 10-3
T3: Router(config-if)# **framing { c-bit | m13}**	Sets the framing on the interface. • **c-bit**—Specifies C-bit parity framing. This is the default for T3. • **m13**—Specifies M13 framing.

Configuring Encapsulation

When traffic crosses a WAN link, the connection needs a Layer 2 protocol to encapsulate traffic. To set the encapsulation method, use the following commands:

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Router(config)# **interface serial** *slot/subslot/port*	Selects the interface to configure. • *slot/subslot/port*—Specifies the location of the interface. See the: "Specifying the Interface Address on a SPA" section on page 10-3
Router(config-if)# **encapsulation** {**hdlc** | **ppp** | **frame-relay**}	Sets the encapsulation method on the interface. • **hdlc**—High-Level Data Link Control (HDLC) protocol for serial interface. This is the default. • **ppp**—PPP (for serial interface). • **frame-relay**—Frame Relay (for serial interface).

Verifying Encapsulation

Use the **show interfaces** command to display the encapsulation method:

```
router# show interfaces serial 0/0/0
show interfaces serial 0/0/0
Serial0/0/0 is up, line protocol is up
  Hardware is SPA-4T3E3
  Internet address is 111.1.1.1/24
  MTU 4470 bytes, BW 44210 Kbit, DLY 200 usec, rely 255/255, load 1/255
  Encapsulation HDLC, crc 32, loopback not set
  Keepalive not set
  Last input 00:00:52, output 2d03h, output hang never
  Last clearing of "show interface" counters 11:07:23
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
        Available Bandwidth 44210 kilobits/sec
  30 second input rate 0 bits/sec, 0 packets/sec
  30 second output rate 0 bits/sec, 0 packets/sec
     1334 packets input, 510922 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
              0 parity
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     0 packets output, 0 bytes, 0 underruns
     0 output errors, 0 applique, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions
```

Configuring Cable Length

The **cablelength** command compensates for the loss in decibels based on the distance from the device to the first repeater in the circuit. A longer distance from the device to the repeater requires that the signal strength on the circuit be boosted to compensate for loss over that distance. To configure cable length, use the following commands:

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Router(config)# **interface serial** *slot/subslot/port*	Selects the interface to configure and enters interface configuration mode. • *slot/subslot/port*—Specifies the location of the interface. See the: "Specifying the Interface Address on a SPA" section on page 10-3
Router(config-if)# **cablelength** *length*	Sets the cable length. • *length*—Range is 0-450 feet. The default is 50 feet. **Note** The cable length command is not available in E3 mode.

Verify Cable Length Setting

Use the **show interfaces serial** command to verify the cable length setting:

```
router# show interfaces serial 0/0/0
Serial0/0/0 is up, line protocol is up
  Hardware is SPA-4T3E3
  Internet address is 111.1.1.1/24
  MTU 4470 bytes, BW 44210 Kbit, DLY 200 usec, rely 255/255, load 1/255
  Encapsulation HDLC, crc 32, loopback not set
  Keepalive not set
  Last input 00:00:52, output 2d03h, output hang never
  Last clearing of "show interface" counters 11:07:23
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
        Available Bandwidth 44210 kilobits/sec
  30 second input rate 0 bits/sec, 0 packets/sec
  30 second output rate 0 bits/sec, 0 packets/sec
     1334 packets input, 510922 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
              0 parity
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     0 packets output, 0 bytes, 0 underruns
     0 output errors, 0 applique, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions.
.
.
```

Configuring Invert Data

Delays between the TE clock and data transmission indicate that the transmit clock signal might not be appropriate for the interface rate and length of cable being used. Different ends of the wire may have variances that differ slightly. Invert the clock signal to compensate for these factors. To configure invert data, use the following commands:

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Router(config)# **interface serial** *slot/subslot/port*	Selects the interface to configure and enters interface configuration mode. • *slot/subslot/port*—Specifies the location of the interface. See the: "Specifying the Interface Address on a SPA" section on page 10-3
Router(config-if)# **invert** {**data**}	Inverts the data. • **data**—Invert the data stream.

Verify Invert Data Setting

Use the **show running configuration** command to verify that invert data was set on the interface:

```
router# show running configuration
.
.
.
interface Serial6/0/0
 ip address 51.1.1.1 255.255.255.0
 logging event link-status
 dsu bandwidth 44210
 framing c-bit
 cablelength 10
 clock source internal
 invert data
 mdl string eic tst
 mdl string lic 67
 mdl string generator test
 mdl transmit path
 mdl transmit test-signal
 no cdp enable
!
.
.
.
```

Saving the Configuration

To save your running configuration to nonvolatile random-access memory (NVRAM), use the following command in privileged EXEC configuration mode:

Command	Purpose
Router# **copy running-config startup-config**	Writes the new configuration to NVRAM.

For more information about managing configuration files, refer to the *Cisco IOS Configuration Fundamentals Configuration Guide, Release 12.2* and *Cisco IOS Configuration Fundamentals Command Reference, Release 12.2* publications.

Verifying the Interface Configuration

Besides using the **show running-configuration** command to display your Cisco 12000 Series router configuration settings, you can use the **show interfaces serial** and the **show controllers serial** commands to get detailed information on a per-port basis for your 2-Port or 4-Port T3/E3 SPA.

Verifying Per-Port Interface Status

To find detailed interface information on a per-port basis for the 2-Port or 4-Port T3/E3 SPA, use the **show interfaces serial** command. For a description of the command output, see Chapter 19, "SIP and SPA Command Reference."

The following example provides sample output for interface port 1 on the SPA located in the first subslot of the SIP installed in slot 5 of a Cisco 12008 router:

```
Router# show interface serial 5/0/1
Serial5/0/1 is up, line protocol is up
  Hardware is SPA-4T3E3
  Internet address is 120.1.1.1/24
  MTU 4470 bytes, BW 44210 Kbit, DLY 200 usec,
     reliability 255/255, txload 234/255, rxload 234/255
  Encapsulation HDLC, crc 16, loopback not set
  Keepalive set (10 sec)
  Last input 00:00:00, output 00:00:01, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 40685000 bits/sec, 115627 packets/sec
  5 minute output rate 40685000 bits/sec, 115624 packets/sec
     4652915554 packets input, 204728203496 bytes, 0 no buffer
     Received 4044 broadcasts (0 IP multicast)
     130 runts, 0 giants, 0 throttles
              0 parity
     1595 input errors, 543 CRC, 0 frame, 0 overrun, 0 ignored, 922 abort
     4653081242 packets output, 204735493748 bytes, 0 underruns
     0 output errors, 0 applique, 4 interface resets
     0 output buffer failures, 0 output buffers swapped out
     2 carrier transitions
```

Monitoring Per-Port Interface Statistics

To find detailed status and statistical information on a per-port basis for the 2-Port or 4-Port T3/E3 SPA, use the **show controllers serial** command. For a description of the command output, see Chapter 19, "SIP and SPA Command Reference."

The following example provides sample output for interface port 1 on the SPA located in the first subslot of the SIP that is installed in slot 5 of the Cisco 12008 router:

```
show controller serial 5/0/2
Serial5/0/2 -
   Framing is c-bit, Clock Source is Line
   Bandwidth limit is 44210, DSU mode 0, Cable length is 10
   rx FEBE since last clear counter 0, since reset 0
   Data in current interval (807 seconds elapsed):
     0 Line Code Violations, 0 P-bit Coding Violation
     0 C-bit Coding Violation
     0 P-bit Err Secs, 0 P-bit Sev Err Secs
```

```
      0 Sev Err Framing Secs, 306 Unavailable Secs
      500 Line Errored Secs, 0 C-bit Errored Secs, 0 C-bit Sev Err Secs
   Data in Interval 1:
      0 Line Code Violations, 0 P-bit Coding Violation
      0 C-bit Coding Violation
      0 P-bit Err Secs, 0 P-bit Sev Err Secs
      0 Sev Err Framing Secs, 0 Unavailable Secs
      564 Line Errored Secs, 0 C-bit Errored Secs, 0 C-bit Sev Err Secs
   Data in Interval 2:
      0 Line Code Violations, 0 P-bit Coding Violation
      0 C-bit Coding Violation
      0 P-bit Err Secs, 0 P-bit Sev Err Secs
      0 Sev Err Framing Secs, 0 Unavailable Secs
      564 Line Errored Secs, 0 C-bit Errored Secs, 0 C-bit Sev Err Secs
   Data in Interval 3:
      0 Line Code Violations, 0 P-bit Coding Violation
      0 C-bit Coding Violation
      0 P-bit Err Secs, 0 P-bit Sev Err Secs
      0 Sev Err Framing Secs, 0 Unavailable Secs
      562 Line Errored Secs, 0 C-bit Errored Secs, 0 C-bit Sev Err Secs
   Data in Interval 4:
      0 Line Code Violations, 0 P-bit Coding Violation
      0 C-bit Coding Violation
      0 P-bit Err Secs, 0 P-bit Sev Err Secs
      0 Sev Err Framing Secs, 0 Unavailable Secs
      560 Line Errored Secs, 0 C-bit Errored Secs, 0 C-bit Sev Err Secs
     .
     .
     .
     Total Data (last 44 15 minute intervals):
          0 Line Code Violations, 0 P-bit Coding Violation,
          0 C-bit Coding Violation,
          0 P-bit Err Secs, 0 P-bit Sev Err Secs,
          0 Sev Err Framing Secs, 0 Unavailable Secs,
          24750 Line Errored Secs, 0 C-bit Errored Secs, 0 C-bit Sev Err Secs

        Transmitter is sending AIS.

        Receiver has loss of signal.

         40434 Sev Err Line Secs, 0 Far-End Err Secs, 0 Far-End Sev Err Secs
         0 P-bit Unavailable Secs, 0 CP-bit Unavailable Secs
         0 CP-bit Far-end Unavailable Secs
         0 Near-end path failures, 0 Far-end path failures

        No FEAC code is being received
       MDL transmission is disabled
```

Configuration Examples

This section includes the following configuration examples:

- DSU Configuration Example, page 10-15
- MDL Configuration Example, page 10-15
- Scrambling Configuration Example, page 10-15
- Framing Configuration Example, page 10-16
- Encapsulation Configuration Example, page 10-16
- Cable Length Configuration Example, page 10-16

- Invert Data Configuration Example, page 10-16
- Trace Trail Buffer Configuration Example, page 10-17

DSU Configuration Example

The following example confgiures DSU on interface port 0 on slot 4, subslot 1.

```
! Specify the serial interface and enter interface configuration mode
!
Router(config)# interface serial 4/1/0
!
! Specify the DSU mode
!
Router(config-if)# dsu mode 0
!
! Specify the DSU bandwidth
!
Router(config-if)# dsu bandwidth 10000
!
! Set the DSU bandwidth to accept or reject the incoming remote requests
!
Router(config-if)# dsu remote accept
```

MDL Configuration Example

The following example configures the MDL strings on interface port 0 on slot 4, subslot 1.

```
! Specify the serial interface and enter interface configuration mode
!
Router(config)# interface serial 4/1/0
!
! Specify the MDL strings
!
Router(config-if)# mdl string eic beic
Router(config-if)# mdl string lic beic
Router(config-if)# mdl string fic bfix
Router(config-if)# mdl string unit bunit
Router(config-if)# mdl string pfi bpfi
Router(config-if)# mdl string port bport
Router(config-if)# mdl string generator bgen
Router(config-if)# mdl transmit path
Router(config-if)# mdl transmit idle-signal
Router(config-if)# mdl transmit test-signal
```

Scrambling Configuration Example

The following example configures scrambling on the T3/E3 interface:

```
! Enter global configuration mode
!
Router# configure terminal
!
! Specify the serial interface and enter interface configuration mode
!
Router(config)# interface serial 4/1/3
!
! Enable scrambling
```

```
!
Router(config-if)# scrambling
```

Framing Configuration Example

The following example configures framing on interface port 1 on slot 4, subslot 1.

```
! Specify the serial interface and enter interface configuration mode
!
Router(config)# interface serial 4/1/1
!
! Specify the framing method
!
Router(config-if)# framing m13
```

Encapsulation Configuration Example

The following example configures encapsulation on interface port 1 on slot 4, subslot 1.

```
! Specify the serial interface and enter interface configuration mode
!
Router(config)# interface serial 4/1/1
!
! Specify the encapsulation method
!
Router(config-if)# encapsulation PPP
```

Cable Length Configuration Example

The following example configures sets the cable length to 200 feet:

```
! Enter global configuration mode
!
Router# configure terminal
!
! Specify the serial interface and enter interface configuration mode
!
Router(config)# interface serial 4/1/3
!
! Specify the cable length
!
Router(config-if)# cablelength 200
```

Invert Data Configuration Example

The following example enables invert data:

```
! Enter global configuration mode
!
Router# configure terminal
!
! Specify the serial interface and enter interface configuration mode
!
Router(config)# interface serial 4/1/3
!
! Enable invert data
```

```
!
Router(config-if)# invert data
```

Trace Trail Buffer Configuration Example

The following example configures the TTB attributes:

```
! Enter global configuration mode
!
Router# configure terminal
!
! Specify the serial interface and enter interface configuration mode
!
Router(config)# interface serial 4/1/3
!
! Specify the TTB attributes
!
Router(config-if)# ttb country ab
Router(config-if)# ttb soperator 56
Router(config-if)# ttb snode 34
Router(config-if)# ttb rnode cd
Router(config-if)# ttb x 7
Router(config-if)# ttb serial 12
```

CHAPTER 11

Configuring the 8-Port Channelized T1/E1 SPA

This chapter provides information about configuring the 8-Port Clear Channel T1/E1 SPA on Cisco 12000 Series Routers. It includes the following sections:

For information about managing your system images and configuration files, refer to the *Cisco IOS Configuration Fundamentals Configuration Guide, Release 12.0* and *Cisco IOS Configuration Fundamentals Command Reference, Release 12.0* publications.

Also refer to the related Cisco IOS Release 12.0 software command reference and master index publications. For more information about accessing these publications, see the "Related Documentation" section in the Preface.

Configuration Tasks

This section describes how to configure the 8-Port Clear Channel T1/E1 SPA for the Cisco 12000 Series Routers and includes information about verifying the configuration.

It includes the following topics:

Required Configuration Tasks

This section lists the required configuration steps to configure the 8-Port Clear Channel T1/E1 SPA. Some of the required configuration commands implement default values that might be appropriate for your network. If the default value is correct for your network, then you do not need to configure the command.

- Setting the Card Type
- Enabling the Interfaces on the Controller
- Verifying Controller Configuration

- Setting the IP Address
- Verifying Interface Configuration

Note To better understand the address format used to specify the physical location of the SIP, SPA, and interfaces, see the: "Specifying the Interface Address on a SPA" section on page 11-6.

Setting the Card Type

The SPA is not functional until the card type is set. Information about the SPA is not indicated in the output of any **show** commands until the card type has been set. There is no default card type.

Note Mixing of interface types is not supported. All ports on a SPA must be of the same type.

To set the card type for the 8-Port Clear Channel T1/E1 SPA, complete these steps:

	Command	Purpose
Step 1	Router# **configure terminal**	Enters global configuration mode.
Step 2	Router(config)# **card type** {**e1** | **t1**} *slot subslot*	Sets the serial mode for the SPA: • **t1**—Specifies T1 connectivity of 1.536 Mbps. B8ZS is the default line code for T1. • **e1**—Specifies a wide-area digital transmission scheme used predominantly in Europe that carries data at a rate of 1.984 Mbps in framed mode and a 2.048 Mbps in unframed E1 mode. • *slot subslot*—Specifies the location of the SPA. See the: "Specifying the Interface Address on a SPA" section on page 11-6
Step 3	Router(config)# **exit**	Exits configuration mode and returns to the EXEC command interpreter prompt.

Enabling the Interfaces on the Controller

To create the interfaces for the 8-Port Clear Channel T1/E1 SPA, complete these steps:

	Command	Purpose
Step 1	Router(config)# **controller** {**t1** | **e1**} *slot/subslot/port*	Select the controller to configure and enter controller configuration mode. • **t1**—Specifies the T1 controller. • **e1**—Specifies the E1 controller. • *slot/subslot/port*—Specifies the location of the interface. See the: "Specifying the Interface Address on a SPA" section on page 11-6
Step 2	Router(config-controller)# **clock source** {**internal** | **line**}	Sets the clock source. **Note** The clock source is set to internal if the opposite end of the connection is set to line and the clock source is set to line if the opposite end of the connection is set to internal. • **internal**—Specifies that the internal clock source is used. • **line**—Specifies that the network clock source is used. This is the default for T1 and E1.
Step 3	Router(config-controller)# **linecode** {**ami** | **b8zs** | **hdb3**}	Selects the linecode type. • **ami**—Specifies Alternate Mark Inversion (AMI) as the linecode type. Valid for T1 and E1 controllers. • **b8zs**—Specifies binary 8-zero substitution (B8ZS) as the linecode type. Valid for T1 controller only. This is the default for T1 lines. • **hdb3**—Specifies high-density binary 3 (hdb3) as the linecode type. Valid for E1 controller only. This is the default for E1 lines.
Step 4	For T1 controllers: Router(config-controller)# **framing** {**sf** | **esf**} For E1 controllers: Router(config-controller)# **framing** {**crc4** | **no-crc4**}	Selects the framing type. • **sf**—Specifies Super Frame as the T1 frame type. • **esf**—Specifies Extended Super Frame as the T1 frame type. This is the default for E1. • **crc4**—Specifies CRC4 as the E1 frame type. This is the default for E1. • **no-crc4**—Specifies no CRC4 as the E1 frame type.

	Command	Purpose

Step 5	Router(config-controller)# **channel-group** *t1 t1-number* {**timeslots** *range* | **unframed**} [**speed** {**56** | **64**}]	Define the time slots that belong to each T1 or E1 circuit.
		• *t1 t1-number*— Channel-group number. When configuring a T1 data line, channel-group numbers can be values from 1 to 28. When configuring an E1 data line, channel-group numbers can be values from 0 to 30.
		• **timeslots** *range*— One or more time slots or ranges of time slots belonging to the channel group. The first time slot is numbered 1. For a T1 controller, the time slot range is from 1 to 24. For an E1 controller, the time slot range is from 1 to 31.
		• **unframed**—Unframed mode (G.703) uses all 32 time slots for data. None of the 32 time slots are used for framing signals.
		• **speed**—(Optional) Speed of the underlying DS0s.
		  – **56**—
		  – **64**—
		Note The default is 64 if speed is not mentioned in the config.
		Note Each channel group is presented to the system as a serial interface that can be configured individually.
		Note Once a channel group has been created with the **channel-group** command, the channel group cannot be changed without removing the channel group. To remove a channel group, see the section: Changing a Channel Group Configuration, page 11-16.

Step 6	Router(config)# **exit**	Exits configuration mode and returns to the EXEC command interpreter prompt.

Verifying Controller Configuration

Use the **show controllers** command to verify the controller configuration:

```
Router(config)# show controllers t1
T1 6/0/1 is up.
  Applique type is Channelized T1
  Cablelength is long gain36 0db
  No alarms detected.
  alarm-trigger is not set
  Framing is ESF, Line Code is B8ZS, Clock Source is Line.
  Data in current interval (395 seconds elapsed):
     0 Line Code Violations, 0 Path Code Violations
     0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 0 Unavail Secs
  Total Data (last 24 hours)
     0 Line Code Violations, 0 Path Code Violations,
     0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins,
```

```
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 0 Unavail Secs
```

Setting the IP Address

To set the IP address for the 8-Port Clear Channel T1/E1 SPA, complete these steps:

	Command	Purpose
Step 1	Router(config)# **interface serial** *slot/subslot/port***:***channel-group*	Selects the interface to configure from global configuration mode. • *slot/subslot/port:channel-group*—Specifies the location of the interface. See the: "Specifying the Interface Address on a SPA" section on page 11-6
Step 2	Router(config-if)# **ip address** *address mask*	Sets the IP address and subnet mask. • *address*—IP address. • *mask*—Subnet mask.
Step 3	Router(config)# **exit**	Exits configuration mode and returns to the EXEC command interpreter prompt.

Verifying Interface Configuration

Use the **show interfaces** command to verify the interface configuration:

```
Router(config)# show interfaces
.
.
.
Serial6/0/1:0 is up, line protocol is up
  Hardware is SPA-T1E1
  MTU 1500 bytes, BW 1536 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation PPP, crc 16, loopback not set
  Keepalive set (10 sec)
  LCP Open, multilink Open
  Last input 00:00:03, output 00:00:03, output hang never
  Last clearing of "show interface" counters 5d17h
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 3194905708
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  30 second input rate 0 bits/sec, 0 packets/sec
  30 second output rate 0 bits/sec, 0 packets/sec
     74223 packets input, 1187584 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicast)
     0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     74227 packets output, 1187751 bytes, 0 underruns
     0 output errors, 0 collisions, 2 interface resets
     0 output buffer failures, 0 output buffers swapped out
     4 carrier transitions no alarm present
  Timeslot(s) Used:1-24, subrate: 64Kb/s, transmit delay is 0 flags
.
.
```

Specifying the Interface Address on a SPA

SPA interface ports begin numbering with "0" from left to right. Single-port SPAs use only the port number 0. To configure or monitor SPA interfaces, you need to specify the physical location of the SIP, SPA, and interface in the CLI. The interface address format is *slot*/*subslot*/*port*, where:

- *slot*—Specifies the chassis slot number in the Cisco 12000 Series Router where the SIP is installed.
- *subslot*—Specifies the secondary slot of the SIP where the SPA is installed.
- *port*—Specifies the number of the individual interface port on a SPA.

The following example shows how to specify the first interface (0) on a SPA installed in the first subslot of a SIP (0) installed in chassis slot 3:

```
Router(config)# interface serial 3/0/0
```

This command shows a serial SPA as a representative example, however the same *slot*/*subslot*/*port* format is similarly used for other SPAs (such as ATM and POS) and other non-channelized SPAs.

For the 8-Port Channelized T1/E1 SPA, the interface address format is *slot/subslot/port*:*channel-group*, where:

- *channel-group*—Specifies the logical channel group assigned to the timeslots within the T1 link.

Optional Configurations

There are several standard, but optional, configurations that might be necessary to complete the configuration of your serial SPA.

Note For additional command output details, see Chapter 19, "SIP and SPA Command Reference".

Configuring Framing

Framing is used to synchronize data transmission on the line. Framing allows the hardware to determine when each packet starts and ends. To configure framing, use the following commands.

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Router(config)# **controller {t1 | e1}** *slot/subslot/port*	Selects the controller to configure. • **t1**—Specifies the T1 controller. • **e1**—Specifies the E1 controller. • *slot/subslot/port*—Specifies the location of the controller. See: "Specifying the Interface Address on a SPA" section on page 11-6
For T1 controllers: Router(config-controller)# **framing {sf | esf}** For E1 controllers: Router(config-controller)# **framing {crc4 | no-crc4 | unframed}**	Set the framing on the interface. • **sf**—Specifies Super Frame as the T1 frame type. • **esf**—Specifies extended Super Frame as the T1 frame type. This is the default. for T1. • **crc4**—Specifies CRC4 frame as the E1 frame type. This is the default for E1. • **no-crc4**—Specifies no CRC4 frame as the E1 frame type. • **unframed**—Unframed mode (G.703) uses all 32 time slots for data.

Verifying Framing Configuration

Use the **show controllers** command to verify the framing configuration:

```
Router# show controllers t1
T1 6/0/0 is down.
  Applique type is Channelized T1
  Cablelength is long gain36 0db
  Receiver has loss of frame.
  alarm-trigger is not set
  Framing is ESF, Line Code is B8ZS, Clock Source is Line.
  Data in current interval (717 seconds elapsed):
     0 Line Code Violations, 0 Path Code Violations
     0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 717 Unavail Secs
  Total Data (last 24 hours)
     0 Line Code Violations, 0 Path Code Violations,
     0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins,
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 86400 Unavail Secs
```

Configuring Encapsulation

When traffic crosses a WAN link, the connection needs a Layer 2 protocol to encapsulate traffic. To set the encapsulation method, use the following commands:

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Router(config)# **interface serial** *slot/subslot/port*:*channel-group*	Selects the interface to configure. • *slot/subslot/port:channel-group*—Specifies the location of the interface. See: "Specifying the Interface Address on a SPA" section on page 11-6
Router(config-if)# **encapsulation** *encapsulation-type* **{hdlc | ppp | frame-relay}**	Set the encapsulation method on the interface. • **hdlc**—High-Level Data Link Control (HDLC) protocol for serial interface. This encapsulation method provides the synchronous framing and error detection functions of HDLC without windowing or retransmission. This is the default for synchronous serial interfaces. • **ppp**—PPP (for serial interface). • **frame-relay**—Frame Relay (for serial interface).

Verifying Encapsulation

Use the **show interfaces serial** command to verify encapsulation on the interface:

```
Router# show interfaces serial 6/0/0:0
Serial6/0/0:0 is down, line protocol is down
  Hardware is SPA-T1E1
  MTU 1500 bytes, BW 1536 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation PPP, crc 32, loopback not set
  Keepalive set (10 sec)
  LCP Closed, multilink Closed
  Last input 1w0d, output 1w0d, output hang never
  Last clearing of "show interface" counters 6d23h
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: weighted fair
  Output queue: 0/1000/64/0 (size/max total/threshold/drops)
     Conversations  0/0/256 (active/max active/max total)
     Reserved Conversations 0/0 (allocated/max allocated)
     Available Bandwidth 1152 kilobits/sec
  30 second input rate 0 bits/sec, 0 packets/sec
  30 second output rate 0 bits/sec, 0 packets/sec
     0 packets input, 0 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicast)
     0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     0 packets output, 0 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions alarm present
```

```
  Timeslot(s) Used:1-24, subrate: 64Kb/s, transmit delay is 0 flags
```

Configuring the CRC Size for T1

All 8-Port Clear Channel T1/E1 SPA interfaces use a 16-bit cyclic redundancy check (CRC) by default, but also support a 32-bit CRC. CRC is an error-checking technique that uses a calculated numeric value to detect errors in transmitted data. The designators 16 and 32 indicate the length (in bits) of the frame check sequence (FCS). A CRC of 32 bits provides more powerful error detection, but adds overhead. Both the sender and receiver must use the same setting.

CRC-16, the most widely used CRC throughout the United States and Europe, is used extensively with WANs. CRC-32 is specified by IEEE 802 and as an option by some point-to-point transmission standards. It is often used on Switched Multimegabit Data Service (SMDS) networks and LANs.

To set the length of the cyclic redundancy check (CRC) on a T1 interface, use these commands:

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Router(config)# **interface serial** *slot/subslot/port***:***channel-group*	Selects the interface to configure. • *slot/subslot/port:channel-group*—Specifies the location of the interface. See the: "Specifying the Interface Address on a SPA" section on page 11-6
Router(config-if)# **crc** {**16** | **32**}	Selects the CRC size in bits. • **16**—16-bit CRC. This is the default • **32**—32-bit CRC.

Verifying the CRC Size

Use the **show interfaces serial** command to verify the CRC size set on the interface:

```
router# show interfaces serial 6/0/0:0
Serial6/0/0:0 is up, line protocol is up
  Hardware is SPA-T1E1
  MTU 1500 bytes, BW 1536 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation PPP, crc 32, loopback not set
  Keepalive set (10 sec)
  LCP Open, multilink Open
  Last input 00:00:38, output 00:00:00, output hang never
  Last clearing of "show interface" counters 01:46:16
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  30 second input rate 0 bits/sec, 0 packets/sec
  30 second output rate 0 bits/sec, 0 packets/sec
     1272 packets input, 20396 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicast)
     0 runts, 0 giants, 0 throttles
     6 input errors, 3 CRC, 0 frame, 0 overrun, 0 ignored, 3 abort
     1276 packets output, 20460 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions no alarm present
  Timeslot(s) Used:1-24, subrate: 64Kb/s, transmit delay is 0 flags
```

Configuring FDL

Facility Data Link (FDL) is a 4-kbps channel provided by the Extended Super Frame (ESF) T1 framing format. The FDL performs outside the payload capacity and allows you to check error statistics on terminating equipment without intrusion.

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Router(config)# **controller t1** *slot/subslot/port*	Selects the controller to configure. • *slot/subslot/port*—Specifies the location of the controller."Specifying the Interface Address on a SPA" section on page 11-6
Router(config-controller)# **fdl** [**ansi** | **att** | **both**]	If the framing format was configured for **esf**, configures the format used for Facility Data Link (FDL). • **ansi**—Select ansi for FDL to use the ANSI T1.403 standard. • **att**—Select att for FDL to use the AT&T TR54016 standard. • **both**—Select both for FDL to use both the ANSI T1.403 standard and the AT&T TR54016 standard.

Verifying FDL

Use the **show controllers t1** command to verify the **fdl** setting:

```
router# show controllers t1
```

```
T1 6/0/1 is up.
  Applique type is Channelized T1
  Cablelength is long gain36 0db
  No alarms detected.
  alarm-trigger is not set
  Framing is ESF, FDL is ansi, Line Code is B8ZS, Clock Source is Line.
  Data in current interval (742 seconds elapsed):
     0 Line Code Violations, 0 Path Code Violations
     0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 0 Unavail Secs
  Total Data (last 73 15 minute intervals):
     1278491 Line Code Violations, 3 Path Code Violations,
     0 Slip Secs, 1 Fr Loss Secs, 177 Line Err Secs, 0 Degraded Mins,
     3 Errored Secs, 0 Bursty Err Secs, 1 Severely Err Secs, 227 Unavail Secs
.
.
.
```

Configuring Multilink Point-to-Point Protocol (Hardware-based)

Multilink Point to Point Protocol (MLPPP) allows you to combine T1 or E1 lines into a bundle that has the combined bandwidth of multiple T1/E1 lines. You choose the number of bundles and the number of T1 or E1 lines in each bundle.

MLPPP for T1/E1 Configuration Guidelines

The required conditions are:

- Only T1 or E1 links in a bundle
- All links on the same SPA
- Maximum of 12 links in a bundle.

Note Some notes about hardware-based MLPPP:

Only 3 fragmentation sizes are possible 128, 256 and 512 bytes

Fragmentation is enabled by default, default size is 512 bytes

Fragmentation size is configured using the **ppp multilink fragment-delay** command after using the **interface multilink** command. The least of the fragmentation sizes (among the 3 sizes possible) satisfying the delay criteria is configured. (e.g., a 192 byte packet causes a delay of 1 millisecond on a T1 link, so the nearest fragmentation size is 128 bytes.

The **show ppp multilink** command will indicate the MLPPP type and the fragmentation size:

```
Router# show ppp multilink
Multilink1, bundle name is Patriot2
Bundle up for 00:00:13
Bundle is Distributed
0 lost fragments, 0 reordered, 0 unassigned
0 discarded, 0 lost received, 206/255 load
0x0 received sequence, 0x0 sent sequence
Member links: 2 active, 0 inactive (max not set, min not set)
Se4/2/0/1:0, since 00:00:13, no frags rcvd
Se4/2/0/2:0, since 00:00:10, no frags rcvd
Distributed fragmentation on. Fragment size 512.  Multilink in Hardware.
```

Fragmentation is disabled explicitly by using the **no ppp multilink fragmentation** command after using the **interface multilink** command.

Create a Multilink Bundle

To create a multilink bundle, use the following commands:

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Router(config)# **interface multilink** *group-number*	Creates a multilink interface and enter multilink interface mode. • *group-number*—The group number for the multilink bundle.
Router(config-if)# **ip address** *address mask*	Sets the IP address for the multilink group. • *address*—The IP address. • *mask*—The IP netmask.

Assign an interface to a Multilink Bundle

To assign an interface to a multilink bundle, use the following commands:

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Router(config)# **interface serial** *slot/subslot/port/t1-number***:***channel-group*	Selects the interface to configure and enters interface configuration mode. See: "Specifying the Interface Address on a SPA" section on page 11-6 • *slot/subslot/port/t1-number***:***channel-group*—Selec t the interface to configure.
Router(config-if)# **encapsulation ppp**	Enables PPP encapsulation.
Router(config-if)# **multilink-group** *group-number*	Assigns the interface to a multilink bundle. • *group-numbe*r—The multilink group number for the T1 or E1 bundle.
Router(config-if)# **ppp multilink**	Enables multilink PPP on the interface.
Repeat these commands for each interface you want to assign to the multilink bundle.	

Configuring fragmentation size on an MLPPP Bundle (optional)

To configure the fragmentation size on a multilink ppp bundle, use the following commands:

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.

Command	Purpose
Router(config)# **interface multilink** *slot/subslot/port/t1-number***:***channel-group*	Creates a multilink interface and enters multilink interface mode. • group-number—The group number for the multilink bundle. Range 1-2147483647
Router(config-if)# **ppp multilink fragment-delay** *delay*	Sets the fragmentation size satisfying the configured delay on the multilink bundle. • delay—delay in milliseconds

Disabling the fragmentation on an MLPPP Bundle (optional)

To assign an interface to a multilink bundle, use the following commands:

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Router(config)# **interface multilink** *group-number*	Creates a multilink interface and enters multilink interface mode. • group-number—The group number for the multilink bundle. Range 1-2147483647
Router(config-if)# **no pppp multilink fragmentation**	Disables the fragmentation on the multilink bundle.

Verifying Multilink PPP

Use the **show ppp multilink** command to verify the PPP multilinks:

```
router# show ppp multilink
Multilink1, bundle name is mybundle
    Bundle up for 01:40:50
    Bundle is Distributed
    0 lost fragments, 0 reordered, 0 unassigned
    0 discarded, 0 lost received, 1/255 load
    0x0 received sequence, 0x0 sent sequence
Member links: 5 active, 0 inactive (max not set, min not set)
    Se6/0/0/1:0, since 01:40:50, no frags rcvd
    Se6/0/1/1:0, since 01:40:09, no frags rcvd
    Se6/0/3/1:0, since 01:15:44, no frags rcvd
    Se6/0/4/1:0, since 01:03:17, no frags rcvd
    Se6/0/6/1:0, since 01:01:06, no frags rcvd
    Se6/0/6:0, since 01:01:06, no frags rcvd
```

Configuring MLFR for T1/E1

Multilink Frame Relay (MLFR) allows you to combine T1/E1 lines into a bundle that has the combined bandwidth of multiple T1/E1 lines. You choose the number of bundles and the number of T1/E1 lines in each bundle. This allows you to increase the bandwidth of your network links beyond that of a single T1/E1 line.

MLFR for T1/E1 Configuration Guidelines

MLFR will function in hardware if all of the following conditions are met:

- Only T1 or E1 member links
- All links are on the same SPA
- Maximum of 12 links in a bundle

Create a Multilink Bundle

To create a multilink bundle, use the following commands:

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Router(config)# **interface mfr** *number*	Configures a multilink Frame Relay bundle interface. • *number*—The number for the Frame Relay bundle.
Router(config-if)# **frame-relay multilink bid** *name*	(Optional) Assigns a bundle identification name to a multilink Frame Relay bundle. • *name*—The name for the Frame Relay bundle. **Note** The bundle identification (BID) will not go into effect until the interface has gone from the down state to the up state. One way to bring the interface down and back up again is by using the **shut** and **no shut** commands in interface configuration mode.

Assign an Interface to a Multilink Bundle

To assign an interface to a multilink bundle, use the following commands:

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Router(config)# **interface serial** *slot/subslot/port***:***channel-group*	Selects the interface to assign. • *slot/subslot/port:channel-group*—Specifies the location of the interface."Specifying the Interface Address on a SPA" section on page 11-6
Router(config-if)# **encapsulation frame-relay mfr** *number* [*name*]	Creates a multilink Frame Relay bundle link and associates the link with a bundle. • *number*—The number for the Frame Relay bundle. • *name*—The name for the Frame Relay bundle.

Command	Purpose
Router(config-if)# **frame-relay multilink lid** *name*	(Optional) Assigns a bundle link identification name with a multilink Frame Relay bundle link. • *name*—The name for the Frame Relay bundle. **Note** The bundle link identification (LID) will not go into effect until the interface has gone from the down state to the up state. One way to bring the interface down and back up again is by using the **shut** and **no shut** commands in interface configuration mode.
Router(config-if)# **frame-relay multilink hello** *seconds*	(Optional) Configures the interval at which a bundle link will send out hello messages. The default value is 10 seconds. • *seconds*—Number of seconds between hello messages sent out over the multilink bundle.
Router(config-if)# **frame-relay multilink ack** *seconds*	(Optional) Configures the number of seconds that a bundle link will wait for a hello message acknowledgment before resending the hello message. The default value is 4 seconds. • *seconds*—Number of seconds a bundle link will wait for a hello message acknowledgment before resending the hello message.
Router(config-if)# **frame-relay multilink retry** *number*	(Optional) Configures the maximum number of times a bundle link will resend a hello message while waiting for an acknowledgment. The default value is 2 tries. • *number*—Maximum number of times a bundle link will resend a hello message while waiting for an acknowledgment.

Verifying Multilink Frame Relay

Use the **show frame-relay multilink detailed** command to verify the Frame Relay multilinks:

```
router# show frame-relay multilink detailed

Bundle: MFR49, State = down, class = A, fragmentation disabled
 BID = MFR49
 No. of bundle links = 1, Peer's bundle-id =
 Bundle links:

  Serial6/0/0:0, HW state = up, link state = Add_sent, LID = test
    Cause code = none, Ack timer = 4, Hello timer = 10,
    Max retry count = 2, Current count = 0,
    Peer LID = , RTT = 0 ms
    Statistics:
    Add_link sent = 21, Add_link rcv'd = 0,
    Add_link ack sent = 0, Add_link ack rcv'd = 0,
    Add_link rej sent = 0, Add_link rej rcv'd = 0,
    Remove_link sent = 0, Remove_link rcv'd = 0,
    Remove_link_ack sent = 0, Remove_link_ack rcv'd = 0,
```

```
Hello sent = 0, Hello rcv'd = 0,
Hello_ack sent = 0, Hello_ack rcv'd = 0,
outgoing pak dropped = 0, incoming pak dropped = 0
```

Invert Data on the T1/E1 Interface

If the interface on the 8-Port Clear Channel T1/E1 SPA is used to drive a dedicated T1 line that does not have B8ZS encoding, you must invert the data stream on the connecting CSU/DSU or on the interface. Be careful not to invert data on both the CSU/DSU and the interface, as two data inversions will cancel each other out. To invert data on a T1/E1 interface, use the following commands:

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Router(config)# **interface serial** *slot/subslot/port***:***channel-group*	Selects the serial interface.
Router(config-if)# **invert data**	Inverts the data stream.

Use the **show running configuration** command to verify that invert data has been set:

```
router# show running configuration
.
.
.
interface Serial6/0/0:0
 no ip address
 encapsulation ppp
 logging event link-status
 load-interval 30
 invert data
 no cdp enable
 ppp chap hostname group1
 ppp multilink
 multilink-group 1
!
.
.
.
```

Changing a Channel Group Configuration

To alter the configuration of an existing channel group, the channel group needs to be removed first. To remove an existing channel group, use the following commands:

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Router(config)# **controller** {**t1** | **e1**} *slot/subslot/port*	Select the controller to configure and enter controller configuration mode. • *slot/subslot/port*—Specifies the location of the interface. See: Specifying the Interface Address on a SPA, page 11-6

Command	Purpose
Router(config-controller)# **no channel-group** *t1 t1-number*	Select the channel group you want to remove. • *t1 t1-number*— Channel-group number.
Follow the steps in the section: Enabling the Interfaces on the Controller, page 11-3	Create a new channel group with the new configuration.

FRF.12 Guidelines

FRF.12 functions in hardware. Note the following:

- The fragmentation is configured at the main interface
- Only 3 fragmentation sizes are available - 128 bytes, 256 bytes, and 512 bytes.

LFI Guidelines

LFI can function two ways - using FRF.12 or MLPPP. MLPPP LFI can be done in both hardware and software while FRF.12 LFI is done only in hardware.

HW MLPPP LFI Guidelines

LFI using MLPPP will function only in hardware if there is just one member link in the MLPPP bundle. The link can be a fractional T1 or full T1. Note the following:

- The **ppp multilink interleave** command needs to be configured to enable interleaving.
- Only three fragmentation sizes are supported - 128 bytes, 256 bytes, and 512 bytes.
- Fragmentation is enabled by default, the default size being 512 bytes.
- A policy-map having a priority class needs to applied to main interface.

FRF.12 LFI Guidelines

LFI using FRF.12 is always done is hardware. Note the following:

- The fragmentation is configured at the main interface
- Only 3 fragmentation sizes are available - 128 bytes, 256 bytes, and 512 bytes.
- A policy-map having a priority class needs to applied to main interface.

Saving the Configuration

To save your running configuration to nonvolatile random-access memory (NVRAM), use the following command in privileged EXEC configuration mode:

Command	Purpose
Router# **copy running-config startup-config**	Writes the new configuration to NVRAM.

For more information about managing configuration files, refer to the *Cisco IOS Configuration Fundamentals Configuration Guide, Release 12.2* and *Cisco IOS Configuration Fundamentals Command Reference, Release 12.2* publications.

Verifying the Interface Configuration

Besides using the **show running-configuration** command to display your Cisco 12000 Series Router configuration settings, you can use the **show interfaces serial** and the **show controllers serial** commands to get detailed information on a per-port basis for your 8-Port Clear Channel T1/E1 SPA.

Verifying Per-Port Interface Status

To find detailed interface information on a per-port basis for the 8-Port Clear Channel T1/E1 SPA, use the **show interfaces serial** command. For a description of the command output, see Chapter 19, "SIP and SPA Command Reference."

The following example provides sample output for interface port 0 on the SPA located in the first subslot of the SIP installed in slot 6 of a Cisco 7609 router:

```
Router# show interface serial 6/0/0:0
Serial6/0/0:0 is up, line protocol is up
  Hardware is SPA-T1E1
  MTU 1500 bytes, BW 1536 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation PPP, crc 32, loopback not set
  Keepalive set (10 sec)
  LCP Open, multilink Open
  Last input 00:00:38, output 00:00:00, output hang never
  Last clearing of "show interface" counters 01:46:16
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  30 second input rate 0 bits/sec, 0 packets/sec
  30 second output rate 0 bits/sec, 0 packets/sec
     1272 packets input, 20396 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicast)
     0 runts, 0 giants, 0 throttles
     6 input errors, 3 CRC, 0 frame, 0 overrun, 0 ignored, 3 abort
     1276 packets output, 20460 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions no alarm present
  Timeslot(s) Used:1-24, subrate: 64Kb/s, transmit delay is 0 flags
```

Configuration Examples

This section includes the following configuration examples:

- Framing and Encapsulation Configuration Example, page 11-19
- CRC Configuration Example, page 11-19
- Facility Data Link Configuration Example, page 11-20
- MLPPP Configuration Example, page 11-20

- Invert Data on the T1/E1 Interface Example, page 11-22
- MFR Configuration Example, page 11-21

Framing and Encapsulation Configuration Example

The following example sets the framing and encapsulation for the controller and interface:

```
! Specify the controller and enter controller configuration mode
!
Router(config)# controller t1 6/0/0
!
! Specify the framing method
!
Router(config-controller)# framing esf
!
! Exit controller configuration mode and return to global configuration mode
!
Router(config-controller)# exit
!
! Specify the interface and enter interface configuration mode
!
Router(config)# interface serial 6/0/0:0
!
! Specify the encapsulation protocol
!
Router(config-if)# encapsulation ppp
!
! Exit interface configuratin mode
!
Router(config-if)# exit
!
! Exit global configuration mode
!
Router(config)# exit
Router#
```

CRC Configuration Example

The following example sets the CRC size for the interface:

```
! Specify the interface and enter interface configuration mode
!
Router(config)# interface serial 6/0/0:0
!
! Specify the CRC size
!
Router(config-if)# crc 32
!
! Exit interface configuration mode and return to global configuration mode
!
Router(config-if)# exit
!
! Exit global configuration mode
!
Router(config)# exit
Router#
```

Facility Data Link Configuration Example

The following example configures Facility Data Link:

```
! Specify the controller and enter controller configuration mode
!
Router(config)# controller t1 6/0/0
!
! Specify the FDL specification
!
Router(config-controller)# fdl ansi
!
! Exit controller configuration mode and return to global configuration mode
!
Router(config-controller)# exit
!
! Exit global configuration mode
!
Router(config)# exit
Router#
```

MLPPP Configuration Example

The following example creates a PPP Multilink bundle:

```
! Enter global configuration mode
!
Router# configure terminal
!
! Create a multilink bundle and assign a group number to the bundle
!
Router(config)# interface multilink 1
!
! Specify an IP address for the multilink group
!
Router(config-if)# ip addres 123.456.789.111 255.255.255.0
!
! Enable Multilink PPP
!
Router(config-if)# ppp multilink
!
! Leave interface multilink configuration mode
!
Router(config-if)# exit
!
! Specify the interface to assign to the multilink bundle
!
Router(config)# interface serial 3/1//0:1
!
! Enable PPP encapsulation on the interface
!
Router(config-if)# encapsulation PPP
!
! Assign the interface to a multilink bundle
!
Router(config-if)# multilink-group 1
!
! Enable Multilink PPP
!
Router(config-if)# ppp multilink
!
```

```
! Exit interface configuration mode
!
Router(config-if)# exit
!
! Exit global configuration mode
!
Router(config)# exit
Router#
```

MFR Configuration Example

The following example configures Multilink Frame Relay (MFR):

```
! Create a MFR interface and enter interface configuration mode
!
Router(config)# interface mfr 49
!
! Assign the bundle identification (BID) name 'test' to a multilink bundle.
!
Router(config-if)# frame-relay multilink bid test
!
! Exit interface configuration mode and return to global configuration mode
!
Router(config-if)# exit
!
! Specify the serial interface to assign to a multilink bundle
!
Router(config)# interface serial 5/1/3:0
!
! Creates a multilink Frame Relay bundle link and associates the link with a multilink
bundle
!
Router(config-if)# encapsulation frame-relay mfr 49
!
! Assigns a bundle link identification (LID) name with a multilink bundle link
!
Router(config-if)# frame-relay multilink lid test
!
! Configures the interval at which the interface will send out hello messages
!
Router(config-if)# frame-relay multilink hello 15
!
! Configures the number of seconds the interface will wait for a hello message
acknowledgement before resending the hello message
!
Router(config-if)# frame-relay multilink ack 6
!
! Configures the maximum number of times the interface will resend a hello message while
waiting for an acknowledgement
!
Router(config-if)# frame-relay multilink retry 5
!
! Exit interface configuration mode and return to global configuration mode
!
Router(config-if)# exit
!
! Exit global configuration mode
!
Router(config)# exit
Router#
```

Invert Data on the T1/E1 Interface Example

The following example inverts the data on the serial interface:

```
! Enter global configuration mode
!
Router# configure terminal
!
! Specify the serial interface and enter interface configuration mode
!
Router(config)# interface serial 5/1/3:0
!
! Configure invert data
!
Router(config-if)# invert data
!
! Exit interface configuration mode and return to global configuration mode
!
Router(config-if)# exit
!
! Exit global configuration mode
!
Router(config)# exit
Router#
```

CHAPTER 12

Configuring the 1-Port Channelized OC-3/STM-1 SPA

This chapter provides information about configuring the 1-Port Channelized OC-3/STM-1 SPA on Cisco 12000 Series Routers. It includes the following sections:

- Configuration Tasks, page 12-1
- Verifying the Interface Configuration, page 12-21

For information about managing your system images and configuration files, refer to the *Cisco IOS Configuration Fundamentals Configuration Guide, Release 12.0* and *Cisco IOS Configuration Fundamentals Command Reference, Release 12.0* publications.

Also refer to the related Cisco IOS Release 12.0 software command reference and master index publications. For more information about accessing these publications, see the "Related Documentation" section in the Preface.

Configuration Tasks

This section describes how to configure the 1-Port Channelized OC-3/STM-1 SPA for the Cisco 12000 Series Routers and includes information about verifying the configuration. This document shows how to configure the 1-Port Channelized OC-3/STM-1 SPA in either SONET or SDH framing modes.

It includes the following topics:

- Required Configuration Tasks, page 12-1
- Selection of Physical Port and Controller configuration, page 12-2
- Optional Configurations, page 12-12
- Saving the Configuration, page 12-21

Required Configuration Tasks

This section lists the required configuration steps to configure the 1-Port Channelized OC-3/STM-1 SPA. Some of the required configuration commands implement default values that might be appropriate for your network. If the default value is correct for your network, then you do not need to configure the command.

- Selection of Physical Port and Controller configuration
- Interface Naming

- SONET mode Configuration
- SDH mode Configuration
- Verifying Interface Configuration

Note To better understand the address format used to specify the physical location of the Cisco 12000 SIP-401, SPA, and interfaces, see the: "Selection of Physical Port and Controller configuration" section on page 12-2.

Selection of Physical Port and Controller configuration

To select the physical port and controller configuration, use the following command:

controller sonet *slot* / *subslot* / *port*

If the 1-Port Channelized OC-3/STM-1 SPA sits in subslot 0 of a Cisco 12000 SIP-401 in slot3, the 1-Port Channelized OC-3/STM-1 SPA port would be identified as controller SONET 3/0/0. Since there is only 1 port on a 1-Port Channelized OC-3/STM-1 SPA, the port number is always 0.

Interface Naming

Interface names are automatically generated, and the format will be dependent on the mode each particular linecard is operating on. The name format of the serial interface created are listed below.

SONET mode

- If framing is SONET and mode is vt-15:

  interface serial [*slot* / *subslot* / *port*].[*sts*1/ *ds1* / *t1*]:[*channel-group*]

- If framing is SONET and mode is CT3

  interface serial [*slot* / *subslot* / *port*].[*sts*1 / *ds1* / *ds1*]:[*channel-group*]

- If framing is SONET and mode is CT3-E1:

  interface serial [*slot* / *subslot* / *port*].[*sts*1 / *ds1* / *e1*]:[*channel-group*]

- If framing is SONET and mode is T3:

  interface serial [*slot* / *subslot* / *port.sts1*]

SDH mode

If the aug mapping is au-4, the au-4 value is always 1; if the aug mapping is au-3, then the only supported mode is c-11 (carrying a T1).

- If SDH-AUG mapping is au-4 and if the tug-3 is mode t3/e3:

  interface serial [*slot / subslot / 0.1 / <tug-3>*]

- If SDH-AUG mapping is au-3:

  interface serial [*slot* / *subslot / port* / *au-3 / <tug-2> / t1*]:[*channel-group*]

- If framing is SDH with ct-12 mode:

  interface serial [*slot/ subslot / 0.1 / <tug-3> / <tug-2> / e1*]:[*channel-group*]

- If framing is SDH with c-11 mode:

  interface serial [*slot / subslot / 0.<au-3> / <tug-2> / t1*]*:* [*channel-group*]

For channelized T3 mode

- If framing is SONET or SDH with au-3:

  interface serial [*slot* | *subslot* | *port*] [*ds3*| *DS1*]*:*[*channel-group*]

Selection of Physical Port and controller Configuration—SONET mode

To create the interface for the 1-Port Channelized OC-3/STM-1 SPA, complete these steps:

	Command	Purpose
Step 1	Router(config)# **controller sonet** *slot/subslot/port*	Select the controller to configure and enter controller configuration mode. • *slot/subslot/port*—Specifies the location of the interface. See the: "Selection of Physical Port and Controller configuration" section on page 12-2 **Note** The port number is always zero on the 1-Port Channelized OC-3/STM-1 SPA.

SONET mode Configuration

To configure the SONET controller, complete these steps:

Step 1	For SONET controllers: Router(config-controller)# **framing** {**sonet** | **sdh**}	Selects the framing type. • **sonet**—Specifies SONET as the frame type. This is the default. • **sdh**—Specifies sdh as the frame type.
Step 2	Router(config-controller)# **clock source** {**internal** | **line**}	Sets the clock source. **Note** The clock source is set to internal if the opposite end of the connection is set to line and the clock source is set to line if the opposite end of the connection is set to internal. • **internal**—Specifies that the internal clock source is used. • **line**—Specifies that the network clock source is used. This is the default for T1 and E1.

Step 3	Router(config-controller)# **[no] loopback** {**local** | **network**]	Enables or disables loopback mode on a sonet controller. • **local loopback**—loops data from the transmit path to the receive path. • **network loopback**—loops data received on the external port to the transmit path and back out the external port. Default is disabled loopback.
Step 4	In SONET framing: Router(config-controller)#**sts-1 sts1-#**	**sts-1 #**—Specifies the SONET STS level.
Step 5	**[no] mode** {**vt-15** | **ct3** | **t3** | **ct3-e1**}	Specifies the mode of operation of a STS-1 path: • **vt-15**—A STS-1 is divided into 7 vtg. Each vtg then divided into 4 VT1.5's, each carrying a T1. • **ct3**—A STS-1 carry a DS3 signal divided into 28 T1s (PDH) • **t3—**STS-1 or AU-4/TUG3 carries a unchannelized (clear channel) T3 • **ct3**—The channelized T3 is carrying E1 circuits
Step 6	• sts1 carries T1s (sonet - vt): router(config-controller-sts1)# **mode vt-15** or • sts1 carries T1s (sonet - ds3 down to ds1): router(config-controller-sts1)# **mode ct3** or • sts1 carries DS3(sonet - ds3): router(config-controller-sts1)# **mode t3**	Selects a mode of operation.
Step 7	Router(config-ctrlr-sts1)# **vtg**? <1-7> vtg number <1-7>	• **vtg**—Specifies the vtg number.

Step 8	Router(config-ctrlr-sts1)#**vtg 1 ?** T1 T1 line configuration Router(config-ctrlr-sts1)#v**tg 1** t1 1 chan 0 tim 1 - 3 Router(config-ctrlr-sts1)#**vtg 2** t1 4 chan 0 tim 1 - 2, 5-6 Router(config-ctrlr-sts1)#**vtg 3** t1 # <1-4> t1 line number <1-4>	Configures the T1s on the vtgs. For SONET framing, vtg# range is 1 to 7.
Step 9	Channelized OC-3: vtg <vtg#>... ct3: no prefix There is no channelized E3 mode. The e1# range is from 1 to 3 The t1# range is from 1 to 4. For PDH mode, where a channelized t3 is mapped into the sts-1, the t1# range is from 1 to 28.	Configures channels. Once TUG-3/STS-1 is configured, then one of the parser modes config-ctrlr-{tug3|au3|sts1} can be set.

SDH mode Configuration

To configure SDH mode, complete the following steps:

Step 1	For SDH controllers: Router(config-controller)# **framing** {**sonet** | **sdh**}	Selects the framing type. • **sonet**—Specifies SONET as the frame type. This is the default. • **sdh**—Specifies sdh as the frame type.
Step 2	Router(config-controller)# **aug mapping** {**au-3** | **au-4**}	Configures AUG mapping for SDH only. If the AUG mapping is configured to be au-4, then the following muxing/alignment/mapping will be used: TUG-3 <--> VC-4 <--> AU-4 <--> AUG If the mapping is configured to be au-3, then the following muxing/alignment/mapping will be used: VC-3 <--> AU-3 <--> AUG This command will be available only when sdh framing is configured. Default is **au-4.**
Step 3	If AUG mapping is au-4: au-4 <au-4#> tug-3 <tug-3#> If AUG mapping is au-3: au-3 <au-3#>	Configures TUG-3/AU-3/STS-1. Depending on the framing mode of Sonet or SDH, each STS-1 and each TUG-3/AU-3 of a STM-1 can be configured with this command. Depending on currently configured AUG mapping setting, this command will further specify TUG-3, AU-3 or STS-1 muxing. As result, the CLI command parser will enter into config-ctrlr-tug3, config-ctrlr-au3 or config-ctrlr-sts1 parser mode, which will make only relevant commands visible. The au-4# is 1. The tug-3# range is from 1 to 3. The au-3# range is from 1 to 3. The sts-1# is from 1 to 3.
Step 4	In SDH framing in AU-4 mode: **[no] mode {c-12 | t3 | e3}**	C-11 and c-12 are container level-n (SDH) Channelized T3s. They are types of T3 channels that are subdivided into 28 T1 channels. • **c-12**—Specifies a AU-4/TUG-3 is divided into 7 tug2. Each tug2 then divided into 3 TU12's, each carrying an E1 (C-12). • **c-11**—Specifies a AU-3 is divided into 7 tug2. Each tug2 then divided into 4 TU11's, each carrying a T1 (C-11). • **t3**—Specifies a STS-1 or AU-4/TUG3 carries a unchannelized (clear channel) T3 • **e3**—Specifies a AU-4/TUG3 carries a unchannelized (clear channel) E3

Configure Channelized DS3

To configure channelized DS3 mode, complete the following steps:

Step 1	Router(config)# **controller sonet** *slot/subslot/port*	Select the controller to configure and enter controller configuration mode. • *slot/subslot/port*—Specifies the location of the interface. See the: "Selection of Physical Port and Controller configuration" section on page 12-2
Step 2	Router(config)#sts-1 *sts1-#*	The sts-1# is from 1 to y, y being the Sonet STS level, such as in OC-3.
Step 3	Router(config)# **t3 framing** {**c-bit** | **m23** | **auto-detect**}	Specifies framing mode. • **c-bit**—Specifies C-bit parity framing. • **m23**—Specifies M23 framing. • **auto-detect—**Detects the framing type at the device at the end of the line and switches to that framing type. If both devices are set to auto-detect, c-bit framing is used.
Step 4	Router(config-controller)# **clock source** {**internal** | **line**}	Sets the clock source. **Note** The clock source is set to internal if the opposite end of the connection is set to line and the clock source is set to line if the opposite end of the connection is set to internal. • **internal**—Specifies that the internal clock source is used. • **line**—Specifies that the network clock source is used.
Step 5	Router(config-controller)# **[no] t3 loopback** {**local** | **network [line** | **payload]** | **remote [line** | **payload]**}	Enables or disables loopback mode on a SONET controller. • **local loopback**—loops data from the transmit path to the receive path. • **network loopback**—loops data received on the external port to the transmit path and back out the external port. • **Remote loopback**—Applicable only to c-bit framing. Default is no loopback.
Step 6	**[no] t3 mdl string** [**eic** | **fic** | **generator** | **lic** | **pfi** | **port** | **unit**} *string* **[no] t3 mdl transmit** {**path** | **idle-signal** | **test-signal**}	Configures MDL support. • **eic**—Specified equipment ID code • **fic**— frame ID code • **generator—**generator number in MDL test signal • **lic**—location ID code • **pfi—**facility ID code in MDL path message • **port**— port number in MDL idle string message • **unit**—unit code Default is no mdl string and no mdl transmit.

Step 7	**t3 equipment** {**customer** | **network**} **loopback**	Equipment customer loopback enables the port to honor remote loopback request. Equipment network loopback disables this functionality. **Note** Remote loopbacks are only available in c-bit framing mode.
Step 8	**t3 bert pattern** *pattern* **interval** *1-14400*	Enables BERT testing.

DS1 Configuration (Channelized T3 mode)

To configure DS1 complete the following steps:

Step 1	[no] *prefix* **t1** *t1#* **clock source** {**internal** | **line**}	Configures the clocking source.
Step 2	[no] *prefix* **t1** *t1#* **fdl** *ansi*	Enables the one-second transmission of the remote performance reports via Facility Data Link (FDL) per ANSI T1.403 Note that without this command, FDL will run in ATT mode. ATT mode is not mutually exclusive or different from ANSI mode, ANSI mode is a super-set of ATT mode.
Step 3	[no] *prefix* **t1** *t1#* **framing** {**sf** | **esf**} [no] *prefix* **t1** *t1#* **yellow** {**detection** | **generation**}	Enables detection and generation of DS1 yellow alarms
Step 4	[no] *prefix* **t1** *t1#* **shutdown**	
Step 5	[no] prefix **t1** *t1#* **channel-group** *channel-group#* **timeslots** *list-of-timeslots* **speed** [**56** | **64**]	**Note**
Step 6	[no] *prefix* **t1** *t1#* **loopback** {**local** | **network line** | **remote** {**line fdl** {**ansi** | **bellcore**} | **payload fdl** **ansi**}}	**Note** Local network payload loopback is not supported due to TEMUX-84/TEMUX-84E limitations. **Note** Only 6 E1 berts can be performed concurrently due to TEMUX-84/TEMUX-84E limitations.

E1 Configuration (Channelized T3/E3 mode)

E1 configuration must be done in channelized DS3 mode. To configure E1, complete the following steps:

Step 1	[no] *prefix* **e1** *e1# channel-group channel-group#* **timeslots** *list-of-timeslots* **speed** [**56** | **64**]	
Step 2	[no] *prefix* **e1** *e1#* **unframed**	
Step 3	[no] *prefix* **e1** *e1#* [**unframed** | **framing**] {**crc4** | **no-crc4**}	
Step 4	[no] *prefix* **e1** *e1#* **clock source** {**internal** | **line**}	Configures clock source.
Step 5	[no] *prefix* **e1** *e1#* **national bits** *pattern*	

Step 6	[no] *prefix* **e1** *e1#* **loopback [local | network]**	
Step 7	[no] *prefix* **e1** *e1#* **shutdown**	

BERT Configuration

To configure BERT (Bit Error Rate Testing), complete the following:

Step 1	[no] */* [**e1** | **t1**] [**e1#** | **t1#**] **bert pattern** {**2^11** | **2^15** || **2^20 QRSS** } **interval** *time*	Send a BERT pattern on a DS1/E1 line.

Running BERT after a Switchover

After a switchover explicitly stop any BERT and then restart BERT on the selected line by completing the following:

Step 1	`Router(config-controller)#` **`no bert`**	Stop the BERT pattern on the currently selected DS1/E1 line.
Step 2	[no] */* [**e1** | **t1**] [**e1#** | **t1#**] **bert pattern** {**2^11** | **2^15** || **2^20 QRSS** } **interval** *time*	Send a BERT pattern on a DS1/E1 line.

Note It is important to stop and then restart your BERT after a switchover, as after a switchover the BERT might still be running, but the Route Processor will show wrong and/or mis-leading information.

Unchannelized E3 Serial Interface Configuration

To configure an unchannelized E3 serial interface, complete the following:

Step 1	[no] **dsu mode** { **cisco** | **digital-link** | **kentrox** }	• **cisco**—Specifies cisco as the dsu mode. • **digital-link**—Specifies Digital link as the dsu mode. Range is from 300-34010. • **kentrox**—Specifies kentrox as the dsu mode. Range is 1000-24500, 34010. Default is **cisco**.
Step 2	[no] **dsu bandwidth** *number*	Specifies the maximum allowed bandwidth in Kpbs.
Step 3	[no] **scramble**	Default is no scramble.
Step 4	[no] **national bit** {**0** | **1**}	Default is 0.
Step 5	[no] **crc** {**16** | **32**}	Default is 16 bit (CRC-CITT).
Step 6	[no] **loopback** {**network** | **local** | **remote**}	
Step 7	[no] **shutdown**	
Step 8	[no] **bert pattern** *pattern* **interval** *1-14400*	An example of a valid pattern is {2^15 | 2^23 | 0s | 1s }.

Use the **show controllers** command to verify the controller configuration:

```
Router(config)# show controllers t1
T1 6/0/1 is up.
  Applique type is Channelized T1
  Cablelength is long gain36 0db
  No alarms detected.
blarm-trigger is not set
  Framing is ESF, Line Code is B8ZS, Clock Source is Line.
  Data in current interval (395 seconds elapsed):
     0 Line Code Violations, 0 Path Code Violations
     0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 0 Unavail Secs
  Total Data (last 24 hours)
     0 Line Code Violations, 0 Path Code Violations,
     0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins,
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 0 Unavail Secs
```

Verifying Interface Configuration

Use the **show interface serial** command to verify the interface configuration:

```
Router(config)# show interface serial
Serial2/0/0.1/2 unassigned YES TFTP administratively down down
Serial2/1/0.1/1/1:0 unassigned YES unset down down
Serial2/1/0.1/2/4:0 unassigned YES unset down down
Serial2/1/0.1/2/4:1 unassigned YES unset down down
Serial2/1/0.2/1:0 unassigned YES unset down down
Serial2/1/0.2/2:0 unassigned YES unset down down
Serial2/1/0.2/3:0 unassigned YES unset down down
Serial2/1/0.3 unassigned YES unset down down
UUT#sh int Serial2/1/0.1/1/1:0
Serial2/1/0.1/1/1:0 is down, line protocol is down
Hardware is Channelized-T3
MTU 1500 bytes, BW 192 Kbit, DLY 20000 usec, rely 255/255, load 1/255
```

```
Encapsulation HDLC, crc 16, loopback not set
Keepalive set (10 sec)
Last input never, output never, output hang never
Last clearing of "show interface" counters never
Queueing strategy: fifo
Output queue 0/40, 0 drops; input queue 0/75, 0 drops
Available Bandwidth 192 kilobits/sec
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
0 packets input, 0 bytes, 0 no buffer
Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
0 packets output, 0 bytes, 0 underruns
0 output errors, 0 collisions, 2 interface resets
0 output buffer failures, 0 output buffers swapped out
0 carrier transitions alarm present
VC 2: timeslot(s): 1-3, Transmitter delay 0, non-inverted data
UUT#sh run | beg 2/1/0
controller SONET 2/1/0
ais-shut
framing sonet
clock source line
overhead j0 1
!
sts-1 1
mode vt-15
vtg 1 t1 1 channel-group 0 timeslots 1-3
vtg 2 t1 4 channel-group 0 timeslots 1-2,5-6
vtg 2 t1 4 channel-group 1 timeslots 3,7,9
!
sts-1 2
mode ct3
t1 1 channel-group 0 timeslots 1-24
t1 2 channel-group 0 timeslots 1-12
t1 3 channel-group 0 timeslots 1
!
sts-1 3
mode t3
!
controller T3 3/1/0
shutdown
cablelength 224
!
controller T3 3/1/1
shutdown
cablelength 224
!
!
interface Loopback0
ip address 172.10.11.1 255.255.255.255
.
.
```

Optional Configurations

There are several standard, but optional, configurations that might be necessary to complete the configuration of your serial SPA.

- Configuring Encapsulation, page 12-13
- Configuring the CRC Size for T1, page 12-13

- Configuring FDL, page 12-14
- Configuring Multilink Point-to-Point Protocol (Hardware-based), page 12-15
- Configuring MLFR, page 12-17
- Invert Data on the T1/E1 Interface, page 12-19
- Changing a Channel Group Configuration, page 12-20
- FRF.12 Guidelines, page 12-20
- LFI Guidelines, page 12-21
- HW MLPPP LFI Guidelines, page 12-21
- FRF.12 LFI Guidelines, page 12-21

Configuring Encapsulation

When traffic crosses a WAN link, the connection needs a Layer 2 protocol to encapsulate traffic. To set the encapsulation method, use the following commands:

	Command	Purpose
Step 1	Router# **configure terminal**	Enters global configuration mode.
Step 2	Router(config)# **interface serial** For addressing information, refer to the "Interface Naming" section on page 12-2.	Selects the interface to configure. • *slot/subslot/port:channel-group*—Specifies the location of the interface.
Step 3	Router(config-if)# **encapsulation** *encapsulation-type* **{hdlc | ppp | frame-relay}**	Set the encapsulation method on the interface. • **hdlc**—High-Level Data Link Control (HDLC) protocol for serial interface. This encapsulation method provides the synchronous framing and error detection functions of HDLC without windowing or retransmission. This is the default for synchronous serial interfaces. • **ppp**—PPP (for serial interface). • **frame-relay**—Frame Relay (for serial interface).
Step 4	Router(config-if)# **crc** {**16** | **32**}	Selects the CRC size in bits. • **16**—16-bit CRC. This is the default • **32**—32-bit CRC.

Configuring the CRC Size for T1

The 1-Port Channelized OC-3/STM-1 SPA interface uses a 16-bit cyclic redundancy check (CRC) by default, but also support a 32-bit CRC. CRC is an error-checking technique that uses a calculated numeric value to detect errors in transmitted data. The designators 16 and 32 indicate the length (in bits) of the frame check sequence (FCS). A CRC of 32 bits provides more powerful error detection, but adds overhead. Both the sender and receiver must use the same setting.

CRC-16, the most widely used CRC throughout the United States and Europe, is used extensively with WANs. CRC-32 is specified by IEEE 802 and as an option by some point-to-point transmission standards. It is often used on Switched Multimegabit Data Service (SMDS) networks and LANs.

To set the length of the cyclic redundancy check (CRC) on a T1 interface, use these commands:

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Router(config)# **interface serial** For addressing information, refer to the "Interface Naming" section on page 12-2.	Selects the interface to configure. • *slot/subslot/port:channel-group*—Specifies the location of the interface.

Configuring FDL

Facility Data Link (FDL) is a 4-kbps channel provided by the Extended Super Frame (ESF) T1 framing format. The FDL performs outside the payload capacity and allows you to check error statistics on terminating equipment without intrusion.

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Router(config)# **controller sonet** *slot/subslot/port* See the "Interface Naming" section on page 12-2.	Selects the controller to configure. • *slot/subslot/port*—Specifies the location of the controller.
Router(config-controller)# **sts-1**	If the framing format was configured for **esf**, configures the format used for Facility Data Link (FDL). • **ansi**—Select ansi for FDL to use the ANSI T1.403 standard.
Router(config-controller)**vtg 1** t1 1 fdl	• **vtg**—Specifies the vtg number

Verifying FDL

Use the **show controllers t1** command to verify the **fdl** setting:

```
router# show controllers t1

T1 6/0/1 is up.
  Applique type is Channelized T1
  Cablelength is long gain36 0db
  No alarms detected.
  alarm-trigger is not set
  Framing is ESF, FDL is ansi, Line Code is B8ZS, Clock Source is Line.
  Data in current interval (742 seconds elapsed):
     0 Line Code Violations, 0 Path Code Violations
     0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 0 Unavail Secs
  Total Data (last 73 15 minute intervals):
     1278491 Line Code Violations, 3 Path Code Violations,
     0 Slip Secs, 1 Fr Loss Secs, 177 Line Err Secs, 0 Degraded Mins,
     3 Errored Secs, 0 Bursty Err Secs, 1 Severely Err Secs, 227 Unavail Secs
.
.
```

.

Configuring Multilink Point-to-Point Protocol (Hardware-based)

Multilink Point to Point Protocol (MLPPP) allows you to combine interfaces which correspind to an entire T1 or E1 multilink bundle. You choose the number of bundles and the number of T1 or E1 lines in each bundle.

MLPPP Configuration Guidelines

The required conditions are:

- Only T1 or E1 links in a bundle
- All links on the same SPA
- Maximum of 12 links in a bundle.

Note Some notes about hardware-based MLPPP:

Only 3 fragmentation sizes are possible 128, 256 and 512 bytes

Fragmentation is enabled by default, default size is 512 bytes

Fragmentation size is configured using the **ppp multilink fragment-delay** command after using the **interface multilink** command. The least of the fragmentation sizes (among the 3 sizes possible) satisfying the delay criteria is configured. (e.g., a 192 byte packet causes a delay of 1 millisecond on a T1 link, so the nearest fragmentation size is 128 bytes.

The **show ppp multilink** command will indicate the MLPPP type and the fragmentation size:

```
Router# show ppp multilink
Multilink1, bundle name is Patriot2
Bundle up for 00:00:13
Bundle is Distributed
0 lost fragments, 0 reordered, 0 unassigned
0 discarded, 0 lost received, 206/255 load
0x0 received sequence, 0x0 sent sequence
Member links: 2 active, 0 inactive (max not set, min not set)
Se4/2/0/1:0, since 00:00:13, no frags rcvd
Se4/2/0/2:0, since 00:00:10, no frags rcvd
Distributed fragmentation on. Fragment size 512.  Multilink in Hardware.
```

Fragmentation is disabled explicitly by using the **no ppp multilink fragmentation** command after using the **interface multilink** command.

Create a Multilink Bundle

To create a multilink bundle, use the following commands:

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Router(config)# **interface multilink** *group-number*	Creates a multilink interface and enter multilink interface mode. • *group-number*—The group number for the multilink bundle.
Router(config-if)# **ip address** *address mask*	Sets the IP address for the multilink group. • *address*—The IP address. • *mask*—The IP netmask.

Assign an interface to a Multilink Bundle

To assign an interface to a multilink bundle, use the following commands:

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Router(config)# **interface serial** For addressing information, refer to the "Interface Naming" section on page 12-2.	Selects the interface to configure and enters interface configuration mode.
Router(config-if)# **encapsulation ppp**	Enables PPP encapsulation.
Router(config-if)# **multilink-group** *group-number*	Assigns the interface to a multilink bundle. • *group-number*—The multilink group number for the T1 or E1 bundle.
Router(config-if)# **ppp multilink**	Enables multilink PPP on the interface.
Repeat these commands for each interface you want to assign to the multilink bundle.	

Configuring fragmentation size on an MLPPP Bundle (optional)

To configure the fragmentation size on a multilink ppp bundle, use the following commands:

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.

Command	Purpose
Router(config)# **interface multilink** For addressing information, refer to the "Interface Naming" section on page 12-2.	Creates a multilink interface and enters multilink interface mode. • group-number—The group number for the multilink bundle. Range 1-2147483647
Router(config-if)# **ppp multilink fragment-delay** *delay*	Sets the fragmentation size satisfying the configured delay on the multilink bundle. • delay—delay in milliseconds

Disabling the fragmentation on an MLPPP Bundle (optional)

To assign an interface to a multilink bundle, use the following commands:

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Router(config)# **interface multilink** *group-number*	Creates a multilink interface and enters multilink interface mode. • group-number—The group number for the multilink bundle. Range 1-2147483647
Router(config-if)# **no pppp multilink fragmentation**	Disables the fragmentation on the multilink bundle.

Configuring MLFR

Multilink Frame Relay (MLFR) allows you to combine T1/E1 lines into a bundle that has the combined bandwidth of multiple T1/E1 lines. You choose the number of bundles and the number of T1/E1 lines in each bundle. This allows you to increase the bandwidth of your network links beyond that of a single T1/E1 line.

MLFR Configuration Guidelines

MLFR will function in hardware if all of the following conditions are met:

- Only T1 or E1 member links
- All links are on the same SPA
- Maximum of 12 links in a bundle

Create a Multilink Bundle

To create a multilink bundle, use the following commands:

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Router(config)# **interface mfr** *number*	Configures a multilink Frame Relay bundle interface. • *number*—The number for the Frame Relay bundle.
Router(config-if)# **frame-relay multilink bid** *name*	(Optional) Assigns a bundle identification name to a multilink Frame Relay bundle. • *name*—The name for the Frame Relay bundle. **Note** The bundle identification (BID) will not go into effect until the interface has gone from the down state to the up state. One way to bring the interface down and back up again is by using the **shut** and **no shut** commands in interface configuration mode.

Assign an Interface to a Multilink Bundle

To assign an interface to a multilink bundle, use the following commands:

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Router(config)# **interface serial** For addressing information, refer to the "Interface Naming" section on page 12-2.	Selects the interface to assign.
Router(config-if)# **encapsulation frame-relay mfr** *number* [*name*]	Creates a multilink Frame Relay bundle link and associates the link with a bundle. • *number*—The number for the Frame Relay bundle. • *name*—The name for the Frame Relay bundle.
Router(config-if)# **frame-relay multilink lid** *name*	(Optional) Assigns a bundle link identification name with a multilink Frame Relay bundle link. • *name*—The name for the Frame Relay bundle. **Note** The bundle link identification (LID) will not go into effect until the interface has gone from the down state to the up state. One way to bring the interface down and back up again is by using the **shut** and **no shut** commands in interface configuration mode.

Command	Purpose
Router(config-if)# **frame-relay multilink hello** *seconds*	(Optional) Configures the interval at which a bundle link will send out hello messages. The default value is 10 seconds. • *seconds*—Number of seconds between hello messages sent out over the multilink bundle.
Router(config-if)# **frame-relay multilink ack** *seconds*	(Optional) Configures the number of seconds that a bundle link will wait for a hello message acknowledgment before resending the hello message. The default value is 4 seconds. • *seconds*—Number of seconds a bundle link will wait for a hello message acknowledgment before resending the hello message.
Router(config-if)# **frame-relay multilink retry** *number*	(Optional) Configures the maximum number of times a bundle link will resend a hello message while waiting for an acknowledgment. The default value is 2 tries. • *number*—Maximum number of times a bundle link will resend a hello message while waiting for an acknowledgment.

Verifying Multilink Frame Relay

Use the **show frame-relay multilink detailed** command to verify the Frame Relay multilinks:

```
router# show frame-relay multilink detailed

Bundle: MFR49, State = down, class = A, fragmentation disabled
 BID = MFR49
 No. of bundle links = 1, Peer's bundle-id =
 Bundle links:

  Serial6/0/0:0, HW state = up, link state = Add_sent, LID = test
    Cause code = none, Ack timer = 4, Hello timer = 10,
    Max retry count = 2, Current count = 0,
    Peer LID = , RTT = 0 ms
    Statistics:
    Add_link sent = 21, Add_link rcv'd = 0,
    Add_link ack sent = 0, Add_link ack rcv'd = 0,
    Add_link rej sent = 0, Add_link rej rcv'd = 0,
    Remove_link sent = 0, Remove_link rcv'd = 0,
    Remove_link_ack sent = 0, Remove_link_ack rcv'd = 0,
    Hello sent = 0, Hello rcv'd = 0,
    Hello_ack sent = 0, Hello_ack rcv'd = 0,
    outgoing pak dropped = 0, incoming pak dropped = 0
```

Invert Data on the T1/E1 Interface

If the interface on the 1-Port Channelized OC-3/STM-1 SPA is used to drive a dedicated T1 line that does not have B8ZS encoding, you must invert the data stream on the connecting CSU/DSU or on the interface. Be careful not to invert data on both the CSU/DSU and the interface, as two data inversions will cancel each other out. To invert data on a T1/E1 interface, use the following commands:

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Router(config)# **interface serial** For addressing information, refer to the "Interface Naming" section on page 12-2.	Selects the serial interface.
Router(config-if)# **invert data**	Inverts the data stream.

Use the **show running configuration** command to verify that invert data has been set:

```
router# show running configuration
.
.
.
interface Serial6/0/0:0
 no ip address
 encapsulation ppp
 logging event link-status
 load-interval 30
 invert data
 no cdp enable
 ppp chap hostname group1
 ppp multilink
 multilink-group 1
!
.
.
.
```

Changing a Channel Group Configuration

To alter the configuration of an existing channel group, the channel group needs to be removed first using the **no** form of the **channel-group** command. To remove an existing channel group, use the following commands:

Command	Purpose
Router# **configure terminal**	Enters global configuration mode.
Router(config)# For addressing information, refer to the "Interface Naming" section on page 12-2.	Select the controller to configure and enter controller configuration mode.
Router(config-controller)# **no channel-group** *t1 t1-number*	Select the channel group you want to remove. • *t1 t1-number*— channel-group number.

FRF.12 Guidelines

FRF.12 functions in hardware. Note the following:

- The fragmentation is configured at the main interface
- Only 3 fragmentation sizes are available - 128 bytes, 256 bytes, and 512 bytes.

LFI Guidelines

LFI can function two ways - using FRF.12 or MLPPP. MLPPP LFI can be done in both hardware and software while FRF.12 LFI is done only in hardware.

HW MLPPP LFI Guidelines

LFI using MLPPP will function only in hardware if there is just one member link in the MLPPP bundle. The link can be a fractional T1 or full T1. Note the following:

- The **ppp multilink interleave** command needs to be configured to enable interleaving.
- Only three fragmentation sizes are supported - 128 bytes, 256 bytes, and 512 bytes.
- Fragmentation is enabled by default, the default size being 512 bytes.
- A policy-map having a priority class needs to applied to main interface.

FRF.12 LFI Guidelines

LFI using FRF.12 is always done is hardware. Note the following:

- The fragmentation is configured at the main interface
- Only 3 fragmentation sizes are available - 128 bytes, 256 bytes, and 512 bytes.
- A policy-map having a priority class needs to applied to main interface.

Saving the Configuration

To save your running configuration to nonvolatile random-access memory (NVRAM), use the following command in privileged EXEC configuration mode:

Command	Purpose
Router# **copy running-config startup-config**	Writes the new configuration to NVRAM.

For more information about managing configuration files, refer to the *Cisco IOS Configuration Fundamentals Configuration Guide, Release 12.0* and *Cisco IOS Configuration Fundamentals Command Reference, Release 12.0* publications.

Verifying the Interface Configuration

Besides using the **show running-configuration** command to display your Cisco 12000 Series Router configuration settings, you can use the **show interface serial** and the **show controllers serial** commands to get detailed information on a per-port basis for your1-Port Channelized OC-3/STM-1 SPA.

Verifying Per-Port Interface Status

To find detailed interface information on a per-port basis for the 1-Port Channelized OC-3/STM-1 SPA use the **show interface serial** command.

The following example provides sample output for interface port 0 on the SPA located in the first subslot of the Cisco 12000 SIP-401 installed in slot 2 of a Cisco 12000 router:

```
Router# show interface serial 2/1/0.2/1:0
Serial2/1/0.2/1:0 is down, line protocol is down
Hardware is Channelized-T3
MTU 1500 bytes, BW 1536 Kbit, DLY 20000 usec, rely 255/255, load 1/255
Encapsulation HDLC, crc 16, loopback not set
Keepalive set (10 sec)
Last input never, output never, output hang never
Last clearing of "show interface" counters never
Queueing strategy: fifo
Output queue 0/40, 0 drops; input queue 0/75, 0 drops
Available Bandwidth 1536 kilobits/sec
5 minute output rate 0 bits/sec, 0 packets/sec
0 packets input, 0 bytes, 0 no buffer
Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
0 packets output, 0 bytes, 0 underruns
0 output errors, 0 collisions, 2 interface resets
0 output buffer failures, 0 output buffers swapped out
0 carrier transitions alarm present
VC 5: timeslot(s): 1-24, Transmitter delay 0, non-inverted data
UUT#sh int Serial2/1/0.3
Serial2/1/0.3 is down, line protocol is down
Hardware is CHOCx SPA
MTU 4470 bytes, BW 44210 Kbit, DLY 200 usec, rely 255/255, load 1/255
Encapsulation HDLC, crc 16, loopback not set
Keepalive set (10 sec)
Last input never, output never, output hang never
Last clearing of "show interface" counters never
Queueing strategy: fifo
Output queue 0/40, 0 drops; input queue 0/75, 0 drops
Available Bandwidth 44210 kilobits/sec
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
0 packets input, 0 bytes, 0 no buffer
Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
0 parity

(Remaining output omitted)
```

CHAPTER 13

Command Summary for Serial SPAs

Table 13-1 provides an alphabetical list of some of the related commands to configure, monitor, and maintain Serial SPAs. For more information about the commands, see Chapter 19, "SIP and SPA Command Reference" in this book and the Cisco IOS Release 12.2 command reference and master index publications.

Table 13-1 Command Summary

Command	**Purpose**
Router(config-subif)**bert errors [number]**	Transmits BERT errors while running any bert pattern.
Router(config-subif)**bert pattern {0s | 1s | 2^15 | 2^20 | 2^23 | alt-0-1 | qrss} interval minutes}**	Starts a BERT pattern on a port.
Router(config-subif)**card type {t1 | e1} slot subslot**	Configures ports on SPA in T1 or E1 mode.
Router(config-subif)**card type {t3 | e3} slot subslot**	Configures ports on SPA in T3 or E3 mode.
Router(config-subif)**framing {sf | esf}**	Selects the frame type for a T1 or E1 data line.
Router(config-subif)**framing {c-bit | m23}**	Selects the frame type for a T3 port.
Router(config-subif)**framing {bypass | c-bit | m13}**	Selects the frame type for a T3 or E3 port.
Router(config-subif)**loopback {dte | local | network {line | payload} | remote}**	Sets a loopback at various points in a transmitting and receiving path
Router(config-subif)**mdl [string {eic | fic | generator | lic | pfi | port | unit}string] | [transmit {idle-signal | path | test-signal}]**	Configures the Maintenance Data Link (MDL) message defined in the ANSI T1.107a-1990 specification
Router(config-subif)**show controllers serial [slot/port]**	Displays serial controller statistics.
Router(config-subif)**show interfaces serial [number[:channel-group]] [accounting]**	Displays information about a serial interface.
Router(config-subif)**t1** *channel* **framing** {**esf** | **sf**}	Specifies the type of framing used by T1 channels.
Router(config-subif)**ttb {country | rnode | serial | snode | soperator | x} line**	Sends a trace trail buffer in E3 g832 framing mode.

PART 4

Packet over SONET Shared Port Adapters

CHAPTER 14

Overview of the POS SPAs

This chapter provides an overview of the release history, and feature and Management Information Base (MIB) support for the Packet over SONET (POS) SPAs on the Cisco 12000 series router.

This chapter includes the following sections:

Release History

Release	Modification
Cisco IOS Release 12.0(32)SY	Support for the following hardware by the Cisco 12000 SIP-401, Cisco 12000 SIP-501, and Cisco 12000 SIP-601 was introduced on the Cisco 12000 series router: • 4-Port OC-3c/STM-1 POS SPA • 8-Port OC-3c/STM-1 POS SPA • 2-Port OC-3c/STM-1 and OC-12c/STM-4 POS SPA • 4-Port OC-3c/STM-1 and OC-12c/STM-4 POS SPA Support for the following hardware by the Cisco 12000 SIP-501 and Cisco 12000 SIP-601 was introduced on the Cisco 12000 series router: • 8-Port OC-3c/STM-1 and OC-12c/STM-4 POS SPA Support for the Spatial Reuse Protocol (SRP) feature was introduced on the OC-192c POS SPAs and the 2-Port OC-48c/STM-16 POS SPA.

Cisco IOS Release 12.0(32)S	Support for the following hardware by the Cisco 12000 SIP-601 was introduced on the Cisco 12000 series router: • 1-Port OC-192c/STM-64 POS/RPR SPA • 1-Port OC-192c/STM-64 POS/RPR XFP SPA • 1-Port OC-192c/STM-64 POS/RPR VSR Optics SPA Support for the following hardware by the Cisco 12000 SIP-501 and Cisco 12000 SIP-601 was introduced on the Cisco 12000 series router: • 2-Port OC-48c/STM-16 POS SPA Cisco Frame Relay and RFC 2427 Frame Relay encapsulation is introduced for all POS SPAs on the Cisco 12000 series router.
Cisco IOS Release 12.0(31)S2	Support for the following hardware by the Cisco 12000 SIP-600 was introduced on the Cisco 12000 series router: • 2-Port OC-48c/STM-16 POS SPA
Cisco IOS Release 12.0(31)S	Support for the following hardware by the Cisco 12000 SIP-600 was introduced on the Cisco 12000 series router: • 1-Port OC-192c/STM-64 POS/RPR SPA • 1-Port OC-192c/STM-64 POS/RPR XFP SPA

POS Technology Overview

Packet-over-SONET is a high-speed method of transporting IP traffic between two points. This technology combines the Point-to-Point Protocol (PPP) with Synchronous Optical Network (SONET) and Synchronous Digital Hierarchy (SDH) interfaces.

SONET is an octet-synchronous multiplex scheme defined by the American National Standards Institute (ANSI) standard (T1.1051988) for optical digital transmission at hierarchical rates from 51.840 Mbps to 2.5 Gbps (Synchronous Transport Signal, STS-1 to STS-48) and greater. SDH is an equivalent international standard for optical digital transmission at hierarchical rates from 155.520 Mbps (Synchronous Transfer Mode-1 [STM-1]) to 2.5 Gbps (STM-16) and greater.

SONET specifications have been defined for single-mode fiber and multimode fiber. The POS SPAs on the Cisco 12000 series router allow transmission over both single-mode and multimode fiber at various optical carrier rates. The multirate SPAs (such as the 2-Port OC-3c/STM-1 and OC-12c/STM-4 POS SPA) support use of OC-3c and OC-12c SFPs.

SONET/SDH transmission rates are integral multiples of 51.840 Mbps. The following transmission multiples are currently specified and used on the POS SPAs on the Cisco 12000 series router:

- OC-3c/STM-1—155.520 Mbps
- OC-12c/STM-4—622.080 Mbps
- OC-48—2.488 Gbps
- OC-192c/STM-64—9.953 Gbps

The POS specification (RFC 1619) describes the use of PPP encapsulation over SONET/SDH links. Because SONET/SDH is, by definition, a point-to-point circuit, PPP is well-suited for use over these links. PPP treats SONET/SDH transport as octet-oriented full-duplex synchronous links. PPP presents an octet interface to the physical layer. The octet stream is mapped into the SONET/SDH Synchronous

Payload Envelope (SPE), with the octet boundaries aligned with the SPE octet boundaries. The PPP frames are located by row within the SPE payload. Because frames are variable in length, the frames are allowed to cross SPE boundaries.

Supported Features

This section provides a list of some of the primary features supported by the POS SPA hardware and software:

- Jumbo frames (up to 9216 bytes)
- Internal buffering to support short bursts of data traffic at the bus interface
- HDLC and PPP encapsulation—All POS SPAs
- Cisco Frame Relay and RFC 2427 Frame Relay encapsulation
- Online insertion and removal (OIR) from the SIP, or OIR of the SIP with the SPA inserted.
- Small form-factor pluggable (XFP) optics module OIR for the 1-Port OC-192c/STM-64 POS/RPR XFP SPA and SFP optics module OIR for the 2-Port OC-48c/STM-16 POS SPA
- Multirate functionality on 2-Port, 4-Port, and 8-Port OC-3c/STM-1 and OC-12c/STM-4 POS SPAs with support of OC-3c and OC-12c SFPs.
- Field-programmable gate array (FPGA) upgrade support

The POS SPAs also support the following groups of features:

- SONET/SDH Compliance Features, page 14-3
- SONET/SDH Error, Alarm, and Performance Monitoring Features, page 14-4
- SONET/SDH Synchronization Features, page 14-4
- WAN Protocol Features, page 14-5
- Network Management Features, page 14-5

SONET/SDH Compliance Features

This section lists the SONET/SDH compliance features supported by the POS SPAs on the Cisco 12000 series router:

- 1+1 SONET Automatic Protection Switching (APS) as per G.783 Annex A
- 1+1 SDH Multiplex Section Protection (MSP) as per G.783 Annex A
- American National Standards Institute (ANSI) T1.105
- ITU-T G.707, G.783, G.957, G.958

- Telcordia GR-253-CORE: SONET Transport Systems: Common Generic Criteria
- Telcordia GR-1244: Clocks for the Synchronized Network: Common Generic Criteria

SONET/SDH Error, Alarm, and Performance Monitoring Features

This section lists the SONET/SDH error, alarm, and performance monitoring features supported by the POS SPAs on the Cisco 12000 series router:

- Signal failure bit error rate (SF-BER)
- Signal degrade bit error rate (SD-BER)
- Signal label payload construction (C2)
- Path trace byte (J1)
- Section:
  - Loss of signal (LOS)
  - Loss of frame (LOF)
  - Error counts for B1
  - Threshold crossing alarms (TCA) for B1
- Line:
  - Line alarm indication signal (LAIS)
  - Line remote defect indication (LRDI)
  - Line remote error indication (LREI)
  - Error counts for B2
  - Threshold crossing alarms (TCA) for B2
- Path:
  - Path alarm indication signal (PAIS)
  - Path remote defect indication (PRDI)
  - Path remote error indication (PREI)
  - Error counts for B3
  - Threshold crossing alarms (TCA) for B3
  - Loss of pointer (LOP)
  - New pointer events (NEWPTR)
  - Positive stuffing event (PSE)
  - Negative stuffing event (NSE)

SONET/SDH Synchronization Features

This section lists the SONET/SDH synchronization features supported by the POS SPAs on the Cisco 12000 series router:

- Local (internal) timing (for inter-router connections over dark fiber or Wavelength Division Multiplex [WDM] equipment)

- Loop (line) timing (for connecting to SONET/SDH equipment)
- +/– 20 ppm clock accuracy over full operating temperature

WAN Protocol Features

This section lists the WAN protocols supported by the POS SPAs on the Cisco 12000 series router:

- RFC 1661, *The Point-to-Point Protocol (PPP)*
- RFC 1662, *PPP in HDLC framing*
- RFC 2615, *PPP over SONET/SDH* (with 1+x43 self-synchronous payload scrambling)
- RFC 3518, *Point-to-Point Protocol (PPP) Bridging Control Protocol (BCP)*
- Cisco Protect Group Protocol over UDP/IP (Port 1972) for APS and MSP
- Multiprotocol Label Switching (MPLS)

Network Management Features

This section lists the network management features supported by the POS SPAs on the Cisco 12000 series router:

- Simple Network Management Protocol (SNMP) Management Information Base (MIB) counters
- Local (diagnostic) loopback
- Network loopback
- NetFlow Data Export
- IP over the Section Data Communications Channel (SDCC)
- RFC 3592 performance statistics for timed intervals (current, 15-minute, multiple 15-minute, and 1-day intervals):
  - Regenerator section
  - Multiplex section
  - Path errored seconds
  - Severely errored seconds
  - Severely errored framed seconds

Restrictions

Table 14-1 provides information about POS feature compatibility and restrictions by SIP and SPA combination.

Table 14-1 POS Feature Compatibility and Restrictions by SIP and SPA Combination

Feature	Cisco 12000 SIP-401	Cisco 12000 SIP-501	Cisco 12000 SIP-600	Cisco 12000 SIP-601
Frame Relay	Supported for all POS SPAs.	Supported for all POS SPAs.	In Cisco IOS Release 12.0(31)S2 and earlier—Not supported. In Cisco IOS Release 12.0(32)S and later—Supported for all POS SPAs.	In Cisco IOS Release 12.0(31)S2 and earlier—Not supported. In Cisco IOS Release 12.0(32)S and later—Supported for all POS SPAs.
Resilient Packet Ring (RPR)	Not supported.	Not supported.	Not supported.	Not supported.

Table 14-1 POS Feature Compatibility and Restrictions by SIP and SPA Combination (continued)

Feature	Cisco 12000 SIP-401	Cisco 12000 SIP-501	Cisco 12000 SIP-600	Cisco 12000 SIP-601
	Not supported for the following SPAs: • 4-Port and 8-Port OC-3c/STM-1 POS SPA • 2-Port and 4-Port OC-12c/STM-4 Multirate POS SPA	Not supported for the following SPAs: • 4-Port and 8-Port OC-3c/STM-1 POS SPA • 2-Port, 4-Port, and 8-Port OC-3c/STM-1 and OC-12c/STM-4 POS SPA	Supported for all POS SPAs.	Not supported for the following SPAs: • 4-Port and 8-Port OC-3c/STM-1 POS SPA • 2-Port, 4-Port, and 8-Port OC-3c/STM-1 and OC-12c/STM-4 POS SPA
	Not supported on any POS SPAs.	In Cisco IOS Release 12.0(32)S and earlier—Not supported. In Cisco IOS Release 12.0(32)SY: • Supported: 2-Port OC-48c/STM-16 POS SPA • Not supported: – 4-Port and 8-Port OC-3c/STM-1 POS SPA – 2-Port, 4-Port, and 8-Port OC-3c/STM-1 and OC-12c/STM-4 POS SPA	In Cisco IOS Release 12.0(32)S and earlier—Not supported. In Cisco IOS Release 12.0(32)SY: • All 1-Port OC-192c/STM-64 POS/RPR SPAs • 2-Port OC-48c/STM-16 POS SPA	In Cisco IOS Release 12.0(32)S and earlier—Not supported. In Cisco IOS Release 12.0(32)SY: • Supported: – All 1-Port OC-192c/STM-64 POS/RPR SPAs – 2-Port OC-48c/STM-16 POS SPA • Not supported: – 4-Port and 8-Port OC-3c/STM-1 POS SPA – 2-Port, 4-Port, and 8-Port OC-3c/STM-1 and OC-12c/STM-4 POS SPA

Supported MIBs

The following MIBs are supported for POS SPAs on the Cisco 12000 series router:

- CISCO-APS-MIB
- CISCO-ENTITY-EXT-MIB
- CISCO-ENTITY-FRU-CONTROL-MIB
- CISCO-OPTICAL-MONITORING-MIB

- CISCO-SRP-MIB—Beginning in Cisco IOS Release 12.0(32)SY for supported SPAs.
- ENTITY-MIB
- IF-MIB (RFC 2233, *The Interface Group MIB using SMIv2*)
- OLD-CISCO-CHASSIS-MIB
- SONET-MIB (RFC 3592, *Definitions of Managed Objects for the SONET/SDH Interface Type*)

To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL:

http://tools.cisco.com/ITDIT/MIBS/servlet/index

If Cisco MIB Locator does not support the MIB information that you need, you can also obtain a list of supported MIBs and download MIBs from the Cisco MIBs page at the following URL:

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

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

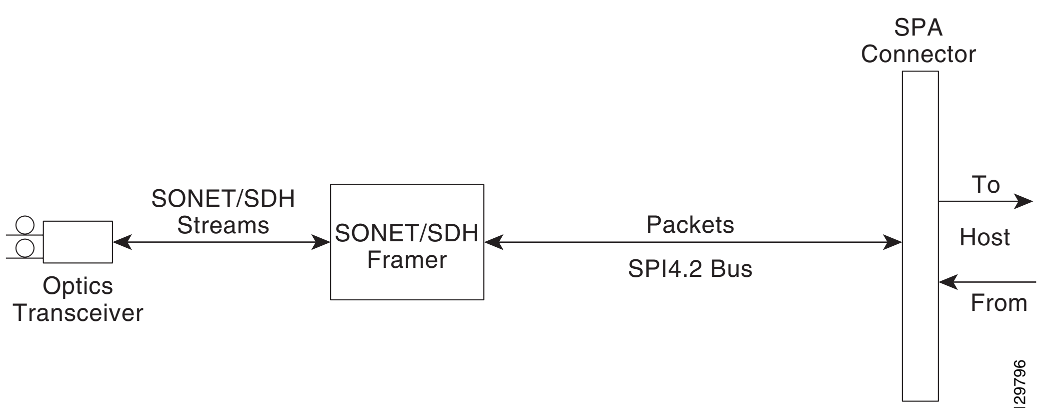
http://www.cisco.com/register

SPA Architecture

1-Port OC-192c/STM-64 POS/RPR XFP SPA Architecture

Figure 14-1 identifies the primary hardware devices that are part of the POS SPA architecture. The figure shows a single optics transceiver supported by both of the POS SPAs. However, the 1-Port OC-192c/STM-64 POS/RPR SPA and 1-Port OC-192c/STM-64 POS/RPR VSR Optics SPA support fixed optics, while the 1-Port OC-192c/STM-64 POS/RPR XFP SPA supports XFP optics. The path of a packet remains the same except for where the optic transceiver support resides.

Figure 14-1 1-Port OC-192c/STM-64 POS/RPR XFP SPA Architecture



In POS mode, every incoming and outgoing packet on the OC-192 POS SPAs goes through the SONET/SDH framer and SPI4.2 interface.

Path of a Packet in the Ingress Direction

The following steps describe the path of an ingress packet through the 1-Port OC-192c/STM-64 POS/RPR XFP SPA:

1. The framer receives SONET/SDH streams from the XFP optics, extracts clocking and data, and processes the section, line, and path overhead.
2. The framer extracts the POS frame payload and verifies the frame size and frame check sequence (FCS).
3. The framer passes valid frames to the System Packet Level Interface 4.2 (SPI4.2) interface on the SPA.
4. The SPI4.2 interface transfers frames to the host through the SPI4.2 bus for further processing and switching.

Path of a Packet in the Egress Direction

The following steps describe the path of an egress packet through the 1-Port OC-192c/STM-64 POS/RPR XFP SPA:

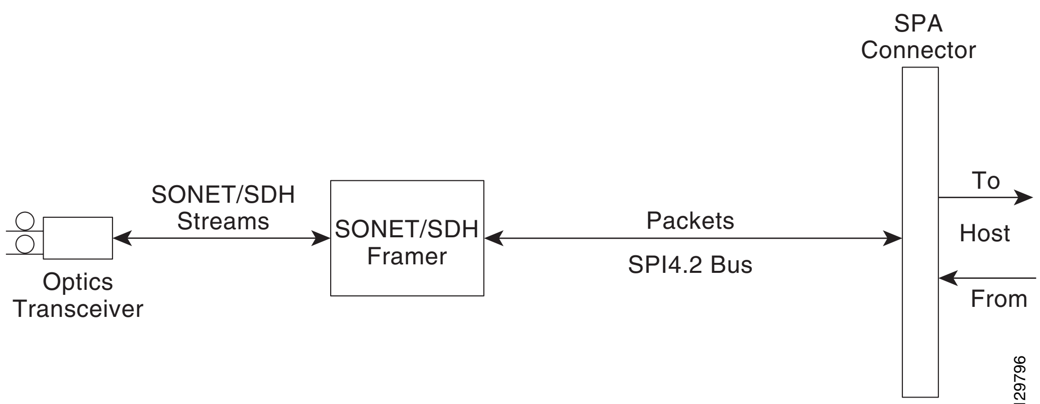
1. The host sends packets to the SPA using the SPI4.2 bus.
2. The SPA stores the data in the appropriate channel's first-in first-out (FIFO) queue.
3. The SPA passes the packet to the framer.
4. The framer accepts the data and stores it in the appropriate channel queue.
5. The framer adds the FCS and SONET/SDH overhead.
6. The framer sends the data to the XFP optics for transmission onto the network.

This section provides an overview of the architecture of the POS SPAs and describes the path of a packet in the ingress and egress directions. Some of these areas of the architecture are referenced in the SPA software and can be helpful to understand when troubleshooting or interpreting some of the SPA CLI and **show** command output.

1-Port OC-192c/STM-64 POS/RPR SPA and 1-Port OC-192c/STM-64 POS/RPR XFP SPA Architecture

Figure 14-2 identifies the primary hardware devices that are part of the POS SPA architecture. The figure shows a single optics transceiver supported by both of the POS SPAs. However, the 1-Port OC-192c/STM-64 POS/RPR SPA supports fixed optics, while the 1-Port OC-192c/STM-64 POS/RPR XFP SPA supports XFP optics. The path of a packet remains the same except for where the optic transceiver support resides.

Figure 14-2 1-Port OC-192c/STM-64 POS/RPR XFP SPA Architecture



In POS mode, every incoming and outgoing packet on the 1-Port OC-192c/STM-64 POS/RPR SPA and 1-Port OC-192c/STM-64 POS/RPR XFP SPAgoes through the SONET/SDH framer, and SPI4.2 interface.

Path of a Packet in the Ingress Direction

The following steps describe the path of an ingress packet through the 1-Port OC-192c/STM-64 POS/RPR XFP SPA:

1. The framer receives SONET/SDH streams from the XFP optics, extracts clocking and data, and processes the section, line, and path overhead.
2. The framer extracts the POS frame payload and verifies the frame size and frame check sequence (FCS).
3. The framer passes valid frames to the System Packet Level Interface 4.2 (SPI4.2) interface on the SPA.
4. The SPI4.2 interface transfers frames to the host through the SPI4.2 bus for further processing and switching.

Path of a Packet in the Egress Direction

The following steps describe the path of an egress packet through the 1-Port OC-192c/STM-64 POS/RPR XFP SPA:

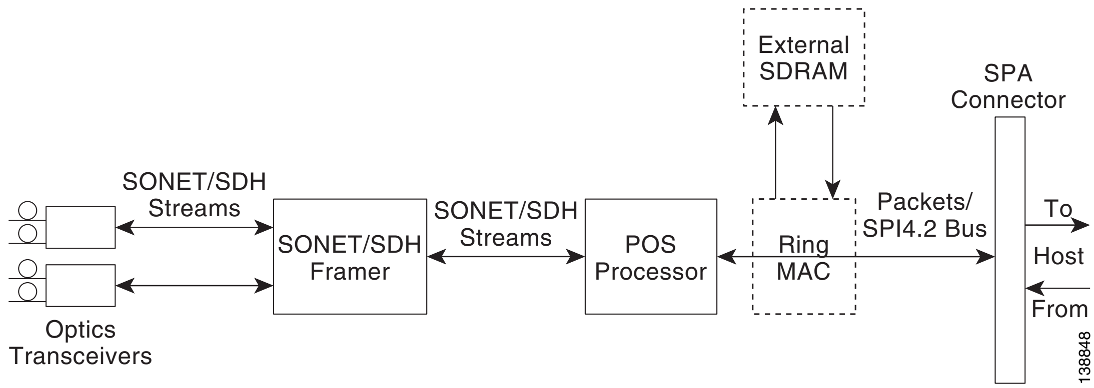
1. The host sends packets to the SPA using the SPI4.2 bus.
2. The SPA stores the data in the appropriate channel's first-in first-out (FIFO) queue.

3. The SPA passes the packet to the framer.
4. The framer accepts the data and stores it in the appropriate channel queue.
5. The framer adds the FCS and SONET/SDH overhead.
6. The framer sends the data to the XFP optics for transmission onto the network.

2-Port OC-48c/STM-16 POS SPA Architecture

Figure 14-3 identifies the primary hardware devices that are part of the 2-Port OC-48c/STM-16 POS SPA architecture.

Figure 14-3 2-Port OC-48c/STM-16 POS SPA Architecture



Path of a Packet in the Ingress Direction

The following steps describe the path of an ingress packet through the 2-Port OC-48c/STM-16 POS SPA:

1. The framer receives SONET/SDH streams from the SFP optics, extracts clocking and data, and processes the section, line, and path overhead.
2. The framer detects Loss of Signal (LOS), Loss of Frame (LOF), Severely Errored Frame (SEF), Line Alarm Indication Signal (AIS-L), Loss of Pointer (LOP), Line Remote Defect Indication Signal (Enhanced RDI-L), Path Alarm Indication Signal (AIS-P), Standard and Enhanced Path Remote Defect Indication Signal (RDI-P), Path Remote Error Indication (Enhanced REI-P). The framer extracts or inserts DCC bytes.
3. The framer processes the S1 synchronization status byte, the pointer action bytes (per Telcordia GR-253-CORE), and extracts or inserts DCC bytes.
4. The POS processor extracts the POS frame payload and verifies the frame size and frame check sequence (FCS).
5. The POS processor supports PPP, Frame Relay, or HDLC modes and optionally performs payload scrambling.
6. The POS processor passes valid frames to the System Packet Level Interface 4.2 (SPI4.2) interface on the SPA.
7. The SPI4.2 interface transfers frames to the host through the SPI4.2 bus for further processing and switching.

Path of a Packet in the Egress Direction

The following steps describe the path of an egress packet through the 2-Port OC-48c/STM-16 POS SPA:

1. The host sends packets to the SPA using the SPI4.2 bus.
2. The SPA stores the data in the appropriate SPI4 channel's first-in first-out (FIFO) queue.
3. The SPA passes the packet from the SPI4 interface to the POS processor where it is encapsulated in a POS frame and FCS is added.
4. The POS frame is sent to the SONET/SDH framer where it is placed into the SONET payload.
5. The framer adds the FCS and SONET/SDH overhead.
6. The framer sends the data to the SFP optics for transmission onto the network.

Displaying the SPA Hardware Type

To verify the SPA hardware type that is installed in your Cisco 12000 series router, you can use the **show diags** command. For other hardware information, you can also use the **show interfaces** or **show controllers** commands. There are several other commands on the Cisco 12000 series router that also provide SPA hardware information. For more information about these commands, see the "Command Summary for POS SPAs" and the "SIP and SPA Commands" chapters in this guide.

Table 14-2 shows the hardware description that appears in the **show** command output for each type of SPA that is supported on the Cisco 12000 series router.

Table 14-2 SPA Hardware Descriptions in show Commands

SPA	Description in show interfaces Command	Description in show diags Command
1-Port OC-192c/STM-64 POS/RPR SPA	Hardware is Packet over SONET	1-port OC192/STM64 POS/RPR Shared Port Adapter / SPA-OC192POS-VSR / SPA-OC192POS-LR
1-Port OC-192c/STM-64 POS/RPR XFP SPA	Hardware is Packet over SONET	1-port OC192/STM64 POS/RPR XFP Optics Shared Port Adapter / SPA-OC192POS-XFP
2-Port OC-48c/STM-16 POS SPA	Hardware is Packet over SONET	2-port OC48/STM16 POS/RPR Shared Port Adapter / SPA-2XOC48POS/RPR
2-Port OC-3c/STM-1 and OC-12c/STM-4 POS SPA	Hardware is Packet over SONET	2-port OC12/STM4 POS Shared Port Adapter / SPA-2XOC12-POS
4-Port OC-3c/STM-1 POS SPA	Hardware is Packet over SONET	4-port OC3/STM1 POS Shared Port Adapter / SPA-2XOC3-POS
4-Port OC-3c/STM-1 and OC-12c/STM-4 POS SPA	Hardware is Packet over SONET	4-port OC12/STM4 POS Shared Port Adapter / SPA-4XOC12-POS
8-Port OC-3c/STM-1 POS SPA	Hardware is Packet over SONET	8-port OC3/STM1 POS Shared Port Adapter / SPA-8XOC3-POS
8-Port OC-3c/STM-1 and OC-12c/STM-4 POS SPA	Hardware is Packet over SONET	8-port OC12/STM4 POS Shared Port Adapter / SPA-8XOC12-POS

Example of the show interfaces Command

The following example shows output from the **show interfaces** command on a Cisco 12000 series router for the only interface port (0) on a 1-Port OC-192c/STM-64 POS/RPR SPA installed in subslot 1 of the SIP installed in chassis slot 1:

```
Router#show interfaces pos 1/1/0
POS1/1/0 is up, line protocol is up
  Hardware is Packet over SONET
  Internet address is 10.41.41.2/24
  MTU 4470 bytes, BW 9952000 Kbit, DLY 100 usec, rely 255/255, load 1/255
  Encapsulation HDLC, crc 32, loopback not set
  Keepalive not set
  Scramble enabled
  Last input 00:00:59, output 00:00:11, output hang never
  Last clearing of "show interface" counters 00:00:14
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
        Available Bandwidth 9582482 kilobits/sec
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     0 packets input, 0 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
              0 parity
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     1 packets output, 314 bytes, 0 underruns
     0 output errors, 0 applique, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions
```

The following example shows output from the **show interfaces** command on a Cisco 12000 series router for the first interface port (0) on a 2-Port OC-48c/STM-16 POS SPA installed in subslot 0 of the SIP installed in chassis slot 0:

```
Router# show interfaces pos3/0/0
POS3/0/0 is down, line protocol is down
  Hardware is Packet over SONET
  MTU 4470 bytes, BW 2488000 Kbit, DLY 100 usec, rely 255/255, load 1/255
  Encapsulation HDLC, crc 32, loopback not set
  Keepalive set (10 sec)
  Scramble enabled
  Last input never, output never, output hang never
  Last clearing of "show interface" counters never
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
        Available Bandwidth 2395851 kilobits/sec
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     0 packets input, 0 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
              0 parity
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     0 packets output, 0 bytes, 0 underruns
     0 output errors, 0 applique, 1 interface resets
     0 output buffer failures, 0 output buffers swapped out
     1 carrier transitions
```

Example of the show diags Command

The following example shows output from the **show diags** command on a Cisco 12000 series router with a 1-Port OC-192c/STM-64 POS/RPR XFP SPA located in subslot 0 of the SIP installed in chassis slot 2:

```
Router# show diags subslot 2/0
```

```
SUBSLOT  2/0 (SPA-OC192POS-XFP): 1-port OC192/STM64 POS/RPR XFP Optics Shared Port Adapter
        Product Identifier (PID) : SPA-OC192POS-XFP
        Version Identifier (VID) : V01
        PCB Serial Number        : PRTA1304177
        Top Assy. Part Number    : 68-2190-01
        Top Assy. Revision       : A0
        Hardware Revision        : 2.1
        CLEI Code                : UNASSIGNED
        Insertion Time           : 3d08h (00:18:18 ago)
        Operational Status       : ok
```

The following example shows output from the **show diags** command on a Cisco 12000 series router with a 2-Port OC-48c/STM-16 POS SPA located in subslot 0 of the SIP installed in chassis slot 3:

```
Router# show diags subslot 3/0

SUBSLOT  3/0 (SPA-2XOC48POS/RPR): 2-port OC48/STM16 POS/RPR Shared Port Adapter
        Product Identifier (PID) : SPA-2XOC48-POS/RPR
        Version Identifier (VID) : V01
        PCB Serial Number        : JAB0922079S
        Top Assy. Part Number    : 68-2226-01
        Top Assy. Revision       : 32
        Hardware Revision        : 1.0
        CLEI Code                :
        Insertion Time           : 00:00:37 (00:04:50 ago)
        Operational Status       : ok
```

Example of the show controllers Command

The following example shows output from the **show controllers pos** command on a Cisco 12000 series router for the only interface port (0) on a 1-Port OC-192c/STM-64 POS/RPR SPA installed in subslot 1 of the SIP installed in chassis slot 1:

```
Router# show controllers pos 1/1/0
POS1/1/0
SECTION
  LOF = 0          LOS    = 0                            BIP(B1) = 0
LINE
  AIS = 0          RDI    = 0          FEBE = 0          BIP(B2) = 0
PATH
  AIS = 0          RDI    = 0          FEBE = 0          BIP(B3) = 0
  LOP = 0          NEWPTR = 0          PSE  = 0          NSE     = 0

Active Defects: None
Active Alarms:  None
Alarm reporting enabled for: SF SLOS SLOF B1-TCA B2-TCA PLOP B3-TCA

Framing: SONET
APS

  COAPS = 0          PSBF = 0
  State: PSBF_state = False
  ais_shut = FALSE
  Rx(K1/K2): 00/00  S1S0 = 00, C2 = 16
  Remote aps status (none); Reflected local aps status (none)
CLOCK RECOVERY
  RDOOL = 0
  State: RDOOL_state = False
PATH TRACE BUFFER : STABLE
  Remote hostname : Test
  Remote interface: POS2/0/0
```

```
  Remote IP addr  : 10.41.41.1
  Remote Rx(K1/K2): 00/00  Tx(K1/K2): 08/00

BER thresholds:  SF = 10e-3  SD = 10e-6
TCA thresholds:  B1 = 10e-6  B2 = 10e-6  B3 = 10e-6
```

CHAPTER 15

Configuring the POS SPAs

This chapter provides information about configuring the Packet over SONET (POS) shared port adapters (SPAs) on the Cisco 12000 Series Router. This chapter includes the following sections:

For more information about the commands used in this chapter, first see Chapter 19, "SIP and SPA Command Reference" which documents new and modified commands. Also refer to the related Cisco IOS Release 12.0 software command reference and master index publications. For more information about accessing these publications, see the "Related Documentation" section.

For information about managing your system images and configuration files, refer to the *Cisco IOS Configuration Fundamentals Configuration Guide, Release 12.0* and *Cisco IOS Configuration Fundamentals Command Reference, Release 12.0* publications.

Configuration Tasks

This section describes how to configure POS SPAs and includes information about verifying the configuration.

It includes the following topics:

Required Configuration Tasks

This section lists the required configuration steps to configure the POS SPAs. Some of the required configuration commands implement default values that might be appropriate for your network. If the default value is correct for your network, then you do not need to configure the command. These commands are indicated by "(As Required)" in the Purpose column.

Required Configuration Tasks for POS SPAs

To configure the POS SPAs, complete the following steps:

	Command	Purpose
Step 1	Router# **configure terminal**	Enters global configuration mode.
Step 2	Router(config)# **interface pos** *slot*/*subslot*/*port*	Specifies the POS interface to configure and enters interface configuration mode, where: • *slot*/*subslot*/*port*—Specifies the location of the interface. See the "Specifying the Interface Address on a SPA" section on page 15-4.
Step 3	Router(config-if)# **ip address** *ip-address mask* [**secondary**]	Sets a primary or secondary IP address for an interface, where: • *ip-address*—Specifies the IP address for the interface. • *mask*—Specifies the mask for the associated IP subnet. • **secondary**—(Optional) Specifies that the configured address is a secondary IP address. If this keyword is omitted, the configured address is the primary IP address.
Step 4	Router(config-if)# **pos framing** {**sonet** | **sdh**}	(As Required) Specifies the POS framing type, where: • **sonet**—Enables Synchronous Optical Network framing for optical carrier (OC) rates. This is the default. • **sdh**—Enables Synchronous Digital Hierarchy framing for synchronous transfer mode (rates. The POS framing type must be configured to be the same on both ends of the POS link.
Step 5	Router(config-if)# **mtu** *bytes*	(As Required) Configures the maximum transmission unit (or packet size) for an interface, where: • *bytes*—Specifies the maximum number of bytes for a packet. The default is 4470 bytes.

	Command	Purpose
Step 6	Router(config-if)# **keepalive** [*period* [*retries*]]	(As Required) Specifies the frequency at which the Cisco IOS software sends messages to the other end of the link, to ensure that a network interface is alive, where: • *period*—Specifies the time interval in seconds for sending keepalive packets. The default is 10 seconds. • *retries*—Specifies the number of times that the device will continue to send keepalive packets without response before bringing the interface down. The default is 5 retries. The keepalive must be configured to be the same on both ends of the POS link.
Step 7	Router(config-if)# **crc** [**16** | **32**]	(As Required) Specifies the length of the cyclic redundancy check (CRC), where: • **16**—Specifies a 16-bit length CRC. • **32**—Specifies a 32-bit length CRC. This is the default for the 1-Port OC-192c/STM-64 POS/RPR SPA, and 1-Port OC-192c/STM-64 POS/RPR XFP SPA, and 2-Port OC-48c/STM-16 POS SPA. The CRC size must be configured to be the same on both ends of the POS link.
Step 8	Router(config-if)# **clock source** {**line** | **internal**}	(As Required) Specifies the clock source for the POS link, where: • **line**—The link uses the recovered clock from the line. This is the default. • **internal**—The link uses the internal clock source.
Step 9	Router(config-if)# **encapsulation** *encapsulation-type*	(As Required) Specifies the encapsulation method used by the interface, where: • *encapsulation-type*—Can be HDLC, PPP, or Frame Relay. The default encapsulation is HDLC. The encapsulation must be configured to be the same on both ends of the POS link. **Note** As of Cisco IOS Release 12.0(31)S, the OC-192c POS SPAs do not support Frame Relay.
Step 10	Router(config-if)# **pos scram-ble-atm**	(As Required) Enables SONET payload scrambling. For the 1-Port OC-192c/STM-64 POS/RPR SPA, 1-Port OC-192c/STM-64 POS/RPR XFP SPA, and 2-Port OC-48c/STM-16 POS SPA the default configuration is SONET payload scrambling enabled. SONET payload scrambling is enabled for the 1-Port OC-192c/STM-64 POS/RPR SPA, the1-Port OC-192c/STM-64 POS/RPR XFP SPA, and the 2-Port OC-48c/STM-16 POS SPA and the option to disable SONET payload scrambling is not available for these SPAs. The SONET payload scrambling must be configured to be the same on both ends of the POS link.
Step 11	Router(config-if)# **no shutdown**	Enables the interface.

Specifying the Interface Address on a SPA

SPA interface ports begin numbering with "0" from left to right. Single-port SPAs use only the port number 0. To configure or monitor SPA interfaces, you need to specify the physical location of the SIP, SPA, and interface in the CLI. The interface address format is *slot*/*subslot*/*port*, where:

- *slot*—Specifies the chassis slot number in the Cisco 12000 Series Router where the SIP is installed.
- *subslot*—Specifies the secondary slot of the SIP where the SPA is installed.
- *port*—Specifies the number of the individual interface port on a SPA.

The following example shows how to specify the first interface (0) on a SPA installed in the first subslot of a SIP (0) installed in chassis slot 3:

```
Router(config)# interface serial 3/0/0
```

This command shows a serial SPA as a representative example, however the same *slot*/*subslot*/*port* format is similarly used for other SPAs (such as ATM and POS) and other non-channelized SPAs.

Modifying the Interface MTU Size

The Cisco IOS software supports three different types of configurable maximum transmission unit (MTU) options at different levels of the protocol stack:

- Interface MTU—Checked by the SPA on traffic coming in from the network. Different interface types support different interface MTU sizes and defaults. The interface MTU defines the maximum packet size allowable (in bytes) for an interface before drops occur. If the frame is smaller than the interface MTU size, but is not smaller than three bytes of payload size, then the frame continues to process.
- IP MTU—Can be configured on a subinterface and is used by the Cisco IOS software to determine whether fragmentation of a packet takes place. If an IP packet exceeds the IP MTU size, then the packet is fragmented.
- Tag or Multiprotocol Label Switching (MPLS) MTU—Can be configured on a subinterface and allows up to six different labels, or tag headers, to be attached to a packet. The maximum number of labels is dependent on your Cisco IOS software release.

Different encapsulation methods and the number of MPLS MTU labels add additional overhead to a packet. For example, for an Ethernet packet, SNAP encapsulation adds an 8-byte header, dot1q encapsulation adds a 2-byte header, and each MPLS label adds a 4-byte header (*n* labels x 4 bytes).

Interface MTU Configuration Guidelines

When configuring the interface MTU size on the POS SPAs, consider the following guidelines:

- If you are also using MPLS, be sure that the **mpls mtu** command is configured for a value less than or equal to the interface MTU.
- If you change the interface MTU size, the giant counter increments when the interface receives a packet that exceeds the MTU size that you configured, plus an additional 88 bytes for overhead, and an additional 2 or 4 bytes for the configured cyclic redundancy check (CRC).

  For example, with a maximum MTU size of 9216 bytes, the giant counter increments:
  - For a 16-bit CRC (or FCS), when receiving packets larger than 9306 bytes (9216 + 88 + 2).
  - For a 32-bit CRC, when receiving packets larger than 9308 bytes (9216 + 88 + 4).

- The Frame Relay Local Management Interface (LMI) protocol requires that all permanent virtual circuit (PVC) status reports fit into a single packet. Using the default MTU of 4470 bytes, this limits the number of data-link connection identifiers (DLCIs) to 890. The following formula demonstrates how to determine the maximum DLCIs for a configured interface MTU:
  - MAX DLCIs = (MTU bytes – 20)/(5 bytes per DLCI)
  - MAX DLCIs for the default MTU = (4470 – 20)/5 = 890 DLCIs per interface

Interface MTU Configuration Task

To modify the MTU size on an interface, use the following command in interface configuration mode:

Command	Purpose
Router(config-if)# **mtu** *bytes*	Configures the maximum packet size for an interface, where: • *bytes*—Specifies the maximum number of bytes for a packet. The default is 4470 bytes.

To return to the default MTU size, use the **no** form of the command.

Verifying the MTU Size

To verify the MTU size for an interface, use the **show interfaces pos** privileged EXEC command and observe the value shown in the "MTU" field.

The following example shows an MTU size of 4470 bytes for interface port 0 (the first port) on the SPA installed in subslot 1 of the SIP that is located in slot 2 of the Cisco 12000 Series Router:

```
Router# show interfaces pos 2/1/0
POS2/1/0 is up, line protocol is up (APS working - active)
  Hardware is Packet over Sonet
  Internet address is 10.1.1.1/24
  MTU 4470 bytes, BW 155000 Kbit, DLY 100 usec,
    reliability 255/255, txload 1/255, rxload 1/255.
.
.
.
```

Modifying the POS Framing

POS framing can be specified as SONET (Synchronous Optical Network) or SDH (Synchronous Digital Hierarchy). SONET and SDH are a set of related standards for synchronous data transmission over fiber-optic networks. SONET is the United States version of the standard published by the American National Standards Institute (ANSI). SDH is the international version of the standard published by the International Telecommunications Union (ITU).

To modify the POS framing, use the following command in interface configuration mode:

Command	Purpose
Router(config-if)# **pos framing** {**sonet** | **sdh**}	Specifies the POS framing type, where: • **sonet**—Enables Synchronous Optical Network framing for optical carrier (OC) rates. This is the default. • **sdh**—Enables Synchronous Digital Hierarchy framing for synchronous transfer mode (rates. The POS framing type must be configured to be the same on both ends of the POS link.

To return to the default, use the **no** form of the command.

Verifying the POS Framing

To verify the POS framing, use the **show controllers pos** privileged EXEC command and observe the value shown in the “Framing” field. The following example shows that POS framing mode is set to SONET for the first interface (0) on the POS SPA installed in subslot 2 of a SIP installed in chassis slot 3:

```
Router# show controllers pos 3/2/0
POS3/2/0
SECTION
LOF = 0 LOS = 0 BIP(B1) = 0
LINE
AIS = 0 RDI = 0 FEBE = 0 BIP(B2) = 0
PATH
AIS = 0 RDI = 0 FEBE = 0 BIP(B3) = 0
PLM = 0 UNEQ = 0 TIM = 0 TIU = 0
LOP = 0 NEWPTR = 0 PSE = 0 NSE = 0

Active Defects: None
Active Alarms: None
Alarm reporting enabled for: SF SLOS SLOF B1-TCA B2-TCA PLOP B3-TCA

Framing: SONET
APS

COAPS = 0 PSBF = 0
State: PSBF_state = False
Rx(K1/K2): 00/00 Tx(K1/K2): 00/00
Rx Synchronization Status S1 = 00
S1S0 = 00, C2 = CF
Remote aps status (none); Reflected local aps status (none)
CLOCK RECOVERY
RDOOL = 0
State: RDOOL_state = False
PATH TRACE BUFFER: STABLE
Remote hostname : sip-sw-7600-2
Remote interface: POS3/2/1
Remote IP addr : 0.0.0.0
Remote Rx(K1/K2): 00/00 Tx(K1/K2): 00/00

BER thresholds: SF = 10e-3 SD = 10e-6
TCA thresholds: B1 = 10e-6 B2 = 10e-6 B3 = 10e-6
```

```
Clock source: internal
```

Modifying the Keepalive Interval

When the keepalive feature is enabled, a keepalive packet is sent at the specified time interval to keep the interface active. The keepalive interval must be configured to be the same on both ends of the POS link.

To modify the keepalive interval, use the following command in interface configuration mode:

Command	Purpose
Router(config-if)# **keepalive** [*period* [*retries*]]	Specifies the frequency at which the Cisco IOS software sends messages to the other end of the link, to ensure that a network interface is alive, where: • *period*—Specifies the time interval in seconds for sending keepalive packets. The default is 10 seconds. • *retries*—Specifies the number of times that the device will continue to send keepalive packets without response before bringing the interface down. The default is 5 retries.

To disable keepalive packets, use the **no** form of this command.

Verifying the Keepalive Interval

To verify the keepalive interval, use the **show interfaces pos** privileged EXEC command and observe the value shown in the "Keepalive" field.

The following example shows that keepalive is enabled for interface port 0 on the POS SPA installed in the SIP that is located in slot 2 of the Cisco 12000 Series Router:

```
Router# show interfaces pos 2/0/0
    Hardware is Packet over Sonet
    Internet address is 10.1.1.1.2
    MTU 9216 bytes, BW 622000 Kbit, DLY 100 usec, reliability 255/255, txload 1/255,
    rxload 1/255
      Keepalive set (10 sec)
.
.
.
```

Modifying the CRC Size

CRC is an error-checking technique that uses a calculated numeric value to detect errors in transmitted data. The CRC size indicates the length in bits of the FCS.

The CRC size must be configured to be the same on both ends of the POS link.

To modify the CRC size, use the following command in interface configuration mode:

Command	Purpose
Router(config-if)# **crc** [**16** | **32**]	(As Required) Specifies the length of the cyclic redundancy check (CRC), where: • **16**—Specifies a 16-bit length CRC. • **32**—Specifies a 32-bit length CRC. This is the default for the 1-Port OC-192c/STM-64 POS/RPR SPA, 1-Port OC-192c/STM-64 POS/RPR XFP SPA, and 2-Port OC-48c/STM-16 POS SPA. The CRC size must be configured to be the same on both ends of the POS link.

To return to the default CRC size, use the **no** form of the command.

Verifying the CRC Size

To verify the CRC size, use the **show interfaces pos** privileged EXEC command and observe the value shown in the "CRC" field.

The following example shows that the CRC size is 16 for interface port 0 on the POS SPA installed in the SIP that is located in slot 2 of the Cisco 12000 Series Router:

```
Router# show interfaces pos 2/0/0
    Hardware is Packet over Sonet
    Internet address is 10.1.1.2.1
    MTU 9216 bytes, BW 622000 Kbit, DLY 100 usec reliability 255/255, txload 1/255, rxload
    1/255
        Encapsulation HDLC, crc 16, loopback not set
.
.
.
```

Modifying the Clock Source

A clock source of internal specifies that the interface clocks its transmitted data from its internal clock. A clock source of line specifies that the interface clocks its transmitted data from a clock recovered from the line's receive data stream.

For information about the recommended clock source settings for POS router interfaces, refer to *Configuring Clock Settings on POS Router Interfaces* at the following URL:

http://www.cisco.com/en/US/tech/tk482/tk607/technologies_tech_note09186a0080094bb9.shtml

To modify the clock source, use the following command in interface configuration mode:

Command	Purpose
Router(config-if)# **clock source** {**line** | **internal**}	Specifies the clock source for the POS link, where: • **line**—The link uses the recovered clock from the line. This is the default. • **internal**—The link uses the internal clock source.

To return to the default clock source, use the **no** form of this command.

Verifying the Clock Source

To verify the clock source, use the **show controllers pos** privileged EXEC command and observe the value shown in the "Clock source" field.

The following example shows that the clock source is internal for interface port 0 on the POS SPA installed in subslot 0 of the SIP that is located in slot 2 of the Cisco 12000 Series Router:

```
Router# show controllers pos 2/0/0
POS2/0/0
SECTION
LOF = 0 LOS = 1 BIP(B1) = 7
LINE
AIS = 0 RDI = 1 FEBE = 20 BIP(B2) = 9
PATH
AIS = 0 RDI = 0 FEBE = 0 BIP(B3) = 5
PLM = 0 UNEQ = 0 TIM = 0 TIU = 0
LOP = 0 NEWPTR = 0 PSE = 0 NSE = 0


Active Defects: None
Active Alarms: None

Alarm reporting enabled for: SF SLOS SLOF B1-TCA LAIS LRDI B2-TCA PAIS PLOP PRDI PUNEQ
B3-TCA RDOOL

APS

COAPS = 2 PSBF = 0
State: PSBF_state = False
Rx(K1/K2): 00/00 Tx(K1/K2): 00/00
Rx Synchronization Status S1 = 00
S1S0 = 02, C2 = CF
CLOCK RECOVERY
RDOOL = 0
State: RDOOL_state = False
PATH TRACE BUFFER: STABLE
Remote hostname : RouterTester. Port 102/1
Remote interface:
Remote IP addr :
Remote Rx(K1/K2): / Tx(K1/K2): /

BER thresholds: SF = 10e-5 SD = 10e-6
```

```
TCA thresholds: B1 = 10e-6 B2 = 10e-6 B3 = 10e-6

Clock source: internal
.
.
.
```

Modifying SONET Payload Scrambling

SONET payload scrambling applies a self-synchronous scrambler (x43+1) to the Synchronous Payload Envelope (SPE) of the interface to ensure sufficient bit transition density.

For the 2-Port and 4-Port OC-3c/STM-1 POS SPA and 1-Port OC-12c/STM-4 POS SPA, the default configuration is SONET payload scrambling disabled.

For the 1-Port OC-192c/STM-64 POS/RPR SPA and 1-Port OC-192c/STM-64 POS/RPR XFP SPA, the default configuration is SONET payload scrambling enabled.

SONET payload scrambling is enabled for the 1-Port OC-192c/STM-64 POS/RPR SPA, the1-Port OC-192c/STM-64 POS/RPR XFP SPA, and the 2-Port OC-48c/STM-16 POS SPA by default, and the option to disable SONET payload scrambling is not available for these SPAs.

SONET payload scrambling must be configured to be the same on both ends of the POS link.

To modify SONET payload scrambling, use the following command in interface configuration mode:

Command	Purpose
Router(config-if)# **pos scramble-atm**	Enables SONET payload scrambling.

To disable SONET payload scrambling, use the **no** form of this command. The option to disable SONET payload scrambling is not available for the 1-Port OC-192c/STM-64 POS/RPR SPA, the1-Port OC-192c/STM-64 POS/RPR XFP SPA, and the 2-Port OC-48c/STM-16 POS SPA.

Verifying SONET Payload Scrambling

To verify SONET payload scrambling, use the **show interfaces pos** privileged EXEC command and observe the value shown in the “Scramble” field.

The following example shows that SONET payload scrambling is disabled for interface port 0 on the POS SPA installed in subslot 0 of the SIP that is located in slot 2 of the Cisco 12000 Series Router:

```
Router# show interfaces pos 2/0/0
    Hardware is Packet over Sonet
    Internet address is 10.0.0.1/24
    MTU 9216 bytes, BW 622000 Kbit, DLY 100 usec,
        reliability 255/255, txload 1/255, rxload 1/255
        Encapsulation HDLC, crc 16, loopback not set
    Keepalive not set
    Scramble disabled
.
.
.
```

Configuring the Encapsulation Type

By default, the POS interfaces support High-Level Data Link Control (HDLC) encapsulation. The encapsulation method can be specified as HDLC, Point-to-Point Protocol (PPP) or Frame Relay. The encapsulation type must be configured to be the same on both ends of the POS link.

Note As of Cisco IOS Release 12.0(31)S, the OC-192c POS SPAs do not support Frame Relay.

To modify the encapsulation method, use the following command in interface configuration mode:

Command	Purpose
Router(config-if)# **encapsulation** *encapsulation-type*	Specifies the encapsulation method used by the interface, where: • *encapsulation-type*—Can be HDLC, PPP, or Frame Relay. The default is HDLC.

Verifying the Encapsulation Method

To verify the encapsulation method, use the **show interfaces pos** privileged EXEC command and observe the value shown in the "Encapsulation" field.

The following example shows the encapsulation method is HDLC for port 0 on the POS SPA installed in subslot 0 of the SIP that is located in slot 2 of the Cisco 12000 Series Router:

```
Router# show interfaces pos 2/0/0
  Hardware is Packet over Sonet
  Internet address is 10.0.0.1/24
  MTU 9216 bytes, BW 622000 Kbit, DLY 100 usec,
  reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation HDLC, crc 16, loopback not set
    Keepalive not set
    Scramble disabled
.
.
.
```

Configuring APS

Automatic protection switching (APS) allows switchover of POS circuits in the event of circuit failure and is often required when connecting SONET equipment to telco equipment. APS refers to the mechanism of using a "protect" POS interface in the SONET network as the backup for a "working" POS interface. When the working interface fails, the protect interface quickly assumes its traffic load. Depending on the configuration, the two circuits may be terminated in the same router, or in different routers.

For more information about APS, refer to *A Brief Overview of Packet Over SONET APS* at the following URL:

http://www.cisco.com/en/US/tech/tk482/tk607/technologies_tech_note09186a0080093eb5.shtml

To configure the working POS interface, use the following command in interface configuration mode:

Command	Purpose
Router(config-if)# **aps working** *circuit-number*	Configures a POS interface as a working APS interface, where: • *circuit-number*—Specifies the circuit number associated with this working interface.

To remove the POS interface as a working interface, use the **no** form of this command.

To configure the protect POS interface, use the following command in interface configuration mode:

Command	Purpose
Router(config-if)# **aps protect** *circuit-number ip-address*	Configures a POS interface as a protect APS interface, where: • *circuit-number*—Specifies the number of the circuit to enable as a protect interface. • *ip-address*—Specifies the IP address of the router that has the working POS interface.

To remove the POS interface as a protect interface, use the **no** form of this command.

Verifying the APS Configuration

To verify the APS configuration or to determine if a switchover has occurred, use the **show aps** command.

The following is an example of a router configured with a working interface. In this example, POS interface 0/0/0 is configured as a working interface in group 1, and the interface is selected (that is, active).

```
Router# show aps
POS0/0/0 working group 1 channel 1 Enabled Selected
```

The following is an example of a router configured with a protect interface. In this example, POS interface 2/1/1 is configured as a protect interface in group 1. The output also shows that the working channel is located on the router with the IP address 10.0.0.1 and that the interface currently selected is enabled.

```
Router# show aps
POS2/1/1 APS Group 1: protect channel 0 (inactive)
Working channel 1 at 10.0.0.1 (Enabled)
  SONET framing; SONET APS signalling by default
  Remote APS configuration: (null)
.
.
.
```

Configuring POS Alarm Trigger Delays

A trigger is an alarm that, when activated, causes the line protocol to go down. The POS alarm trigger delay helps to ensure uptime of a POS interface by preventing intermittent problems from disabling the line protocol. The POS alarm trigger delay feature delays the setting of the line protocol to down when trigger alarms are received. If the trigger alarm was sent because of an intermittent problem, the POS alarm trigger delay can prevent the line protocol from going down when the line protocol was functional.

Line-Level and Section-Level Triggers

The **pos delay triggers line** command is used for POS router interfaces connected to internally-protected Dense Wavelength Division Multiplexing (DWDM) systems. This command is invalid for interfaces that are configured as working or protect APS. Normally a few microseconds of line- or section-level alarms brings down the link until the alarm has been clear for ten seconds. If you configure holdoff, the link-down trigger is delayed for 100 milliseconds. If the alarm stays up for more than 100 milliseconds, the link is brought down. If the alarm clears before 100 milliseconds, the link remains up.

The following line- and section-level alarms are triggers, by default, for the line protocol to go down:

- Line alarm indication signal (LAIS)
- Section loss of signal (SLOS)
- Section loss of frame (SLOF)

You can issue the **pos delay triggers line** command to delay a down trigger of the line protocol on the interface. You can set the delay from 50 to 10000 milliseconds. The default delay is 100 milliseconds.

To configure POS line- or section -level triggers, use the following commands beginning in interface configuration mode:

	Command	Purpose
Step 1	Router(config-if)# **pos delay triggers line** *ms*	Specifies a delay for setting the line protocol to down when a line-level trigger alarm is received, where: • *ms*—Specifies the delay in milliseconds. The default delay is 100 milliseconds.

	Command	Purpose
Step 2	Router(config-if)# **pos threshold** {**b1-tca** | **b2-tca** | **b3-tca** | **sd-ber** | **sf-ber**} *rate*	Configures the POS bit error rate (BER) threshold values of the specified alarms, where: • **b1-tca** *rate*—Specifies the B1 BER threshold crossing alarm. The default is 6. • **b2-tca** *rate*—Specifies the B2 BER threshold crossing alarm. The default is 6. • **b3-tca** *rate*—Specifies the B3 BER threshold crossing alarm. The default is 6. • **sd-ber** *rate*—Specifies the signal degrade BER threshold. The default is 6. • **sf-ber** *rate*—Specifies the signal failure BER threshold. The default is 3. • *rate*—Specifies the bit error rate from 3 to 9 (10e-n). The default varies by the type of threshold that you configure.
Step 3	Router(config-if)# **pos ais-shut**	Sends a line alarm indication signal (AIS-L) to the other end of the link after a **shutdown** command has been issued to the specified POS interface. AIS-L is also known as LAIS when alarm-related output is generated using the **show controllers pos** command. By default, the AIS-L is not sent to the other end of the link. Stops transmitting the AIS-L by issuing either the **no shutdown** or the **no pos ais-shut** commands.

To disable alarm trigger delays, use the **no** form of the **pos delay triggers line** command.

To determine which alarms are reported on the POS interface, and to display the BER thresholds, use the **show controllers pos** command.

Path-Level Triggers

You can issue the **pos delay triggers path** command to configure various path alarms as triggers and to specify an activation delay between 50 and 10000 milliseconds. The default delay value is 100 milliseconds. The following path alarms are not triggers by default. You can configure these path alarms as triggers and also specify a delay:

- Path alarm indication signal (PAIS)
- Path remote defect indication (PRDI)
- Path loss of pointer (PLOP)
- sf-ber (signal failure [SF] bit error rate [BER])
- b1-tca (B1 BER threshold crossing alarm [TCA])
- b2-tca (B2 BER TCA)
- b3-tca (B3 BER TCA)

The **pos delay triggers path** command can also bring down the line protocol when the higher of the B2 and B3 error rates is compared with the signal failure (SF) threshold. If the SF threshold is crossed, the line protocol of the interface goes down.

To configure POS path-level triggers, use the following command in interface configuration mode:

Command	Purpose
Router(config-if)# **pos delay triggers path** *ms*	Specifies that path-level alarms should act as triggers and specifies a delay for setting the line protocol to down when a path-level trigger alarm is received, where: • *ms*—Specifies the delay in milliseconds. The default delay is 100 milliseconds.

To disable path-level triggers, use the **no** form of this command.

Verifying POS Alarm Trigger Delays

To verify POS alarm trigger delays, use the **show controllers pos** privileged EXEC command and observe the values shown in the "Line alarm trigger delay" and "Path alarm trigger delay" fields.

The following example shows the POS alarm trigger delays for interface port 0 on the POS SPA installed in the SIP that is located in slot 2 of the Cisco 12000 Series Router:

```
Router# show controllers pos 2/0/0 details
POS2/0/0
SECTION
LOF = 0 LOS = 1 BIP(B1) = 5
LINE
AIS = 0 RDI = 1 FEBE = 5790 BIP(B2) = 945
PATH
AIS = 0 RDI = 0 FEBE = 0 BIP(B3) = 5
PLM = 0 UNEQ = 0 TIM = 0 TIU = 0
LOP = 1 NEWPTR = 0 PSE = 0 NSE = 0

Active Defects: None
Active Alarms: None
Alarm reporting enabled for: SF SLOS SLOF B1-TCA B2-TCA PLOP B3-TCA

Line alarm trigger delay = 100 ms
Path alarm trigger delay = 100 ms
.
.
.
```

Configuring SDCC

Before any management traffic can traverse the section data communication channel (SDCC) links embedded in the POS SPA overhead, the SDCC interfaces must be configured and activated.

SDCC Configuration Guidelines

When configuring SDCC on a POS SPA, consider the following guidelines:

- SDCC must be enabled on the main POS interfaces.
- SDCC can be configured on up to two interfaces of the 4-Port OC-3c/STM-1 POS SPA.
- SDCC supports only HDLC and PPP encapsulation, not Frame Relay.

SDCC Configuration Task

To configure the POS SPAs for SDCC, complete the following steps:

	Command	Purpose
Step 1	Router(config)# **interface sdcc** *slot/subslot/port*	Specifies the SDCC interface and enters interface configuration mode, where: • *slot/subslot/port*—Specifies the location of the interface. See the "Specifying the Interface Address on a SPA" section on page 15-4.
Step 2	Router(config-if)# **ip address** *ip-address mask* [**secondary**]	Sets a primary or secondary IP address for an interface, where: • *ip-address*—Specifies the IP address for the interface. • *mask*—Specifies the mask for the associated IP subnet. • **secondary**—(Optional) Specifies that the configured address is a secondary IP address. If this keyword is omitted, the configured address is the primary IP address.
Step 3	Router(config-if)# **no shutdown**	Enables the interface.

Verifying the SDCC Interface Configuration

To verify the SDCC interface, use the **show interfaces sdcc** privileged EXEC command and observe the value shown in the "Hardware is" field.

The following example shows the SDCC interface port 1 on the POS SPA installed in subslot 0 of the SIP that is located in slot 5 of the Cisco 12000 Series Router:

```
Router# show interfaces sdcc 5/0/1
SDCC5/0/1 is up, line protocol is up
  Hardware is SDCC
  Internet address is 10.14.14.14/8
  MTU 1500 bytes, BW 155000 Kbit, DLY 20000 usec,
     reliability 5/255, txload 1/255, rxload 1/255
  Encapsulation HDLC, crc 16, loopback not set
  Keepalive not set
  Last input 00:01:24, output never, output hang never
  Last clearing of ''show interface'' counters 00:01:30
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
  5 packets input, 520 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicast)
     0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
  5 packets output, 520 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions
```

Saving the Configuration

To save your running configuration to nonvolatile random-access memory (NVRAM), use the following command in privileged EXEC configuration mode:

Command	Purpose
Router# **copy running-config startup-config**	Writes the new configuration to NVRAM.

For more information about managing configuration files, refer to the *Cisco IOS Configuration Fundamentals Configuration Guide, Release 12.0* and *Cisco IOS Configuration Fundamentals Command Reference, Release 12.0* publications.

Shutting Down and Restarting an Interface on a SPA

You can shut down and restart any of the interface ports on a SPA independently of each other. Shutting down an interface stops traffic and then enters the interface into an "administratively down" state.

If you are preparing for an OIR of a SPA, it is not necessary to independently shut down each of the interfaces prior to deactivation of the SPA. You do not need to independently restart any interfaces on a SPA after OIR of a SPA or SIP. For more information about performing an OIR for a SPA, see the "Handling SPAs" section on page 5-1.

To shut down an interface on a SPA, use the following command in interface configuration mode:

Command	Purpose
Router(config-if)# **shutdown**	Disables an interface.

To restart an interface on a SPA, use the following command in interface configuration mode:

Command	Purpose
Router(config-if)# **no shutdown**	Restarts a disabled interface.

Verifying the Interface Configuration

Besides using the **show running-configuration** command to display your Cisco 12000 Series Router configuration settings, you can use the **show interfaces pos** and **show controllers pos** commands to get detailed information on a per-port basis for your POS SPAs.

Verifying Per-Port Interface Status

To find detailed interface information on a per-port basis for the POS SPAs, use the **show interfaces pos** command. For a description of the command output, see Chapter 19, "SIP and SPA Command Reference."

The following example provides sample output for interface port 0 (the first port) on the SPA located in the subslot 0 of the SIP that is installed in slot 3 of the Cisco 12000 Series Router:

```
Router# show interfaces pos 3/0/0
POS3/0/0 is up, line protocol is up
  Hardware is Packet over Sonet
  MTU 4470 bytes, BW 622000 Kbit, DLY 100 usec,
     reliability 194/255, txload 1/255, rxload 1/255
  Encapsulation FRAME-RELAY, crc 16, loopback not set
  Keepalive set (10 sec)
  Scramble disabled
  LMI enq sent  18, LMI stat recvd 0, LMI upd recvd 0
  LMI enq recvd 1473, LMI stat sent  1473, LMI upd sent  0, DCE LMI up
  LMI DLCI 1023  LMI type is CISCO  frame relay DCE
  FR SVC disabled, LAPF state down
  Broadcast queue 0/256, broadcasts sent/dropped 2223/1, interface
broadcasts 1977
  Last input 00:00:05, output 00:00:05, output hang never
  Last clearing of "show interface" counters 04:46:02
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     47019 packets input, 163195100 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicast)
     14332 runts, 925 giants, 0 throttles
              0 parity
     17820 input errors, 1268 CRC, 0 frame, 0 overrun, 0 ignored, 10 abort
     49252 packets output, 170900767 bytes, 0 underruns
     0 output errors, 0 applique, 2 interface resets
     0 output buffer failures, 0 output buffers swapped out
     3 carrier transitions.
```

Monitoring Per-Port Interface Statistics

To find detailed alarm and error information on a per-port basis for the POS SPAs, use the **show controllers pos** command. For a description of the command output, see Chapter 19, "SIP and SPA Command Reference."

The following is sample output from the **show controllers pos** command on a Cisco 7600 series router for POS interface 4/3/0 (which is the interface for port 0 of the SPA in subslot 3 of the SIP in chassis slot 4):

```
Router# show controllers pos 4/3/0
POS4/3/0
SECTION
  LOF = 0          LOS    = 0                            BIP(B1) = 65535
LINE
  AIS = 0          RDI    = 0          FEBE = 65535      BIP(B2) = 16777215
PATH
  AIS = 0          RDI    = 0          FEBE = 65535      BIP(B3) = 65535
  PLM = 0          UNEQ   = 0          TIM  = 0          TIU     = 0
  LOP = 0          NEWPTR = 3          PSE  = 0          NSE     = 0
Active Defects: None
Active Alarms:  None
Alarm reporting enabled for: SF SLOS SLOF B1-TCA B2-TCA PLOP B3-TCA

Framing: SONET
APS
```

```
  COAPS = 1          PSBF = 0
  State: PSBF_state = False
  Rx(K1/K2): 00/00  Tx(K1/K2): 00/00
  Rx Synchronization Status S1 = 00
  S1S0 = 00, C2 = CF
  Remote aps status (none); Reflected local aps status (none)
CLOCK RECOVERY
  RDOOL = 0
  State: RDOOL_state = False
PATH TRACE BUFFER: STABLE
  Remote hostname : woodson
  Remote interface: POS3/0/0
  Remote IP addr  : 0.0.0.0
  Remote Rx(K1/K2): 00/00  Tx(K1/K2): 00/00

BER thresholds:  SF = 10e-3  SD = 10e-6
TCA thresholds:  B1 = 10e-6  B2 = 10e-6  B3 = 10e-6

  Clock source:  internal
```

Configuration Examples

This section includes the following examples for configuring a POS SPA installed in a Cisco 12000 Series Router:

- Basic Interface Configuration Example, page 15-20
- MTU Configuration Example, page 15-20
- POS Framing Configuration Example, page 15-21
- Keepalive Configuration Example, page 15-21
- CRC Configuration Example, page 15-21
- Clock Source Configuration Example, page 15-22
- SONET Payload Scrambling Configuration Example, page 15-22
- Encapsulation Configuration Example, page 15-22
- APS Configuration Example, page 15-22
- POS Alarm Trigger Delays Configuration Example, page 15-23
- SDCC Configuration Example, page 15-24

Basic Interface Configuration Example

The following example shows how to enter global configuration mode to enter global configuration mode to specify the interface that you want to configure, configure an IP address for the interface, enable the interface, and save the configuration. This example configures interface port 0 (the first port) of the SPA located in subslot 0 of the SIP that is installed in slot 2 of the Cisco 12000 Series Router:

```
!Enter global configuration mode
!
Router# configure terminal
!
! Specify the interface address
!
Router(config)# interface pos 2/0/0
!
! Configure an IP address
!
Router(config-if)# ip address 192.168.50.1 192.255.255.0
!
! Enable the interface
!
Router(config-if)# no shutdown
!
! Save the configuration to NVRAM
!
Router(config-if)# exit
Router# copy running-config startup-config
```

MTU Configuration Example

The following example sets the MTU to 4470 bytes on interface port 1 (the second port) of the SPA located in the bottom subslot (1) of the SIP that is installed in slot 2 of the Cisco 12000 Series Router:

```
!Enter global configuration mode
!
Router# configure terminal
!
! Specify the interface address
!
Router(config)# interface pos 2/1/1
!
! Configure MTU
!
Router(config-if)# mtu 4470
```

POS Framing Configuration Example

The following example shows how to change from the default POS framing of SONET to SDH:

```
!Enter global configuration mode
!
Router# configure terminal
!
! Specify the interface address
!
Router(config)# interface pos 2/1/1
! (The default pos framing is sonet)
!
!Modify the framing type
!
Router(config-if)# pos framing sdh
```

Keepalive Configuration Example

The following example shows how to change from the default keepalive period of 10 seconds to 20 seconds:

```
!Enter global configuration mode
!
Router# configure terminal
!
! Specify the interface address
!
Router(config)# interface pos 2/1/1
!
! Configure keepalive 20
!
Router(config-if)# keepalive 20
```

CRC Configuration Example

The following example shows how to change the CRC size from 32 bits to the default 16 bits for POS SPAs:

```
!Enter global configuration mode
!
Router# configure terminal
!
! Specify the interface address
!
Router(config)# interface pos 2/1/1
!
! Configure crc 16
!
Router(config-if)# crc 16
```

Clock Source Configuration Example

The following example shows how to change from the default clock source of internal to line:

```
!Enter global configuration mode
!
Router# configure terminal
!
! Specify the interface address
!
Router(config)# interface pos 2/1/1
!
! Configure the clock source
!
Router(config-if)# clock source line
```

SONET Payload Scrambling Configuration Example

The following example shows how to change from a default SONET payload scrambling of disabled to enabled:

```
!Enter global configuration mode
!
Router# configure terminal
!
! Specify the interface address
!
Router(config)# interface pos 2/1/1
!
! Configure the SONET payload scrambling
!
Router(config-if)# pos scramble-atm
```

Encapsulation Configuration Example

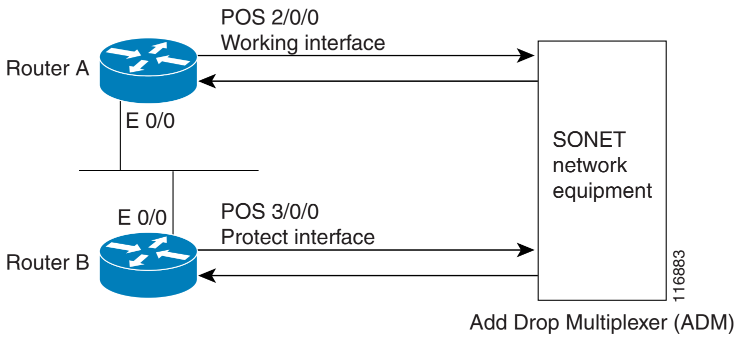
The following example shows how to change from the default encapsulation method of HDLC to PPP:

```
!Enter global configuration mode
!
Router# configure terminal

! Specify the interface address

Router(config)# interface pos 2/1/1
!
! Configure ppp
!
Router(config-if)# encapsulation ppp
```

APS Configuration Example

The following example shows the configuration of APS on router A and router B, and how to configure more than one protect or working interface on a router by using the **aps group** command. See Figure 15-1.

Figure 15-1 Basic APS Configuration



In this example, router A is configured with the working interface and router B is configured with the protect interface. If the working interface on router A becomes unavailable, the connection will automatically switch over to the protect interface on router B. The loopback interface is used as the interconnect. The **aps group** command is used even when a single protect group is configured.

On router A, which contains the working interface, use the following configuration:

```
Router# configure terminal
Router(config)# interface loopback 1
Router(config-if)# ip address 10.10.10.10 255.0.0.0
Router(config)# interface pos 2/0/0
Router(config-if)# aps group 1
Router(config-if)# aps working 1
Router(config-if)# pos ais-shut
Router(config-if)# end
```

On router B, which contains the protect interface, use the following configuration:

```
Router# configure terminal
Router(config)# interface pos 3/0/0
Router(config-if)# aps group 1
Router(config-if)# aps protect 1 10.10.10.10
Router(config-if)# pos ais-shut
Router(config-if)# end
```

POS Alarm Trigger Delays Configuration Example

The following example shows how to change POS line-level and path-level alarm trigger delays from the default of 100 milliseconds to 200 milliseconds:

```
!Enter global configuration mode
!
Router# configure terminal
!
! Specify the interface address
!
Router(config)# interface pos 2/1/1
!
Router(config-if)# pos delay triggers line 200
Router(config-if)# pos delay triggers path 200
```

SDCC Configuration Example

The following example shows how to configure an SDCC interface:

```
!
! Specify the SDCC interface
!
Router(config)# interface sdcc 5/0/0
!
! Specify the IP address
!
Router(config-if)# ip address 10.14.14.14. 255.0.0.0
!
! Enable the interface
!
Router(config-if)# no shutdown
```

CHAPTER 16

Command Summary for the POS SPAs

Table 16-1 provides an alphabetical list of some of the related commands to configure, monitor, and maintain the POS SPAs. For more information about the commands, see Chapter 19, "SIP and SPA Command Reference".

If the command is not located in this guide refer to the Cisco IOS Release 12.0 command reference and master index publications.

Table 16-1 Command Summary for POS SPAs

Command	Purpose
Router(config-if)# **aps protect** *circuit-number ip-address*	Configures a Packet over SONET (POS) interface as a protect automatic protection switching (APS) interface.
Router(config-if)# **aps working** *circuit-number*	Configures a Packet over SONET (POS) interface as a working APS interface.
Router(config-if)# **clock source** {**line** | **internal**}	Specifies the clock source for the POS link.
Router(config-if)# **crc** [**16** | **32**]	Specifies the length of the cyclic redundancy check (CRC).
Router(config-if)# **encapsulation** *encapsulation-type*	Specifies the encapsulation method used by the interface.
Router(config)# Router(config)# **hw-module subslot** *slot*/*subslot* **srp** {**mate** *slot*/*subslot*}	Changes the POS SPA from POS mode to SRP mode for all interfaces on the POS SPA. The mate keyword is not required for the 2-Port OC-48c/STM-16 POS SPA.
Router(config)# **interface pos** *slot/subslot/port*	Specifies a POS interface.
Router(config)# **interface sdcc** *slot/subslot/port*	Specifies an SDCC interface.
Router(config)# **interface srp** *slot/subslot/port*	Specifies an SRP interface.
Router(config-if)# **ip address** *ip-address mask* [**secondary**]	Specifies a primary or secondary IP address for an interface.
Router(config-if)# **keepalive** [*period* [*retries*]]	Specifies the frequency at which the Cisco IOS software sends messages to the other end of the link, to ensure that a network interface is alive.
Router(config-if)# **mtu** *bytes*	Configures the maximum transmission unit (or packet size) for an interface.
Router(config-if)# **no shutdown**	Enables an interface.
Router(config-if)# **pos ais-shut**	Sends a line alarm indication signal (AIS-L) to the other end of the link after a **shutdown** command has been issued to the specified POS interface.

Table 16-1 Command Summary for POS SPAs (continued)

Command	Purpose
Router(config-if)# **pos delay triggers line** *ms*	Specifies a delay for setting the line protocol to down when a line-level trigger alarm is received.
Router(config-if)# **pos delay triggers path** *ms*	Specifies that path-level alarms should act as triggers and specifies a delay for setting the line protocol to down when a path-level trigger alarm is received.
Router(config-if)# **pos framing** {**sonet** | **sdh**}	Specifies the POS framing type.
Router(config-if)# **pos scramble-atm**	Enables SONET payload scrambling.
Router(config-if)# **pos threshold** {**b1-tca** | **b2-tca** | **b3-tca** | **sd-ber** | **sf-ber**} *rate*	Configures the POS bit rate error (BER) threshold values of the specified alarms.
Router# **show aps**	Displays information about the current APS feature.
Router# **show controllers pos** *slot*/*subslot*/*port*	Displays information POS controllers.
Router# **show diags subslot** *slot*/*subslot* [**details** | **summary**]	Displays hardware information for a SPA.
Router# **show interfaces pos** *slot*/*subslot*/*port*	Displays configuration information and statistics for a POS interface.
Router# **show interfaces sdcc** *slot*/*subslot*/*port*	Displays configuration information for a SDCC interface.

PART 5

Field-Programmable Devices

CHAPTER 17

Upgrading Field-Programmable Devices

In general terms, field-programmable devices (FPDs) are hardware devices implemented on router cards that support separate upgrades. The term “FPD” has been introduced to collectively and generically describe any type of programmable hardware device on SPAs. FPDs were introduced on the Cisco 12000 series routers to support SPAs.

This chapter describes the information that you need to know to verify image versions and to perform SPA FPD upgrades.

This chapter includes the following sections:

Release History

Table 17-1 provides the release and modification history for all FPD-related features on the Cisco 12000 series routers.

Table 17-1 FPD Release History

Release	Modification
Cisco IOS Release 12.0(31)S	SPAs were released on Cisco 12000 series routers for the first time. FPD images were introduced to support these SPAs.

FPD Quick Upgrade

This section provides information if you simply want to upgrade FPD for SPAs as quickly as possible. These instructions are not always feasible for operating network environments and are not the only methods available for upgrading FPD. If these methods of upgrade are not suitable for your situation, see the various other sections of this document for other methods of upgrading FPD.

This section addresses the following topics:

- FPD Quick Upgrade Before Upgrading your Cisco IOS Release (Recommended), page 17-2
- FPD Quick Upgrade After Upgrading your Cisco IOS Release, page 17-2

FPD Quick Upgrade Before Upgrading your Cisco IOS Release (Recommended)

Step 1 When getting your Cisco IOS image, download the FPD image package for the Cisco IOS release that you are upgrading to to any Flash disk on your router before booting the new version of Cisco IOS. The FPD image package can be retrieved from the same site where you went to get your Cisco IOS image. Do not change the name of the FPD image package.

Step 2 Boot using the new version of Cisco IOS. When the new Cisco IOS boots, it by defaults searches for the FPD image package in the router flash file systems and the FPD images will be updated automatically as part of the IOS boot process.

FPD Quick Upgrade After Upgrading your Cisco IOS Release

Step 1 An FPD upgrade is not always necessary after Cisco IOS is upgraded. If you have already upgraded your Cisco IOS, enter the **show hw-module all fpd** command to see if all system FPDs are compatible. If the FPDs are compatible, no further action is necessary. If at least one FPD needs an upgrade, proceed to Step 2.

Step 2 Go to the cisco.com site where you downloaded your specific Cisco IOS software and locate the FPD image package, if you haven't already.

Step 3 Download this FPD image package to a Flash disk on your router. Do not change the name of the FPD image package.

Do not change any FPD-related settings on your system (if **upgrade fpd auto** or **upgrade fpd path** has been changed, change the settings back to the default settings using the **no** form of the command). Reboot your Cisco IOS release software. When the new Cisco IOS boots, it by defaults searches for the FPD image package in the Flash file systems and the FPD images will be updated automatically as part of the IOS boot process.

Overview of FPD Images and Packages

An FPD image package is used to upgrade FPD images. Whenever a Cisco IOS image is released that supports carrier cards and SPAs, a companion FPD image package is also released for that Cisco IOS software release. The FPD image package is available from Cisco.com and is accessible from the Cisco Software Center page where you also go to download your Cisco IOS software image.

If you are running SPAs on your router and are upgrading your Cisco IOS image, you should download the FPD image package file before booting the router using the new Cisco IOS release. If the SPA requires an FPD upgrade and the Cisco IOS image is unable to locate an FPD image package, the system messages will indicate that the FPD image is incompatible and you will need to go to the Cisco Software Center on Cisco.com to download the FPD image package for your Cisco IOS software release. An FPD incompatibility on a SPA disables all interfaces on that SPA until the incompatibility is addressed.

Note The FPD automatic upgrade feature only searches for the FPD image package file that is the same version number as the Cisco IOS release being used by the system. For example, if the Cisco IOS release being used is Cisco IOS Release 12.0(31)S, then the system will search for the FPD image package file that supports the specific Cisco IOS release (c12k-fpd-pkg.120-31.S.pkg). Therefore, ensure the FPD image package file on your system is compatible with your Cisco IOS release and do not change the name of the FPD image package file.

Upgrading FPD Images

This section documents some of the common scenarios where FPD image updates are necessary. It discusses the following scenarios:

- Migrating to a Newer Cisco IOS Release, page 17-3
- Upgrading FPD Images in a Production System, page 17-5

Migrating to a Newer Cisco IOS Release

This section discusses the following topics:

- Upgrading FPD Images Before Booting the New Cisco IOS Release (Recommended), page 17-3
- Upgrading FPD Images in a Production System, page 17-5

Upgrading FPD Images Before Booting the New Cisco IOS Release (Recommended)

If you are still running your old Cisco IOS Release but are preparing to load a newer version of Cisco IOS, you can upgrade FPD for the new Cisco IOS Release using the following method:

- Placing FPD Image Package on Flash Disk Before Upgrading IOS (Recommended), page 17-3

Placing FPD Image Package on Flash Disk Before Upgrading IOS (Recommended)

Placing the FPD image package for the IOS release that you are upgrading to before upgrading IOS is the recommended method for upgrading FPD because it is simple in addition to being fast. To perform this type of FPD upgrade, follow these steps:

Step 1 While still running the Cisco IOS release that will be upgraded, place the FPD image package for the new version of Cisco IOS onto one of your router's Flash file systems. For instance, if you are running Cisco IOS Release 12.0(31)S and are upgrading to Cisco IOS Release 12.0(32)S, place the FPD image package for Cisco IOS Release 12.0(32)S onto a Flash file system while still running Cisco IOS Release 12.0(31)S. The FPD image package for a specific IOS release can be located on cisco.com from the same area where you download that Cisco IOS software image. Your router and SPAs should continue to operate normally since this action will have no impact on the current FPDs.

Caution Do not change the filename of the FPD image package file. The Cisco IOS searches for the FPD image package file by filename, so the FPD image package file cannot be found if it has been renamed.

Step 2 Reboot your router using the new upgraded Cisco IOS image. As part of the bootup process, the router will search for the FPD image package. Since the default settings for the FPD image package search are to check for the FPD image package for the specific Cisco IOS Release in a Flash file system, the FPD image package will be located during the bootup procedure and all FPDs that required upgrades will be upgraded.

Step 3 When the router has booted, verify the upgrade was successful by entering the **show hw-module all fpd** command.

Upgrading FPD Images after Booting the New Cisco IOS Release

The following steps explain how to upgrade FPD images if you have already upgraded your Cisco IOS release but still need to upgrade your FPD images.

To perform an FPD upgrade after the new Cisco release has been booted, follow these steps:

Step 1 If you are unsure if your FPD images for your SPAs are compatible, enter the **show hw-module all fpd** command to verify compatibility of all SPAs. If all of your SPAs are compatible, there is no reason to perform this upgrade.

Step 2 If an FPD upgrade is necessary, place the FPD image package for the new version of Cisco IOS onto the router's Flash Disk or on an accessible FTP or TFTP server. The FPD image package can be located on cisco.com from the same area where you downloaded your Cisco IOS software image.

Step 3 Enter the **upgrade hw-module subslot** *slot-number***/***subslot-number file-url* **[force]** command. The *file-url* command should direct users to the location of the FPD image package. For instance, if you had placed the FPD image package for Release 12.0(31)S on the TFTP server mytftpserver/myname/myfpdpkg, you would enter **upgrade hw-module subslot** *slot-number***/***subslot-number* **tftp://mytftpserver/myname/myfpdpkg/c12k-fpd-pkg.120-31.S.pkg** to complete this step.

If multiple SPAs require upgrades, the different pieces of hardware will have to be updated individually.

Note the **force** option is used in this command. This option will force an FPD upgrade even if no FPD mismatch is detected. In instances where the **upgrade hw-module** command is entered, this option is almost never necessary and should only be entered if requested by a technical support representative.

Step 4 Verify the upgrade was successful by entering the **show hw-module all fpd** command.

Upgrading FPD Images in a Production System

Adding a SPA to a production system presents the possibility that the SPA may contain versions of FPD images that are incompatible with the Cisco IOS release currently running the router. Additionally, some processor CPU is required to perform FPD upgrades. The performance impact will vary depending on various factors, including network traffic load, the type of processing engine used, and the type of service configured.

For these reasons, we recommend that one of the following alternatives be used to perform the FPD upgrade on a production system if possible:

- Using a Non-Production System to Upgrade the SPA FPD Image, page 17-5
- Verifying System Compatibility Before Upgrading, page 17-5

Using a Non-Production System to Upgrade the SPA FPD Image

Before beginning the upgrade, ensure:

- The spare system is running the same version of the Cisco IOS software release that the target production system is running.
- The automatic upgrade feature is enabled on the spare system (the automatic upgrade feature is enabled by default. It can also be enabled using the **upgrade fpd auto** command).

Use the following procedure to perform an upgrade on a spare system:

Step 1 Download the FPD image package file to the router's flash file system or TFTP or FTP server accessible by the spare system. In most cases, it is preferable to place the file in a Flash file system since the router, by default, searches for the FPD image package in the Flash file systems. If the Flash file systems are full, use the **upgrade fpd path** command to direct the router to search for the FPD image package in the proper location.

Step 2 Insert the SPA into the spare system.

If an upgrade is required, the system will perform the necessary FPD image updates so that when this SPA is inserted to the target production system it will not trigger an FPD upgrade operation there.

Step 3 Verify the upgrade was successful by entering the **show hw-module all fpd** command.

Step 4 Remove the SPA from the spare system after the upgrade.

Step 5 Insert the SPA into the target production system.

Verifying System Compatibility Before Upgrading

If a spare system is not available to perform an upgrade, you can check for system compatibility by disabling the automatic upgrade feature before inserting the SPA(the automatic upgrade feature is enabled by default. It can be disabled using the **no upgrade fpd auto** command).

- If the FPD images on the SPA are compatible with the system, you will only need to re-enable the automatic upgrade feature (the automatic upgrade feature can be re-enabled using the **upgrade fpd auto** command).
- If the FPD images on the SPA are not compatible with the system, the SPA is disabled but will not impact system performance by attempting to perform an automatic upgrade.

Use the following procedure to check the FPD images on the SPA for system compatibility:

Step 1 Disable the automatic upgrade feature using the **no upgrade fpd auto** global configuration command.

Step 2 Insert the SPA into the system.

If the FPD images are compatible, the SPAs will operate successfully after bootup.

If the FPD images are not compatible, the SPA is disabled. At this point we recommend that you wait for a scheduled maintenance when the system is offline to manually perform the FPD upgrade using one of the procedures outlined in the "Upgrading FPD Images" section on page 17-3.

Step 3 Re-enable the automatic upgrade feature using the **upgrade fpd auto** global configuration command.

Optional FPD Procedures

This section provides information for optional FPD-related functions. None of the topics discussed in this section are necessary for completing FPD upgrades, but may be useful in some FPD-related scenarios. It covers the following topics:

Manually Upgrading SPA FPD Images

To manually upgrade the current FPD version on a SPA, use the following command:

```
Router# upgrade hw-module subslot slot-number/subslot-number file file-url [force]
```

In this example, *slot-number* is the slot where the SIP is installed, *subslot-number* is the subslot number where the SPA is located, *file-url* is the location and name of the FPD image package file, and **force** is an option that forces the SPA to perform an FPD upgrade even if FPD is compatible (the **force** option is almost never necessary and should only be entered if requested by a technical support representative). The SPA will automatically be reloaded to complete the FPD upgrade.

Caution An image upgrade can require a long period of time to complete depending on the hardware being upgraded.

Upgrading FPD From an FTP or TFTP Server

The generally recommended method to perform an FPD image upgrade is to download the FPD image package to a Flash file system and use the FPD automatic upgrade. By default, the system searches the Flash file systems for the FPD image package file when an FPD incompatibility is detected.

This default behavior of loading an FPD image from Flash can be changed using the **upgrade fpd path** global configuration command, which sets the path to search for the FPD image package file to a location other than the router's Flash file systems.

For large deployments where all the systems are being upgraded to a specific Cisco IOS software release, we recommend that the FPD image package file be placed on an FTP or TFTP server that is accessible to all the affected systems, and then use the **upgrade fpd path** global configuration command to configure the routers to look for the FPD image package file from the FTP or TFTP server prior to the reloading of the system with the new Cisco IOS release.

Note This approach can also be used if there is not enough disk space on the system Flash card to hold the FPD image package file.

To download an FPD image package file to an FTP or TFTP server, use the following procedure:

Step 1 Copy the FPD image package file to the FTP or TFTP server.

Step 2 Access the router from a connection that does not use the SPA interface for access, if possible. We recommend not using the SPA interface as your connection to the router because an FPD incompatibility disables all interfaces on the SPA, making a manual FPD upgrade impossible through a SPA interface. If access through one of the SPA ports is the only access to the router you have, do not use the TFTP or FTP upgrade method. Instead, copy the FPD image package to your router's default Flash card before upgrading your Cisco IOS Release. This will allow the router to find the FPD image package during the first IOS bootup and upgrade FPD automatically.

Step 3 From global configuration mode, use the **upgrade fpd path** command to instruct the router to locate the FPD image package file from the FTP or TFTP server location.

For example, enter one of the following global configuration commands from the target system's console:

```
Router(config)# upgrade fpd path tftp://my_tftpserver/fpd_pkg_dir/
```
or
```
Router(config)# upgrade fpd path ftp://login:password@my_ftpserver/fpd_pkg_dir/
```

Note The final "/" at the end of each of the above examples is required. If the path is specified without the trailing "/" character, the command will not work properly.

In these examples, *my_tftpserver* or *my_ftpserver* is the path to server name, *fpd_pkg_dir* is the directory on the TFTP server where the FPD image package is located, and *login:password* is your FTP login name and password.

Step 4 Make sure that the FPD automatic upgrade feature is enabled by examining the output of the **show running-config** command (look for the *upgrade fpd auto* configuration line in the output. If there are no upgrade commands in the output, then **upgrade fpd auto** is enabled because it is the default setting.) If automatic upgrades are disabled, use the **upgrade fpd auto** global configuration command to enable automatic FPD upgrades.

Step 5 Enter the **show upgrade fpd file** command to ensure your router is connecting properly to the default FPD image package. If you are able to generate output related to the FPD image package using this command, the upgrade should work properly.
In the following example, the router is able to generate FPD image package information for the FPD image package on the TFTP server.

```
Router#show upgrade fpd file
tftp://mytftpserver/myname/myfpdpkg/c12k-fpd-pkg.120-31.S.pkg
Loading myname/myfpdpkg//c12k-fpd-pkg.120-31.S.pkg from 223.255.254.254 (via Ethernet0):
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
[OK - 1577472 bytes]

Cisco Field Programmable Device Image Package for IOS
C12K Family FPD Image Package (c12k-fpd-pkg.120-31.S.pkg), Version 12.0(31)S
Copyright (c) 2004-2005 by cisco Systems, Inc.
Built Thu 31-Mar-2005 22:24 by luislu


=============================== ==============================================
                                        Bundled FPD Image Version Matrix
                                ==============================================
                                                                     Min. Req.
Supported Card Types            ID  Image Name                Version  H/W Ver.
=============================== == ========================= ========= =========
2-port T3/E3 Serial SPA          1 T3E3 SPA ROMMON              2.12      0.0
                                 2 T3E3 SPA I/O FPGA            0.24      0.0
                                 3 T3E3 SPA E3 FPGA             0.6       0.0
                                 4 T3E3 SPA T3 FPGA             0.14      0.0
------------------------------- -- ------------------------- --------- ---------
4-port T3/E3 Serial SPA          1 T3E3 SPA ROMMON              2.12      0.0
                                 2 T3E3 SPA I/O FPGA            0.24      0.0
                                 3 T3E3 SPA E3 FPGA             0.6       0.0
                                 4 T3E3 SPA T3 FPGA             0.14      0.0
------------------------------- -- ------------------------- --------- ---------
2-port Channelized T3 SPA        1 CT3 SPA ROMMON               2.12      0.100
                                 2 CT3 SPA I/O FPGA             1.4       0.100
                                 3 CT3 SPA T3 FPGA R1           0.11      0.100
                                 3 CT3 SPA T3 FPGA R2           0.15      0.200
------------------------------- -- ------------------------- --------- ---------
4-port Channelized T3 SPA        1 CT3 SPA ROMMON               2.12      0.100
                                 2 CT3 SPA I/O FPGA             1.4       0.100
                                 3 CT3 SPA T3 FPGA R1           0.11      0.100
                                 3 CT3 SPA T3 FPGA R2           0.15      0.200
------------------------------- -- ------------------------- --------- ---------
1-port OC-192 POS/SRP FH SPA     1 1-Port POS/RPR SPA IOFPGA    1.2       0.0
------------------------------- -- ------------------------- --------- ---------
1-port OC-192 POS/SRP HH SPA     1 1-Port POS/RPR SPA IOFPGA    1.2       0.0
                                 1 1-Port POS/RPR SPA IOFPGA    1.2       2.0
------------------------------- -- ------------------------- --------- ---------
1-port OC-48 POS/SRP HH SPA      1 1-Port POS/RPR SPA IOFPGA    1.2       0.0
------------------------------- -- ------------------------- --------- ---------
10-port GE SPA                   1 GE SPA FPGA                  1.6       0.0
------------------------------- -- ------------------------- --------- ---------
5-port GE SPA                    1 GE SPA FPGA                  1.6       0.0
------------------------------- -- ------------------------- --------- ---------
1-port 10GE SPA                  1 10GE SPA FPGA                1.6       0.0
=============================== ==============================================
```

Step 6 Save the configuration and reload the system with the new Cisco IOS release.

During the system startup after the reload, the necessary FPD image version check for all the SPAs will be performed and any upgrade operation will occur automatically if an upgrade is required. In each upgrade operation, the system extracts the necessary FPD images to the SPA from the FPD image package file located on the FTP or TFTP server.

Modifying the Default Path for the FPD Image Package File Location

By default, the Cisco IOS software looks for the FPD image package file on a Flash file system when performing an automatic FPD image upgrade.

Note Be sure there is enough space on one of your Flash file systems to accommodate the FPD image package file.

Alternatively, you can store an FPD image package file elsewhere. However, because the system looks on the Flash file systems by default, you need to change the FPD image package file location so that the system is directed to search an alternate location (such an FTP or TFTP server) that is accessible by the Cisco IOS software. Enter the **upgrade fpd path** *fpd-pkg-dir-url* global configuration command, where *fpd-pkg-dir-url* is the alternate location, to instruct the router to search for the FPD image package elsewhere.

When specifying the *fpd-pkg-dir-url*, be aware of the following:

- The *fpd-pkg-dir-url* is the path to the FPD image package, but the FPD image package should not be specified as part of the *fpd-pkg-dir-url*. For instance, if the c12k-fpd-pkg.120-31.S.pkg file can be found on the TFTP server using the path mytftpserver/myname/myfpdpkg/c12k-fpd-pkg.120-31.S.pkg and you wanted the router to utilize this FPD image package for FPD upgrades, the **upgrade fpd path tftp://mytftpserver/myname/myfpdpkg/** command should be entered so the router knows where to find the file. The actual filename should not be specified.
- The final "/" character in the *fpd-pkg-dir-url* is required. In the preceding example, note that the *fpd-pkg-dir-url* is **tftp://mytftpserver/myname/myfpdpkg/.** Entering **tftp://mytftpserver/myname/myfpdpkg** (note: the final "/" character is missing) as the *fpd-pkg-dir-url* in that scenario would not work**.**

If the **upgrade fpd path** global configuration command has not been entered to direct the router to locate an FPD image package file in an alternate location, the system searches the Flash file systems on the Cisco 12000 series router for the FPD image package file.

Failure to locate an FPD image package file when an upgrade is required will disable the SPA. Because SPAs will not come online until FPD is compatible, the SPA will also be disabled if it requires an FPD upgrade and the automatic upgrade feature is disabled.

Upgrading Multiple FPD Images

A single piece of hardware can contain multiple FPD images. The Cisco 12000 series routers can upgrade up to 4 FPD images simultaneously. However, only one FPD upgrade per router slot can occur at a time, so all FPD images on all SPAs in a single slot will have to wait for the previous FPD upgrade to finish before their specific FPD upgrade begins.

Users should note that some FPD images require the SPA to reload to complete. The FPD upgrade process will perform this step automatically, so users do not have to intervene. However, the other FPDs in the hardware of the specified slot will have to wait for this reload to complete before their upgrade process begins.

During an automatic upgrade, the Cisco 12000 series router will upgrade as many FPDs as possible at a time. No user intervention is possible or necessary. The upgrade process will not stop until all FPD images have been updated.

During manual upgrades, it is important to note that users can only specify upgrades for a single piece of hardware each time the **upgrade hw-module** [**slot** *slot-number* | **subslot** *slot-number/subslot-number*] is entered. The up to 4 simultaneous upgrades applies to the manual upgrades as well; if you individually specify multiple manual FPD upgrades, only 4 FPDs can be upgraded simultaneously and that can only occur when the hardware is in different router slots. The FPD upgrade process will stop when all FPDs for the specified hardware have been upgraded.

Displaying Current and Minimum Required FPD Image Versions

To display the current version of FPD images on the SPAs installed on your router, use the **show hw-module** [*slot-number/subslot-number* | **all**] **fpd** command, where *slot-number* is the slot number where the SIP is installed, and *subslot-number* is the number of the SIP subslot where a target SPA is located. Entering the **all** keyword shows information for hardware in all router slots.

The following examples show the output when using this **show** command.

The output display in this example shows that FPD versions on SPAs in the system meet the minimum requirements:

```
Router#show hw-module all fpd

==== ====================== ====== =============================================
                            H/W    Field Programmable   Current   Min. Required
Slot Card Type              Ver.   Device: "ID-Name"    Version      Version
==== ====================== ====== ================== =========== ==============
 2/0 SPA-1XTENGE-XFP        2.1    1-10GE I/O FPGA        1.6         1.6
---- ---------------------- ------ ------------------ ----------- --------------
 2/1 SPA-10X1GE             1.0    1-GE I/O FPGA          1.6         1.6
---- ---------------------- ------ ------------------ ----------- --------------
 3/0 SPA-4XCT3/DS0          0.253  1-ROMMON               2.12        2.12
                                   2-I/O FPGA             1.4         1.4
                                   3-T3 SUBRATE FPGA      0.15        0.15
---- ---------------------- ------ ------------------ ----------- --------------
 3/1 SPA-4XCT3/DS0          0.253  1-ROMMON               2.12        2.12
                                   2-I/O FPGA             1.4         1.4
                                   3-T3 SUBRATE FPGA      0.15        0.15
==== ====================== ====== =============================================
```

This example shows the output when using the *slot-number/subslot-number* argument to identify a particular SPA:

```
Router#show hw-module subslot 3/1 fpd

==== ====================== ====== =============================================
                            H/W    Field Programmable   Current   Min. Required
Slot Card Type              Ver.   Device: "ID-Name"    Version      Version
==== ====================== ====== ================== =========== ==============
 3/1 SPA-4XCT3/DS0          0.253  1-ROMMON               2.12        2.12
                                   2-I/O FPGA             1.4         1.4
                                   3-T3 SUBRATE FPGA      0.15        0.15
==== ====================== ====== =============================================
```

The output display in this example shows that the SPA in subslots 3/0 and 3/1 are disabled because at least one of the programmable devices on each SPA does not meet the minimum version requirements. The output also contains a "NOTES" section that provides the name of the FPD image package file needed to upgrade the disabled FPD image.

```
Router#show hw-module all fpd

==== ====================== ====== =============================================
                             H/W   Field Programmable   Current   Min. Required
Slot Card Type               Ver.  Device: "ID-Name"    Version      Version
==== ====================== ====== ================== =========== ==============
 2/0 SPA-1XTENGE-XFP         2.1   1-10GE I/O FPGA        1.6         1.6
---- ---------------------- ------ ------------------ ----------- --------------
 2/1 SPA-10X1GE              1.0   1-GE I/O FPGA          1.6         1.6
---- ---------------------- ------ ------------------ ----------- --------------
 3/0 SPA-4XCT... <DISABLED>  0.253 1-ROMMON               2.12        2.12
                                   2-I/O FPGA             1.1         1.4     *
                                   3-T3 SUBRATE FPGA      0.15        0.15
---- ---------------------- ------ ------------------ ----------- --------------
 3/1 SPA-4XCT... <DISABLED>  0.253 1-ROMMON               2.12        2.12
                                   2-I/O FPGA             1.1         1.4     *
                                   3-T3 SUBRATE FPGA      0.15        0.15
==== ====================== ====== =============================================
 NOTES:
      - FPD images that are required to be upgraded are indicated with a '*'
        character in the "Minimal Required Version" field.
      - The following FPD image package file is required for the upgrade:
        "c12k-fpd-pkg.120-31.S.pkg"
```

Displaying Information About the Default FPD Image Package

You can use the **show upgrade fpd package default** command to find out which SPAs are supported with your current Cisco IOS release and which FPD image package you need for an upgrade.

```
Router# show upgrade fpd package default

*************************************************************************
This IOS release requires the following default FPD Image Package for
the automatic upgrade of FPD images:
*************************************************************************

Version: 12.0(31)S

Package Filename: c12k-fpd-pkg.120-31.S.pkg

   List of card type supported in this package:

                                Minimal
         No. Card Type          HW Ver.
        ---- ------------------ -------
          1) 2xT3E3 SPA           0.0
          2) 4xT3E3 SPA           0.0
          3) 10xGE SPA            0.0
          4) 5xGE SPA             0.0
          5) 1x10GE XFP SPA       0.0
          6) 1xOC192 POS/RPR HH   0.0
          7) 1xOC192 POS/RPR FH   0.0
          8) 2xCT3 SPA            0.100
          9) 2xCT3 SPA            0.200
         10) 4xCT3 SPA            0.100
```

```
 11) 4xCT3 SPA           0.200
---- ------------------ -------
```

Verifying the FPD Image Upgrade Progress

You can use the **show upgrade fpd progress** command to view a "snapshot" of the upgrade progress while an FPD image upgrade is taking place. The following example shows the type of information this command displays:

```
Router# show upgrade fpd progress

FPD Image Upgrade Progress Table:

 ==== =================== ====================================================
                          Field Programmable    Time
 Slot Card Description    Device :"ID-Name"    Needed   Time Left  State
 ==== =================== ================== ========== ========== ===========
  2/0 SPA-1XTENGE-XFP     1-10GE I/O FPGA     00:06:00   00:05:17  Updating...
 ---- ------------------- ------------------ ----------- --------- -----------
  2/1 SPA-10X1GE        1-GE I/O FPGA     --:--:--   --:--:--  Waiting...
 ==== =================== ====================================================
```

FPD Image Upgrade Examples

This section provides examples of automatic and manual FPD image upgrades. It includes the following examples:

- System Cannot Locate FPD Image Package File for an Automatic FPD Image Upgrade Example, page 17-12
- Automatic FPD Image Upgrade Example, page 17-13
- Manual FPD Image Upgrade Example, page 17-13

System Cannot Locate FPD Image Package File for an Automatic FPD Image Upgrade Example

The following example displays the output when a SPA-4XCT3/DS0 requires an FPD upgrade and the **upgrade fpd auto** command is *enabled*, but the system cannot find the FPD image package file.

```
SLOT 3:00:13:16: %SPA_OIR-6-INSCARD: Card inserted in Subslot 1
SLOT 3:00:13:27: %SPA_PLUGIN-6-FIRMWARE_DOWNLOADING: SPA-4XCT3/DS0[3/1]: Downloading SPA
firmware (bundled)...via shared memory.
SLOT 3:00:13:31: %SPA_PLUGIN-6-FIRMWARE_APPS_DOWNLOADING: SPA-4XCT3/DS0[3/1]: Downloading
SPA firmware application (bundled)...via shared memory.
01:01:18: %FPD_MGMT-3-INCOMP_IMG_VER: Incompatible I/O FPGA (FPD ID=2) image version
detected for SPA-4XCT3/DS0 card in subslot 3/1. Detected version = 1.1, minimum required
version = 1.4. Current HW version = 0.253.
01:01:18: %FPD_MGMT-5-UPGRADE_ATTEMPT: Attempting to automatically upgrade the FPD
image(s) for SPA-4XCT3/DS0 card in subslot 3/1. Use 'show upgrade fpd progress' command to
view the upgrade progress ...
SLOT 3:00:13:43: %SPA_OIR-6-INSCARD: Card inserted in Subslot 0
01:01:20: %FPD_MGMT-3-PKG_FILE_SEARCH_FAILED: FPD image package
(c12k-fpd-pkg.120-31.S.pkg) cannot be found in system's flash card or disk to do FPD
upgrade.
```

```
01:01:20: %FPD_MGMT-5-CARD_DISABLED: SPA-4XCT3/DS0 card in subslot 3/1 is being disabled
because of an incompatible FPD image version. Note that the c12k-fpd-pkg.120-31.S.pkg
package will be required if you want to perform the upgrade operation.
```

Automatic FPD Image Upgrade Example

The following example shows the output displayed when a SPA-4XCT3/DS0 requires an FPD image upgrade and the **upgrade fpd auto** command is *enabled*. The required FPD image is automatically upgraded.

```
01:43:56: %FPD_MGMT-3-INCOMP_IMG_VER: Incompatible I/O FPGA (FPD ID=2) image version
detected for SPA-4XCT3/DS0 card in subslot 3/1. Detected version = 1.1, minimum required
version = 1.4. Current HW version = 0.253.
01:43:56: %FPD_MGMT-5-UPGRADE_ATTEMPT: Attempting to automatically upgrade the FPD
image(s) for SPA-4XCT3/DS0 card in subslot 3/1. Use 'show upgrade fpd progress' command to
view the upgrade progress ...
01:43:56: %FPD_MGMT-6-BUNDLE_DOWNLOAD: Downloading FPD image bundle for SPA-4XCT3/DS0 card
in subslot 3/1 ...
01:43:57: %FPD_MGMT-6-UPGRADE_TIME: Estimated total FPD image upgrade time for
SPA-4XCT3/DS0 card in subslot 3/1 = 00:00:50.
01:43:57: %FPD_MGMT-6-UPGRADE_START: I/O FPGA (FPD ID=2) image upgrade in progress for
SPA-4XCT3/DS0 card in subslot 3/1. Updating to version 1.4. PLEASE DO NOT INTERRUPT DURING
THE UPGRADE PROCESS (estimated upgrade completion time = 00:00:50) ...via shared memory.
01:44:23: %FPD_MGMT-6-UPGRADE_PASSED: I/O FPGA (FPD ID=2) image in the SPA-4XCT3/DS0 card
in subslot 3/1 has been successfully updated from version 1.1 to version 1.4. Upgrading
time = 00:00:25.652
01:44:23: %FPD_MGMT-6-OVERALL_UPGRADE: All the attempts to upgrade the required FPD images
have been completed for SPA-4XCT3/DS0 card in subslot 3/1. Number of successful/failure
upgrade(s): 1/0.
01:44:23: %FPD_MGMT-5-CARD_POWER_CYCLE: SPA-4XCT3/DS0 card in subslot 3/1 is being power
cycled for the FPD image upgrade to take effect.
```

Manual FPD Image Upgrade Example

In the following example, FPD for the 1-Port 10 Gigabit Ethernet SPA in subslot 2/0 is upgraded manually from the FPD image package file that was placed on disk0:.

```
Router#upgrade hw-module subslot 2/0 file disk1:c12k-fpd-pkg.120-31.S.pkg

% The following FPD(s) will be upgraded for SPA-1XTENGE-XFP (H/W ver = 2.1) in subslot
2/0:

    ================== =========== =========== ============
    Field Programmable   Current     Upgrade   Estimated
    Device: "ID-Name"    Version     Version   Upgrade Time
    ================== =========== =========== ============
    1-10GE I/O FPGA        1.5         1.6       00:00:20
    ================== =========== =========== ============


% Are you sure that you want to perform this operation? [no]: y
% Restarting the target card in subslot 2/0 for FPD image upgrade. Please wait ...

Router#
01:59:32: %FPD_MGMT-6-UPGRADE_TIME: Estimated total FPD image upgrade time for
SPA-1XTENGE-XFP card in subslot 2/0 = 00:00:20.
01:59:32: %FPD_MGMT-6-UPGRADE_START: 10GE I/O FPGA (FPD ID=1) image upgrade in progress
for SPA-1XTENGE-XFP card in subslot 2/0. Updating to version 1.6. PLEASE DO NOT INTERRUPT
DURING THE UPGRADE PROCESS (estimated upgrade completion time = 00:00:20) ...
```

```
01:59:55: %FPD_MGMT-6-UPGRADE_PASSED: 10GE I/O FPGA (FPD ID=1) image in the
SPA-1XTENGE-XFP card in subslot 2/0 has been successfully updated from version 1.5 to
version 1.6. Upgrading time = 00:00:23.440
01:59:55: %FPD_MGMT-6-OVERALL_UPGRADE: All the attempts to upgrade the required FPD images
have been completed for SPA-1XTENGE-XFP card in subslot 2/0. Number of successful/failure
upgrade(s): 1/0.
01:59:55: %FPD_MGMT-5-CARD_POWER_CYCLE: SPA-1XTENGE-XFP card in subslot 2/0 is being power
cycled for the FPD image upgrade to take effect.
```

Troubleshooting Problems with FPD Image Upgrades

This section contains information to help troubleshoot problems that can occur during the upgrade process.

Power Failure or Removal of a SPA During an FPD Image Upgrade

If the FPD upgrade operation is interrupted by a power failure or the removal of the SPA, it could corrupt the FPD image. This corruption of the FPD image file makes the SPA unusable by the router and the system will display the following message when it stops trying to power up the SPA:

Note To find more information about FPD-related messages, check the system error messages guide for your Cisco IOS software release.

```
02:10:10: %SPA_OIR-3-SPA_POWERED_OFF: subslot 2/0: SPA 1x10GE XFP SPA powered off after 5
failures within 600 seconds
```

The **show hw-module subslot** *slot-number/subslot-number* **fpd** command can be used to verify that the SPA is using a corrupted FPD image. In this example, the SPA in slot 4/1 is corrupted.

```
Router#show hw-module subslot 2/0 fpd

==== ====================== ====== =============================================
                             H/W   Field Programmable   Current   Min. Required
Slot Card Type               Ver.  Device: "ID-Name"    Version      Version
==== ====================== ====== ================== =========== ==============
 2/0 SPA-1XTENGE-XFP         2.1   1-10GE I/O FPGA   ?.?           ?.?
==== ====================== ====== =============================================
```

Performing a FPD Recovery Upgrade

The recovery upgrade procedure can only be performed on a SPA that has been powered off by the system after it has failed all of the retries attempted to initialize the SPA.

The following example displays the output of an attempt to perform a recovery upgrade before all the initialization retries have been attempted for the SPA in subslot 2/0.

```
02:04:08: %FPD_MGMT-4-UPGRADE_EXIT: Unexpected exit of FPD image upgrade operation for
SPA-1XTENGE-XFP card in subslot 2/0.
02:04:15: %FPD_MGMT-5-CARD_DISABLED: SPA-1XTENGE-XFP card in subslot 2/0 is being disabled
because of an incompatible FPD image version. Note that the c12k-fpd-pkg.120-31.S.pkg
package will be required if you want to perform the upgrade operation.
Router#upgrade hw-module subslot 2/0 file disk1:c12k-fpd-pkg.120-31.S.pkg
```

```
% Cannot get FPD version information for version checking. If a previous upgrade attempt
has failed for the target card, then a recovery upgrade would be required to fix the
failure.


% The following FPD(s) will be upgraded for SPA-1XTENGE-XFP (H/W ver = 2.1) in subslot
2/0:

    ================== =========== =========== ============
    Field Programmable   Current     Upgrade   Estimated
    Device: "ID-Name"    Version     Version   Upgrade Time
    ================== =========== =========== ============
    1-10GE I/O FPGA        ?.?         1.6       00:00:20
    ================== =========== =========== ============


% Do you want to perform the recovery upgrade operation? [no]: y
% Cannot perform recovery upgrade operation because the target card is not in a failed
state. Please try again later.
```

Once the following error message is displayed, you can perform the recovery upgrade:

Note You must wait to see this error message before you attempt the upgrade.

```
%SPA_OIR-3-SPA_POWERED_OFF: subslot 2/0: SPA 1x10GE XFP SPA powered off after 5 failures
within 600 seconds
```

Perform the manual FPD image upgrade method using the **upgrade hw-module subslot** command to recover from a corrupted image after the SPA has been powered off by the system. In this command, *slot-number* is the slot where the SIP is installed, *subslot-number* is the subslot of the SIP where the SPA is located, and *file-url* is the location of the FPD image package file.

Note Before proceeding with this operation, make sure that the correct version of the FPD image package file has been obtained for the corresponding Cisco IOS release that the system is using.

The following example displays the console output of a recovery upgrade operation:

```
Router#upgrade hw-module subslot 2/0 file disk1:c12k-fpd-pkg.120-31.S.pkg

% Cannot get FPD version information for version checking. If a previous upgrade attempt
has failed for the target card, then a recovery upgrade would be required to fix the
failure.


% The following FPD(s) will be upgraded for SPA-1XTENGE-XFP (H/W ver = 2.1) in subslot
2/0:

    ================== =========== =========== ============
    Field Programmable   Current     Upgrade   Estimated
    Device: "ID-Name"    Version     Version   Upgrade Time
    ================== =========== =========== ============
    1-10GE I/O FPGA        ?.?         1.6       00:00:20
    ================== =========== =========== ============


% Do you want to perform the recovery upgrade operation? [no]: y
```

```
% Proceeding with recovery upgrade operation ...

Router#
02:14:47: %FPD_MGMT-6-UPGRADE_TIME: Estimated total FPD image upgrade time for
SPA-1XTENGE-XFP card in subslot 2/0 = 00:00:20.
02:14:47: %FPD_MGMT-6-UPGRADE_START: Unknown FPD (FPD ID=1) image upgrade in progress for
SPA-1XTENGE-XFP card in subslot 2/0. Updating to version 1.6. PLEASE DO NOT INTERRUPT
DURING THE UPGRADE PROCESS (estimated upgrade completion time = 00:00:20) ...
02:15:10: %FPD_MGMT-6-UPGRADE_PASSED: Unknown FPD (FPD ID=1) image in the SPA-1XTENGE-XFP
card in subslot 2/0 has been successfully updated from version ?.? to version 1.6.
Upgrading time = 00:00:23.540
02:15:10: %FPD_MGMT-6-OVERALL_UPGRADE: All the attempts to upgrade the required FPD images
have been completed for SPA-1XTENGE-XFP card in subslot 2/0. Number of successful/failure
upgrade(s): 1/0.
02:15:10: %FPD_MGMT-5-CARD_POWER_CYCLE: SPA-1XTENGE-XFP card in subslot 2/0 is being power
cycled for the FPD image upgrade to take effect.
```

Verifying a Successful Upgrade

After the upgrade process is complete, you can use the **show hw-module subslot** *slot-number/subslot-number* **fpd** command to verify that the FPD image has been successfully upgraded:

```
Router#show hw-module subslot 2/0 fpd

==== ====================== ====== =============================================
                            H/W    Field Programmable   Current   Min. Required
Slot Card Type              Ver.   Device: "ID-Name"    Version      Version
==== ====================== ====== ================== =========== ==============
 2/0 SPA-1XTENGE-XFP         2.1   1-10GE I/O FPGA        1.6         1.6
==== ====================== ====== =============================================
```

CHAPTER 18

Command Summary for FPDs

Table 18-1 provides an alphabetical list of some of the related commands to configure, monitor, and upgrade FPD images for SPAs on the Cisco 12000 Series Router. For more information about the commands, see Chapter 19, "SIP and SPA Command Reference" in this book.

Table 18-1 FPD Command Summary

Command	Purpose
Router# **show hw-module** [**subslot** *slot-number***/***subslot-number* | **all**] **fpd**	Displays all current versions of FPD image files for all of the active SPAs on a router.
Router# **show upgrade fpd file** *file-url*	Displays the contents of an FPD image package file.
Router# **show upgrade fpd package default**	Displays the default FPD image package file that is needed for the router to properly support the SPAs running on the Cisco IOS software release.
Router# **show upgrade fpd progress**	Displays the progress of an FPD upgrade while an FPD upgrade is taking place.
Router# **show upgrade fpd table**	Displays various information used by the Cisco IOS software to manage the FPD image package file.
Router(config)# **upgrade fpd auto**	Configures the router to automatically upgrade the current FPD images on a SPA when an FPD version incompatibility is detected.
Router(config)# **upgrade fpd path** *fpd-pkg-dir-url*	Configures the router to search for an FPD image package file in a location other than the router's primary Flash file system during an automatic FPD upgrade.
Router# **upgrade hw-module subslot** *slot-number***/***subslot-number* **file** *file-url* [**force**]	Manually upgrades the current FPD image package on a SPA.

CHAPTER 19

SIP and SPA Command Reference

This chapter documents new and modified commands. All other commands used with this feature are documented in the Cisco IOS Release 12.0 command reference and master index publications.

Note Some of the commands in this chapter apply to multiple Cisco products and are supported on different platforms. The documentation for these commands describes differences in syntax and usage for certain platform or product variations. Therefore, when you see multiple forms of syntax, examples, or usage guidelines for a command in this guide, be sure to locate the heading within the command reference page that corresponds to the related SPA (or SIP) for your platform.

The following list shows the new and modified commands contained in this chapter:

bert errors

To transmit bert errors while running any bert pattern, use the **bert error** command in interface configuration mode.

bert errors [*number*]

Syntax Description

number	(Optional) Range of 1-255 bert errors that may be introduced in a bert pattern.

Defaults

Default is 1

Command Modes

Interface configuration

Command History

Release	Modification
12.1(12c)EX1	This command was introduced for Cisco 7304 routers.
12.2(18)S	This command was introduced on Cisco 7304 routers running Cisco IOS Release 12.2 S.
12.2(18)SXE	This command was integrated into Cisco IOS release 12.2(18)SXE to support SPAs on the Cisco 7600 series router.
12.0(31)S	This command was integrated into Cisco IOS Release 12.0(31)S.

Usage Guidelines

Use this command to test link availability by injecting a fixed number of bert errors when a pattern is running and check that the same number of errors were received on the remote end.

Examples

This example injects 200 bit errors in a running bit pattern on slot 5, bay 2.

```
Router# configure terminal
Router(config)#int serial 5/0/0
Router(config-if)#bert errors 200
```

Related Commands

Command	Description
bert pattern	Start a BERT pattern on a port.
show controller serial	Displays serial line statistics.

bert pattern

To start a BERT pattern on a port, use the **bert pattern** command in interface configuration mode. Use the **no bert pattern** command to stop the sequence.

bert pattern {**0s** | **1s** | **2^15** | **2^20** | **2^23** | **alt-0-1** | **qrss**} **interval** *minutes*}

no bert pattern {**0s** | **1s** | **2^15** | **2^20** | **2^23** | **alt-0-1** | **qrss**} **interval** *minutes*}

Syntax Description

0s	Repeating pattern of zeros (...000...).
1s	Repeating pattern of ones (...111...).
2^15	Pseudorandom 0.151 test pattern that is 32,768 bits in length.
2^20	Pseudo-andom 0.153 test pattern that is 1,048,575 bits in length.
2^23	Pseudorandom 0.151 test pattern that is 8,388,607 bits in length.
alt-0-1	Repeating pattern of alternating zeros and ones (...01010...).
qrss	Pseudorandom quasi-random signal sequence (QRSS) 0.151 test pattern that is 1,048,575 bits in length.
interval *minutes*	Specifies the length of the BERT test in minutes.

Defaults

Bert is disabled by default.

Command Modes

Interface configuration

Command History

Release	Modification
11.1CC	The command was introduced.
12.0(5)XE	The command was enhanced as an ATM interface configuration command
12.0(7)XE1	Support for Cisco 7100 series routers was added.
12.1(5)T	This command was integrated into Cisco IOS Release 12.1(5)T.
12.1(12c)EX1	Support for Cisco 7304 routers was added.
12.2(18)S	Support for Cisco 7304 routers was added.
12.2(18)SXE	This command was integrated into Cisco IOS Release 12.2(18)SXE to support SPAs on the Cisco 7600 series router.
12.0(31)S	This command was integrated into Cisco IOS Release 12.0(31)S.

Usage Guidelines

Use the **bert pattern** commamd to start or stop a specific bit pattern. To test link availability, start a pattern on one end and put the remote end in network loopback and verify that there are no bert errors.

Examples

This example starts a bert pattern on slot 5, bay 0.

```
Router# configure terminal
```

```
Router(config)#int serial 5/0/0
Router(config-if)#bert pattern 0s
```

Related Commands

Command	Description
bert errors	Transmit bert errors while running any bert pattern.
show controller serial	Displays serial line statistics.
loopback	Loopback at various points in the transmit and receive path.

card type (T1/E1)

To configure the ports on SPA in T1 or E1 mode, use the **card type** command in global configuration mode. To deselect the card type, use the **no** form of this command.

Note The **no** form of this command is not supported on the Cisco 12000 router family.

card type {**t1** | **e1**} *slot subslot*

no card type {**t1** | **e1**} *slot subslot*

Syntax Description

slot	Chassis slot number. Refer to the appropriate hardware manual for slot information. For SIPs, refer to the platform-specific SPA hardware installation guide or the corresponding "Identifying Slots and Subslots for SIPs and SPAs" topic in the platform-specific SPA software configuration guide.
subslot	Secondary slot number on a SPA interface processor (SIP) where a SPA is installed. Refer to the platform-specific SPA hardware installation guide and the corresponding "Specifying the Interface Address on a SPA" topic in the platform-specific SPA software configuration guide for subslot information.
t1	Clear-channel T1 with integrated data service units (DSUs).
e1	Clear-channel E1 with integrated data service units (DSUs).

Defaults

No default behavior or values. There is no card type when the SPA is inserted for the first time. The user must configure this command before they can configure individual ports.

Command Modes

Global configuration

Command History

Release	Modification
12.0(5)XE	This command was introduced.
12.0(7)T	This command was integrated into Cisco IOS Release 12.0(7)T.
12.2S	This command was integrated into Cisco IOS Release 12.2S.
12.2(18)SXE	This command was integrated into Cisco IOS Release 12.2(18)SXE to support SPAs on the Cisco 7600 series routers.
12.0(31)S	This command was integrated into Cisco IOS Release 12.0(31)S to support SPAs on the Cisco 12000 series routers.

Usage Guidelines

To change all the SPA ports from T1 or T3 to E1 or E3 (or E3 to T3), you must deselect the card type and then configure the card with the new type of interface.

Examples

The following example configures all ports of a T3/E3 SPA, seated in slot 5, bay 2, in T3 mode:

```
Router# configure terminal
Router(config)# card type t3 5 2
```

Related Commands

Command	Description
show interface serial	Displays the serial interface type and other information.

card type (T3/E3)

To configure the ports on SPA in T3 or E3 mode, use the **card type** command in global configuration mode. To deselect the card type, use the **no** form of this comand.

Note The **no** form of this command is not supported on the Cisco 12000 router family.

card type {**t3** | **e3**} *slot subslot*

no card type {**t3** | **e3**} *slot subslot*

Syntax Description

slot	Chassis slot number. Refer to the appropriate hardware manual for slot information. For SIPs, refer to the platform-specific SPA hardware installation guide or the corresponding “Identifying Slots and Subslots for SIPs and SPAs” topic in the platform-specific SPA software configuration guide.
subslot	Secondary slot number on a SPA interface processor (SIP) where a SPA is installed. Refer to the platform-specific SPA hardware installation guide and the corresponding “Specifying the Interface Address on a SPA” topic in the platform-specific SPA software configuration guide for subslot information.
t3	Clear-channel T3 with integrated data service units (DSUs).
e3	Clear-channel E3 with integrated data service units (DSUs).

Defaults

No default behavior or values. There is no card type when the SPA is inserted for first time. The user must configure this command before they can configure individual ports.

Command Modes

Global configuration

Command History

Release	Modification
12.0(5)XE	This command was introduced.
12.0(7)T	This command was integrated into Cisco IOS Release 12.0(7)T.
12.1(1)T	This command was introduced.
12.2(11)YT	This command was integrated into Cisco IOS Release 12.2(11)YT and implemented on the following platforms: Cisco 2650XM, Cisco 2651XM, Cisco 2691, Cisco 3660 series, Cisco 3725, and Cisco 3745 routers.
12.2(15)T	This command was integrated into Cisco IOS Release 12.2(15)T.
12.3(1)	This command was integrated into Cisco IOS Release 12.3(1) and support was added for Cisco 2610XM, Cisco 2611XM, Cisco 2620XM, Cisco 2621XM, Cisco 2650XM, Cisco 2651XM, Cisco 2691, Cisco 3631, Cisco 3660, Cisco 3725, and Cisco 3745 platforms.
12.2S	This command was integrated into Cisco IOS Release 12.2S.

Release	Modification
12.2(18)SXE	This command was integrated into Cisco IOS Release 12.2(18)SXE to support SPAs on the Cisco 7600 series routers.
12.0(31)S	This command was integrated into Cisco IOS Release 12.0(31)S.

Usage Guidelines

To change all the SPA ports from T3 to E3, you must deselect the **card type** and then configure the card with the new type of interface.

Once a card type is issued, the user can enter the **no card type** command and then another card type command to configure a new card type. The user must save the configuration to NVRAM and reboot the router in order for the new configuration to take effect.

When the router comes up, the software comes up with the new card type. Note that the software will reject the configuration associated with the old controller and old interface. The user will now have to configure the new controller and serial interface and save it.

Examples

The following example configures all ports of a T3/E3 SPA, seated in slot 5, bay 2, in T3 mode:

```
Router# configure terminal
Router(config)# card type t3 5 2
```

Related Commands

Command	Description
show interface serial	Displays the serial interface type and other information.

framing (T1/E1 controller)

To select the frame type for the T1 or E1 data line, use the **framing** command in controller configuration mode.

T1 Lines

framing {**sf** | **esf**}

E1 Lines

framing {**crc4** | **no-crc4**} [**australia**]

T1 Shared Port Adapter

framing {**sf** | **esf**}

no framing {**sf** | **esf**}

E1 Shared Port Adapter

framing {**crc4** | **no-crc4** | **unframed**}

no framing {**crc4** | **no-crc4** | **unframed**}

Syntax Description

sf	Specifies super frame as the T1 frame type. This is the default for T1.
esf	Specifies extended super frame as the T1 frame type.
crc4	Specifies CRC4 frame as the E1 frame type. This is the default for E1.
no-crc4	Specifies no CRC4 frame as the E1 frame type.
australia	(Optional) Specifies the E1 frame type used in Australia.

Defaults

sf (for a T1 line)

crc4 (for an E1 line)

Command Modes

Controller configuration

Command History

Release	Modification
12.2S	This command was integrated into Cisco IOS Release 12.2S.
12.2(18)SXE	This command was integrated into Cisco IOS Release 12.2(18)SXE to support SPAs on the Cisco 7600 series routers.
12.0(31)S	This command was integrated into Cisco IOS Release 12.0(31)S.

Usage Guidelines

Use this command in configurations in which the router or access server is intended to communicate with T1 or E1 fractional data lines. The service provider determines the framing type required for your T1/E1 circuit.

To return to the default mode on a T1/E1 SPA, use the **no** form of this command. This command does not have a **no** form for other T1/E1 lines.

Examples

The following example selects extended super frame as the T1 frame type:

```
Router(config-controller)# framing esf
```

Related Commands

Command	Description
cablelength	Specifies the distance of the cable from the routers to the network equipment.
linecode	Selects the linecode type for T1 or E1 line.

framing (T3 controller)

To choose framing mode on a T3 port, use the **framing** command in controller configuration mode. To return to the default mode, use the **no** form of this command.

T3 Controllers

framing {**c-bit** | **m23**}

no framing

T3/E3 Shared Port Adapters and the Cisco 7500 Series Routers with CT3IP Port Adapter

framing {**c-bit** | **m23** | **auto-detect**}

no framing

Syntax Description

auto-detect	Specifies detection of the framing type that it receives from the far-end equipment.
c-bit	Specifies that C-bit framing is used as the T3 framing type.
m23	Specifies that M23 framing is used as the T3 framing type.

Defaults

c-bit (for T3 and most T3 controllers)

auto-detect (for the CT3IP in a Cisco 7500 series router)

Command Modes

Controller configuration

Command History

Release	Modification
11.1CA	This command was introduced.
12.2(11)YT	This command was integrated into Cisco IOS Release 12.2(11)YT and implemented on the following platforms for T3: Cisco 2650XM, Cisco 2651XM, Cisco 2691, Cisco 3660 series, Cisco 3725, and Cisco 3745 routers.
12.2(15)T	This command was integrated into Cisco IOS Release 12.2(15)T.
12.2S	This command was integrated into Cisco IOS Release 12.2S.
12.2(18)SXE	This command was integrated into Cisco IOS Release 12.2(18)SXE to support SPAs on the Cisco 7600 series routers.
12.0(31)S	This command was integrated into Cisco IOS Release 12.0(31)S.

Usage Guidelines

Use the **framing** command to set the framing mode on the T3/E3 port.

Examples

The following example sets the framing mode on a T3 interface.

```
Router# configure terminal
Router(config)# controller t1 6/0/0
Router(config-controller)# framing m23
```

The following example sets the framing for the CT3IP to C-bit:

```
Router(config)# controller t3 9/0/0
Router(config-controller)# framing c-bit
```

Related Commands

Command	Description
controller	Configures a T1, E1, or T3 controller and enters controller configuration mode.
show controller	Displays controller configuration.

framing (T3/E3 interface)

To choose framing mode on a T3 port, use the **framing** command in interface configuration mode. To return to the default mode, use the **no** form of this command.

framing {**bypass** | **c-bit** | **m13**}

no framing {**bypass** | **c-bit** | **m13**}

To choose framing mode on an E3 port, use the **framing** command in interface configuration mode. To return to the default mode, use the **no** form of this command.

framing {**bypass** | **g751** | **g832**}

no framing {**bypass** | **g751** | **g832**}

Syntax Description

bypass	Bypasses DS3 framing mode.
c-bit	Enables DS3 C-bit framing mode.
m13	Enables DS3 M13 framing mode.
g751	Enables E3 G.751 framing mode.
g832	Enables E3 G.832 framing mode.

Defaults

T3: C-bit framing

E3: g751 framing

Command Modes

Interface configuration

Command History

Release	Modification
11.1	This command was introduced.
12.2S	This command was integrated into Cisco IOS Release 12.2S.
12.2(18)SXE	This command was integrated into Cisco IOS Release 12.2(18)SXE to support SPAs on the Cisco 7600 series routers. The **g832** keyword option was added to the command.
12.0(31)S	This command was integrated into Cisco IOS Release 12.0(31)S.

Usage Guidelines

Use the **framing** command to set the framing mode on the T3 port.

Examples

The following example sets the framing mode on the first port on slot 5.

```
Router# configure terminal
Router(config)# interface serial 5/0/0
Router(config-if)# framing bypass
```

Related Commands

Command	Description
show controller serial	Displays serial line statistics.

hw-module subslot reload

To restart a shared port adapter (SPA) and its interfaces, use the **hw-module subslot reload** command in privileged EXEC configuration mode. The command does not have a **no** form.

hw-module subslot *slot*/*subslot* **reload**

Syntax Description

slot	Chassis slot number. Refer to the appropriate hardware manual for slot information. For SIPs, refer to the platform-specific SPA hardware installation guide or the corresponding “Identifying Slots and Subslots for SIPs and SPAs” topic in the platform-specific SPA software configuration guide.
/subslot	Secondary slot number on a SPA interface processor (SIP) where a SPA is installed. Refer to the platform-specific SPA hardware installation guide and the corresponding “Specifying the Interface Address on a SPA” topic in the platform-specific SPA software configuration guide for subslot information.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.2(25)S3	This command was introduced.
12.2(18)SXE	This command was integrated into Cisco IOS Release 12.2(18)SXE to support SPAs on the Cisco 12000 Series Routers.
12.0(31)S	This command was integrted into Cisco IOS Release 12.0(31)S to support SPAs on the Cisco 12000 series routers.

Usage Guidelines

The **hw-module subslot reload** command stops and starts power to the SPA. This command is useful when you want to restart all interfaces on a SPA.

The command is recommended to restart a SPA under some of the following conditions:

- To restart a SPA after it has been powered off because of a failure.
- To recover from corrupted messaging between the RouteProcessor (RP) and the SIP.

Examples

The following command power cycles the SPA in subslot 2 of the SIP installed in chassis slot 13:

```
Router# hw-module subslot 13/2 reload
Router#
```

Note The **hw-module subslot reload** command does not produce a message on the router console to indicate the status of the command action. However, some interface configurations might produce console output related to the action of reloading the SPA.

Related Commands

Command	Description
show hw-module subslot oir	Displays the operational status of a SPA.

hw-module subslot shutdown

To shut down a shared port adapter (SPA) with or without power and ensure that the SPA remains shut down, use the **hw-module subslot shutdown** command in global configuration mode. To reenable the SPA, use the **no** form of this command.

hw-module subslot *slot*/*subslot* **shutdown** [**powered** | **unpowered**]

no hw-module subslot *slot*/*subslot* **shutdown** [**powered** | **unpowered**]

Syntax Description

slot	Chassis slot number. Refer to the appropriate hardware manual for slot information. For SIPs, refer to the platform-specific SPA hardware installation guide or the corresponding “Identifying Slots and Subslots for SIPs and SPAs” topic in the platform-specific SPA software configuration guide.
/*subslot*	Secondary slot number on a SPA interface processor (SIP) where a SPA is installed. Refer to the platform-specific SPA hardware installation guide and the corresponding “Specifying the Interface Address on a SPA” topic in the platform-specific SPA software configuration guide for subslot information.
powered	(Optional) Shuts down the SPA and all of its interfaces, and leaves them in an administratively down state with power enabled. This is the default state.
unpowered	(Optional) Shuts down the SPA and all of its interfaces, and leaves them in an administratively down state wihout power. As of 12.0(31)S the unpowered CLI option for the hw-module shutdown command is no longer supported.

Defaults

If this command is not used, **no hw-module subslot shutdown** is the default behavior. The SPA will not be shutdown unless specified by the user.

If this command is entered but both **powered** and **unpowered** are not specified in the CLI, **powered** is the default.

Command Modes

Global configuration

Command History

Release	Modification
12.2(25)S3	This command was introduced.
12.2(18)SXE	This command was integrated into Cisco IOS Release 12.2(18)SXE.
12.0(31)S	This command was integrated into Cisco IOS Release 12.0(31)S.

Usage Guidelines

When you shut down a SPA, you can choose to put it into one of two states:

- Powered state—(Default) Shuts down the SPA, but the SPA remains powered on. Use this option when you plan to leave the SPA physically installed and cabled in the router. You might choose to do this if you want to install a SPA and configure it, but do not want it online or to start communicating with the remote end of the connection.
- Unpowered state—Shuts down the SPA and removes power from the SPA. Use this option when you plan to remove the SPA from the chassis.

This command is useful when a user wants all the interfaces on a SPA disabled but does not or cannot remove the SPA. Unlike the **hw-module subslot stop** EXEC command on the Cisco 7304 router, this command is saved in the configuration file and will keep the SPA disabled when other router events (such as a router reload or OIR) attempt to restart the SPA. All other settings and configurations of the SPA will be maintained even if the SPA itself is shutdown using this command.

As a general rule, you do not need to shut down a SPA if you are removing it and replacing it with the same exact model of SPA in an online insertion and removal (OIR) operation. However, you should shut down a SPA whenever you are replacing a SPA with a different model of SPA.

When you shut down a SPA using the **hw-module subslot shutdown** command, it remains shut down even if you reset the router or install a new SPA in that subslot. You must manually reenable the card, using the **no hw-module subslot shutdown** command, so you can begin using the card again.

Examples

The following example shows how to disable the SPA in subslot 4/1 while leaving the SPA in the router chassis. This command will be saved to the configuration file and no actions, outside of changing this configuration, will reenable the SPA:

```
Router(config)# hw-module subslot 4/1 shutdown unpowered
```

The following example shows how to configure the SPA to resume normal operation after the unpowered option has been used to disable the SPA:

```
Router(config)# hw-module subslot 4/1 shutdown powered
```

No messages are provided on the console when you shut down or reenable a SPA.

Related Commands

Command	Description
show hw-module subslot oir	Displays the operational status of a SPA.
hw-module slot[1]	Deactivates or reactivates a carrier card that is installed in a router slot. This command is entered in EXEC mode and is not saved to the configuration file.

1. Refer to the *Cisco 7300 Series Platform-Specific Commands* publication.

hw-module subslot srp

To change from Packet over SONET (POS) mode to Spatial Reuse Protocol (SRP) mode for all interfaces on a POS/Resilient Packet Ring (RPR) SPA, use the **hw-module subslot srp** command in global configuration mode.

hw-module subslot *slot***/***subslot* **srp** {**mate** *slot***/***subslot*}

no hw-module subslot *slot***/***subslot* **srp** {**mate** *slot***/***subslot*}

Syntax Description

slot	Chassis slot number. Refer to the appropriate hardware manual for slot information. For SIPs, refer to the platform-specific SPA hardware installation guide or the corresponding "Identifying Slots and Subslots for SIPs and SPAs" topic in the platform-specific SPA software configuration guide.
/subslot	Secondary slot number on a SPA interface processor (SIP) where a SPA is installed. Refer to the platform-specific SPA hardware installation guide and the corresponding "Specifying the Interface Address on a SPA" topic in the platform-specific SPA software configuration guide for subslot information.
mate *slot***/***subslot*	(Not required for the 2-Port OC-48c/STM-16 POS SPA) Specifies the location of the SPA that is the SRP mate.

Defaults

No default behavior or values

Command Modes

Global configuration

Command History

Release	Modification
12.0(32)SY	This command was introduced.

Usage Guidelines

When enabling SRP mode using the **hw-module subslot srp** command, consider the following guidelines:

- For proper configuration of SRP for SPAs installed in the same SIP, you should enable SRP using the **hw-module subslot srp** command on the POS SPA that is installed in the lower-numbered slot/subslot combination. This SPA is considered the host SRP interface.
- You only need to configure the **hw-module subslot srp** command on the host SRP interface—not on the mate SRP interface.
- The host SRP interface becomes "Side A" of the SRP interface. The slot number of the side-A interface must be lower than the slot location of the SRP mate (side B) interface. Also, you must specify the side-A interface location for configuration of any SRP options.

- The **mate** keyword does not apply to the 2-Port OC-48c/STM-16 POS SPA. For a single 2-Port OC-48c/STM-16 POS SPA, mating is done internally between the two SONET ports, and no mate cabling is required.
- The SIP reads the information it receives from the hardware cable mating to validate the mate cable connectivity with your software configuration.
- You must shut down the POS interface before enabling SRP.
- When you change the SPA mode, the SPA automatically reloads.
- The entire SPA operates either in POS mode or SRP mode—you cannot have some interfaces configured for POS mode, and other interfaces configured for SRP mode.

Examples

The following example shows how to enable SRP on a 1-Port OC-192c/STM-64 POS/RPR SPA:

```
Router(config)# interface pos 1/0/0
Router(config-if)# shutdown
Router(config-if)# exit
Router(config))# hw-module subslot 1/0 srp mate 1/1
Router(config)# interface srp 1/0/0
```

Related Commands

Command	Description
interface srp	Configures a POS/RPR SPA interface as an SRP interface.

interface

To configure an interface type and enter interface configuration mode, use the **interface** command in global configuration mode.

Standard Syntax

interface *type number* [*name-tag*]

Analysis Module Network Module

interface analysis-module *slot***/***unit*

Content Engine Network Module

interface content-engine *slot***/***unit*

Cisco 7200 Series and Cisco 7500 Series with a Packet over SONET Interface Processor

interface *type slot***/***port*

Cisco 7200 VXR Router used as a Router Shelf in a Cisco AS5800 Universal Access Server

interface *type router-shelf***/***slot***/***port*

Cisco 7500 Series with Channelized T1 or E1

interface serial *slot***/***port***:***channel-group*

Cisco 7500 Series with Ports on VIP Cards

interface *type slot***/***port-adapter***/***port*

To configure a subinterface, use this form of the **interface** global configuration command.

Cisco 7200 Series

interface *type slot***/***port***.***subinterface-number* [**multipoint** | **point-to-point**]

Cisco 7500 Series

interface *type slot***/***port-adapter***.***subinterface-number* [**multipoint** | **point-to-point**]

Cisco 7500 Series with Ports on VIP Cards

interface *type slot***/***port-adapter***/***port***.***subinterface-number* [**multipoint** | **point-to-point**]

Shared Port Adapters

interface *type slot***/***subslot***/***port*[**.***subinterface-number*]

Syntax Description

type	Type of interface to be configured. See Table 19-1.
number	Port, connector, or interface card number. On Cisco 4700 series routers, specifies the network interface module (NIM) or network processor module (NPM) number. The numbers are assigned at the factory at the time of installation or when added to a system, and can be displayed with the **show interfaces** command.
name-tag	(Optional) Specifies the logic name to identify the server configuration so that multiple server configurations can be entered. This optional argument is for use with the Redundant Link Manager (RLM) feature.
slot	Chassis slot number. Refer to the appropriate hardware manual for slot information. For SIPs, refer to the platform-specific SPA hardware installation guide or the corresponding "Identifying Slots and Subslots for SIPs and SPAs" topic in the platform-specific SPA software configuration guide.
/subslot	Secondary slot number on a SIP where a SPA is installed. Refer to the platform-specific SPA hardware installation guide and the corresponding "Specifying the Interface Address on a SPA" topic in the platform-specific SPA software configuration guide for subslot information.
/unit	Number of the daughter card on the network module. For analysis module and content engine (CE) network modules, always use 0.
/port	Port or interface number. Refer to the appropriate hardware manual for port information. For SPAs, refer to the corresponding "Specifying the Interface Address on a SPA" topics in the platform-specific SPA software configuration guide.
router-shelf	Router shelf number in a Cisco AS5800 universal access server. Refer to the appropriate hardware manual for router shelf information.
:*channel-group*	Channel group number. Cisco 7500 series routers specify the channel group number in the range of 0 to 4 defined with the **channel-group** controller configuration command.
/port-adapter	Port adapter number. Refer to the appropriate hardware manual for information about port adapter compatibility.
.*subinterface-number*	Subinterface number in the range 1 to 4294967293. The number that precedes the period (.) must match the number to which this subinterface belongs.
multipoint | **point-to-point**	(Optional) Specifies a multipoint or point-to-point subinterface. There is no default.

Defaults

No interface types are configured.

Command Modes

Global configuration

Note To use this command with the RLM feature, you must be in interface configuration mode.

Command History

Release	Modification
10.0	This command was introduced for the Cisco 7000 series routers.
11.0	This command was implemented on the Cisco 4000 series routers.
12.0(3)T	The optional *name-tag* argument was added for the RLM feature.
12.2(13)T	The **content-engine** keyword was added.
12.2(15)T	The **lex** keyword was removed because the LAN Extension feature is no longer available in Cisco IOS software.
12.3(7)T	The **analysis-module** keyword was added.
12.2(20)S2	This command was implemented for SPAs on the Cisco 7304 router.
12.2(18)SXE	This command was implemented for SPAs on the Cisco 7600 series routers.
12.0(31)S	This command was implemented for SPAs on the Cisco 12000 series routers.

Usage Guidelines

This command does not have a **no** form.

Subinterfaces can be configured to support partially meshed Frame Relay networks. Refer to the "Configuring Serial Interfaces" chapter in the *Cisco IOS Interface and Hardware Component Configuration Guide*.

Table 19-1 displays the keywords that represent the types of interfaces that can be configured with the **interface** command. Replace the *type* argument with the appropriate keyword from the table.

Table 19-1 Interface Type Keywords

Keyword	Interface Type
analysis-module	Analysis module interface. The analysis module interface is a Fast Ethernet interface on the router that connects to the internal interface on the Network Analysis Module (NAM). This interface cannot be configured for subinterfaces or for speed, duplex mode, and similar parameters. See the command-line interface (CLI) help for a list of valid parameters.
async	Port line used as an asynchronous interface.
atm	ATM interface.
bri	ISDN BRI. This interface configuration is propagated to each of the B channels. B channels cannot be individually configured. The interface must be configured with dial-on-demand commands in order for calls to be placed on that interface.
content-engine	Content engine (CE) network module interface. The CE network module interface cannot be configured for subinterfaces or for speed, duplex mode, and similar parameters. See the command-line interface (CLI) help for a list of valid parameters. The **content-engine** keyword was formerly documented as the **interface content-engine** command.
dialer	Dialer interface.
ethernet	Ethernet IEEE 802.3 interface.
fastethernet	100-Mbps Ethernet interface. The **fastethernet** keyword was formerly documented as the **interface fastethernet** command.
fddi	FDDI interface.
gigabitethernet	1000-Mbps Ethernet interface. The **gigabitethernet** keyword was formerly documented as the **interface gigabitethernet** command.
group-async	Master asynchronous interface. The **group-async** keyword was formerly documented as the **interface group-async** command.
hssi	High-Speed Serial Interface (HSSI).
loopback	Software-only loopback interface that emulates an interface that is always up. It is a virtual interface supported on all platforms. The *number* argument is the number of the loopback interface that you want to create or configure. There is no limit on the number of loopback interfaces that you can create.
null	Null interface.
port-channel	Port channel interface. The **port-channel** keyword was formerly documented as the **interface port-channel** command.

Table 19-1 Interface Type Keywords (continued)

Keyword	Interface Type
pos	Packet OC-3 interface on the Packet-over-SONET (POS) interface processor. The **pos** keyword was formerly documented as the **interface pos** command.
sdcc	Section data communications channel interface.
serial	Serial interface.
switch	Switch interface.
tokenring	Token Ring interface.
tunnel	Tunnel interface; a virtual interface. The *number* argument is the number of the tunnel interface that you want to create or configure. There is no limit on the number of tunnel interfaces that you can create.
vg-anylan	100VG-AnyLAN port adapter. The **vg-anylan** keyword was formerly documented as the **interface vg-anylan** command.

Using the analysis-module Keyword

The analysis module interface is used to access the NAM console for the initial configuration. After the NAM IP parameters are configured, the analysis module interface is typically used only during NAM software upgrades and while troubleshooting if the NAM Traffic Analyzer is inaccessible.

Visible only to the Cisco IOS software on the router, the analysis module interface is an internal Fast Ethernet interface on the router that connects to the internal NAM interface. The analysis module interface is connected to the router's Peripheral Component Interconnect (PCI) backplane, and all configuration and management of the analysis module interface must be performed from the Cisco IOS CLI.

Using the group-async Keyword

Using the **group-async** keyword, you create a single asynchronous interface with which other interfaces are associated as members using the **group-range** command. This one-to-many configuration allows you to configure all associated member interfaces by entering one command on the group master interface, rather than entering this command on each individual interface. You can create multiple group masters on a device; however, each member interface can be associated only with one group.

Using the port-channel Keyword

The Fast EtherChannel feature allows multiple Fast Ethernet point-to-point links to be bundled into one logical link to provide bidirectional bandwidth of up to 800 Mbps. You can configure the port-channel interface as you would any Fast Ethernet interface.

After you create a port-channel interface, you assign Fast Ethernet interfaces (up to four) to it. For information on how to assign a Fast Ethernet interface to a port-channel interface, refer to the **channel-group** interface configuration command.

Caution The port-channel interface is the routed interface. Do not enable Layer 3 addresses on the physical Fast Ethernet interfaces. Do not assign bridge groups on the physical Fast Ethernet interfaces because it creates loops. Also, you must disable spanning tree.

Caution With Release 11.1(20)CC, the Fast EtherChannel supports Cisco Express Forwarding (CEF) and distributed Cisco Express Forwarding (dCEF). We recommend that you clear all explicit **ip route-cache distributed** commands from the Fast Ethernet interfaces before enabling dCEF on the port-channel interface. Clearing the route cache gives the port-channel interface proper control of its physical Fast Ethernet links. When you enable CEF/dCEF globally, all interfaces that support CEF/dCEF are enabled. When CEF/dCEF is enabled on the port-channel interface, it is automatically enabled on each of the Fast Ethernet interfaces in the channel group. However, if you have previously disabled CEF/dCEF on the Fast Ethernet interface, CEF/dCEF is not automatically enabled. In this case, you must enable CEF/dCEF on the Fast Ethernet interface.

As you work with the **port-channel** keyword, consider the following points:

- Currently, if you want to use the Cisco Discovery Protocol (CDP), you must configure it only on the port-channel interface and not on the physical Fast Ethernet interface.
- If you do not assign a static MAC address on the port-channel interface, the Cisco IOS software automatically assigns a MAC address. If you assign a static MAC address and then later remove it, Cisco IOS software automatically assigns a MAC address.

Using the vg-anylan Keyword

The 100VG-AnyLAN port adapter provides a single interface port that is compatible with and specified by IEEE 802.12. The 100VG-AnyLAN port adapter provides 100 Mbps over Category 3 or Category 5 unshielded twisted-pair (UTP) cable with RJ-45 terminators, and supports IEEE 802.3 Ethernet packets.

You configure the 100VG-AnyLAN port adapter as you would any Ethernet or Fast Ethernet interface. The 100VG-AnyLAN port adapter can be monitored with the IEEE 802.12 Interface MIB.

Examples

Serial Interface Example

The following example shows how to configure serial interface 0 with PPP encapsulation:

```
Router(config)# interface serial 0
Router(config-if)# encapsulation ppp
```

Loopback Interace Example

The following example shows how to enable loopback mode and assigns an IP network address and network mask to the interface. The loopback interface established here will always appear to be up.

```
Router(config)# interface loopback 0
Router(config-if)# ip address 10.108.1.1 255.255.255.0
```

Cisco 7500 Series Router Ethernet Interface Processor Example

The following example shows how to configure Ethernet port 4 on the Ethernet Interface Processor (EIP) in slot 2 on the Cisco 7500 series router:

```
Router(config)# interface ethernet 2/4
```

Cisco 7500 Series Router Token Ring Interface Example

The following example shows how to configure the Token Ring interface processor in slot 1 on port 0 of a Cisco 7500 series router:

```
Router(config)# interface tokenring 1/0
```

Network Analysis Module Interface Example

The following example configures an analysis module interface when the NAM router is in router slot 1:

```
Router(config)# interface analysis-module 1/0
```

Content Engine Network Module Interface Example

The following example configures an interface for a content engine network module in slot 1:

```
Router(config)# interface content-engine 1/0
```

Cisco 4700 Series Router Fast Ethernet Interface Example

The following example shows how to configure Fast Ethernet interface 0 for standard ARPA encapsulation (the default setting) on a Cisco 4700 series router:

```
Router(config)# interface fastethernet 0
```

Gigabit Ethernet Interface Example

The following example shows how to configure the Gigabit Ethernet interface for slot 0, port 0:

```
Router(config)# interface gigabitethernet 0/0
```

Asynchronous Group Master Interface Example

The following example shows how to define asynchronous group master interface 0:

```
Router(config)# interface group-async 0
```

Port Channel Interface Example

The following example shows how to create a port-channel interface with a channel group number of 1 and adds two Fast Ethernet interfaces to port-channel 1:

```
Router(config)# interface port-channel 1
Router(config-if)# ip address 10.1.1.10 255.255.255.0
Router(config-if)# exit
Router(config)# interface fastethernet 1/0/0
Router(config-if)# channel-group 1
Router(config-if)# exit
Router(config)# interface fastethernet 4/0/0
Router(config-if)# channel-group 1
```

Packet over SONET Interface Example

The following example shows how to specify the single Packet OC-3 interface on port 0 of the POS OC-3 port adapter in slot 2:

```
Router(config)# interface pos 2/0
```

100VG-AnyLAN Interface Example

The following example shows how to specify the 100VG-AnyLAN port adapter in the first port adapter in slot 1:

```
Router(config)# interface vg-anylan 1/0/0
```

Frame Relay Subinterface Example

The following example shows how to configure a partially meshed Frame Relay network. In this example, subinterface serial 0.1 is configured as a multipoint subinterface with two associated Frame Relay permanent virtual connections (PVCs), and subinterface serial 0.2 is configured as a point-to-point subinterface.

```
Router(config)# interface serial 0
```

```
Router(config-if)# encapsulation frame-relay
Router(config-if)# exit
Router(config)# interface serial 0/0.1 multipoint
Router(config-if)# ip address 10.108.10.1 255.255.255.0
Router(config-if)# frame-relay interface-dlci 42 broadcast
Router(config-if)# frame-relay interface-dlci 53 broadcast
Router(config-if)# exit
Router(config)# interface serial 0/0.2 point-to-point
Router(config-if)# ip address 10.108.11.1 255.255.255.0
Router(config-if)# frame-relay interface-dlci 59 broadcast
```

T1 Serial Interface Example

The following example shows how to configure circuit 0 of a T1 link for PPP encapsulation:

```
Router(config)# controller t1 4/1
Router(config-controller)# circuit 0 1
Router(config-controller)# exit
Router(config)# interface serial 4/1:0
Router(config-if)# ip address 10.108.13.1 255.255.255.0
Router(config-if)# encapsulation ppp
```

SDCC Interface on a POS Shared Port Adapter Example

The following example configures the first interface (port 0) as a section data communications channel (SDCC) interface on a POS SPA, where the SPA is installed in the top subslot (0) of the MSC, and the MSC is installed in slot 4 of the Cisco 7304 router:

```
Router(config)# interface sdcc 4/3/0
Router(config-if)# ip address 10.1.9.2 255.255.255.0
Router(config-if)# logging event link-status
Router(config-if)# load-interval 30
Router(config-if)# no keepalive
Router(config-if)# no fair-queue
Router(config-if)# no cdp enable
```

Shared Port Adapter Interface Example

The following example configures the second interface (port 1) on a 4-Port 10/100 Fast Ethernet SPA for standard ARPA encapsulation (the default setting), where the SPA is installed in the bottom subslot (1) of the MSC, and the MSC is installed in slot 2 of the Cisco 7304 router:

```
Router(config)# interface fastethernet 2/1/1
```

Related Commands

Command	Description
channel-group	Defines the timeslots that belong to each T1 or E1 circuit.
channel-group (Fast EtherChannel)	Assigns a Fast Ethernet interface to a Fast EtherChannel group.
clear interface	Resets the hardware logic on an interface.
controller	Configures an E1, J1, T1, or T3 controller and enters controller configuration mode.
group-range	Creates a list of asynchronous interfaces that are associated with a group interface on the same device.
mac-address	Sets the MAC layer address.
ppp	Starts an asynchronous connection using PPP.
show controllers content-engine	Displays controller information for CE network modules.

Command	Description
show interfaces	Displays information about interfaces.
show interfaces content-engine	Displays basic interface configuration information for a CE network module.
shutdown (RLM)	Shuts down all of the links under the RLM group.
slip	Starts a serial connection to a remote host using SLIP.

loopback (T3/E3 interface)

To loopback at various points in the transmit and receive path, use the **loopback** command in interface configuration mode. To stop the loopback, use the **no** form of this command.

PA-T3 Port Adapter

loopback {**dte** | **local** | **network** {**line** | **payload**} | **remote**}

no loopback

PA-E3 Port Adapter

loopback {**dte** | **local** | **network** {**line** | **payload**}}

no loopback

T3/E3 Shared Port Adapters

loopback {**dte** | **local** | **dual** | **network** {**line** | **payload**} | **remote**}

no loopback {**dte** | **local** | **dual** | **network** {**line** | **payload**} | **remote**}

Syntax Description

dte	Loopback after the line interface unit (LIU) towards the terminal.
local	Loopback after going through the framer toward the terminal.
dual	Sets both local loopback and network line loopback.
network {**line** | **payload**}	Sets the loopback toward the network before going through the framer (**line**) or after going through the framer (**payload**).
remote	Sends FEAC to set remote in loopback.

Defaults

No loopback by default.

Command Modes

Interface configuration

Command History

Release	Modification
11.1	This command was introduced.
11.3	This command was introduced.
12.2(11)YT	This command was integrated into Cisco IOS Release 12.2(11)YT and implemented on the following platforms for E3: Cisco 2650XM, Cisco 2651XM, Cisco 2691, Cisco 3660 series, Cisco 3725, and Cisco 3745 routers.
12.2(15)T	This command was integrated into Cisco IOS Release 12.2(15)T.
12.2S	This command was integrated into Cisco IOS Release 12.2S.

Release	Modification
12.2(18)SXE	This command was integrated into Cisco IOS Release 12.2(18)SXE to support SPAs on the Cisco 7600 series routers. The **dual** keyword was added.
12.0(31)S	This command was integrated into Cisco IOS Release 12.0(31)S.

Usage Guidelines

Use the **loopback** command to diagnose problems on the local port, between the framer and the line interface unit (LIU) level.

Examples

The following example creates a loopback on slot 5, bay 0 after the LIU towards the terminal.

```
Router# configure terminal
Router(config)# interface serial 5/0/0
Router(config-if)# loopback dte
```

mdl

To configure the Maintenance Data Link (MDL) message defined in the ANSI T1.107a-1990 specification, use the **mdl** command in controller configuration mode.

mdl [**string** {**eic** | **fic** | **generator** | **lic** | **pfi** | **port** | **unit**}*string*] | [**transmit** {**idle-signal** | **path** | **test-signal**}]

no mdl [**string** {**eic** | **fic** | **generator** | **lic** | **pfi** | **port** | **unit**}*string*] | [**transmit** {**idle-signal** | **path** | **test-signal**}]

Syntax Description

string eic *string*	Specifies the Equipment Identification Code; can be up to 10 characters.
string fic *string*	Specifies the Frame Identification Code; can be up to 10 characters.
string generator *string*	Specifies the Generator number string sent in the MDL Test Signal message; can be up to 38 characters.
string lic *string*	Specifies the Location Identification Code; can be up to 11 characters.
string pfi *string*	Specifies the Path Facility Identification Code sent in the MDL Path message; can be up to 38 characters.
string port *string*	Specifies the Port number string sent in the MDL Idle Signal message; can be up to 38 characters.
string unit *string*	Specifies the Unit Identification Code; can be up to 6 characters.
transmit idle-signal	Enables MDL Idle-Signal message transmission.
transmit path	Enables MDL Path message transmission.
transmit test-signal	Enables MDL Test-Signal message transmission.

Defaults

No default behavior or values

Command Modes

Controller configuration

Command History

Release	Modification
11.3	This command was introduced.
12.1(13)EX	This command was introduced on the Cisco 7304 router.
12.2(11)YT	This command was integrated into Cisco IOS Release 12.2(11)YT and implemented on the following platforms: Cisco 2650XM, Cisco 2651XM, Cisco 2691, Cisco 3660 series, Cisco 3725, and Cisco 3745 routers.
12.2(15)T	This command was integrated into Cisco IOS Release 12.2(15)T.
12.2(18)S	This command was introduced on Cisco 7304 routers running Cisco IOS Release 12.2 S.
12.2(18)SXE	This command was integrated into Cisco IOS Release 12.2(18)SXE to support SPAs on the Cisco 7600 series routers.
12.0(31)S	This command was integrated into Cisco IOS Release 12.0(31)S.

Usage Guidelines

Use the **mdl** command to send msgs in maintainance data link in T3 c-bit framing mode.

Examples

The following example sends a test signal on the maintenance data link.

```
Router# configure terminal
Router(config)#controller t3 5/0/0
Router(config-controller)#mdl transmit test-signal
```

Related Commands

Command	Description
controller	Configures a T1, E1, or T3 controller and enters controller configuration mode.
show controllers serial	Displays serial line statistics.

show controllers pos

To display information about a Packet over SONET (POS) interface, use the **show controllers pos** command in privileged EXEC mode. The command does not have a **no** form.

Cisco 7500 Series Routers

show controllers pos [*slot*/*port-adapter*/*port*] [**details** | **pm** [*time-interval*]]

Cisco 12000 Series Routers

show controllers pos [*slot*/*port*] [**details** | **pm** [*time-interval*]]

POS Shared Port Adapters

show controllers pos [*slot*/*subslot*/*port*[/*sub_int*]] [**alarm** | **details** | **pm** [*time-interval*]]

Syntax Description

slot	(Optional) Chassis slot number. Refer to the appropriate hardware manual for slot information. For SIPs, refer to the platform-specific SPA hardware installation guide or the corresponding "Identifying Slots and Subslots for SIPs and SPAs" topic in the platform-specific SPA software configuration guide.
/*port-adapter*	(Optional) Port adapter number. Refer to the appropriate hardware manual for information about port adapter compatibility.
/*subslot*	(Optional) Secondary slot number on a SPA interface processor (SIP) where a SPA is installed. Refer to the platform-specific SPA hardware installation guide and the corresponding "Specifying the Interface Address on a SPA" topic in the platform-specific SPA software configuration guide for subslot information.
/*port*	(Optional) Port or interface number. Refer to the appropriate hardware manual for port information. For SPAs, refer to the corresponding "Specifying the Interface Address on a SPA" topics in the platform-specific SPA software configuration guide.
/*sub_int*	(Optional) Subinterface number.
alarm	(Optional) SONET/SDH alarm event counters.
details	(Optional) In addition to the normal information displayed by the **show controllers pos** command, the **details** keyword provides a hexadecimal and ASCII "dump" of the path trace buffer.
pm	(Optional) Displays SONET performance monitoring statistics accumulated for a 24-hour period in 15-minute intervals.
time-interval	(Optional) Number of the SONET MIB 15-minute time interval in the range from 1 to 96. If the *time-interval* argument is not specified, the performance monitoring statistics for the current time interval are displayed.

Defaults

If you do not specify any slot addressing, information for all installed POS interfaces is displayed.

The **show controllers pos** command with the **pm** keyword displays SONET performance monitoring statistics accumulated at 15-minute intervals, and these statistics can be queried using Simple Network Management Protocol (SNMP) tools. The performance monitoring statistics are collected according to the RFC 1595 specification.

The information that this command displays is generally useful only for diagnostic tasks performed by Cisco Systems technical support personnel.

If no interface is specified, the command displays information for all POS interfaces.

Command Modes

Privileged EXEC

Command History

Release	Modification
11.1CC	This command was introduced.
12.2 S	This command was integrated into Cisco IOS Release 12.2 S.
12.2(25)S3	This command was integrated into Cisco IOS Release 12.2(25)S3 to support SPAs on the Cisco 7304 router. The command was modified to support a new addressing format for SPAs on the Cisco 7304 router.
12.2(18)SXE	This command was integrated into Cisco IOS Release 12.2(18)SXE to support SPAs on the Cisco 7600 series routers.
12.0(31)S	This command was integrated into Cisco IOS Release 12.0(31)S to support SPAs on the Cisco 12000 series routers.

Examples

Example of the show controllers pos Command on the Cisco 7500 Series Router

The following is sample output from the **show controllers pos** command on a Cisco 7500 series router:

```
Router# show controllers pos

POS2/0/0
SECTION
  LOF = 0          LOS = 2335                         BIP(B1) = 77937133
LINE
  AIS = 2335       RDI = 20         FEBE = 3387950089 BIP(B2) = 1622825387
PATH
  AIS = 2340       RDI = 66090      FEBE = 248886263  BIP(B3) = 103862953
  LOP = 246806     NEWPTR = 11428072   PSE = 5067357     NSE = 4645

Active Defects: B2-TCA B3-TCA
Active Alarms:  None
Alarm reporting enabled for: B1-TCA

APS
  COAPS = 12612784   PSBF = 8339
  State: PSBF_state = False
  Rx(K1/K2): 00/CC  Tx(K1/K2): 00/00
  S1S0 = 03, C2 = 96
CLOCK RECOVERY
  RDOOL = 64322060
  State: RDOOL_state = True
PATH TRACE BUFFER: UNSTABLE
  Remote hostname :
```

```
  Remote interface:
  Remote IP addr  :
  Remote Rx(K1/K2): ../..  Tx(K1/K2): ../..
BER thresholds:  SF = 10e-3  SD = 10e-8
TCA thresholds:  B1 = 10e-7  B2 = 10e-3  B3 = 10e-6
```

Table 19-2 describes the fields shown in this display.

Table 19-2 show controllers pos Field Descriptions

Field	Description
POS*x/y/z*	Slot number of the POS interface.
LOF	Section loss of frame is detected when a severely error framing (SEF) defect on the incoming SONET signal persist for 3 milliseconds.
LOS	Section loss of signal is detected when an all-zeros pattern on the incoming SONET signal lasts 19 plus or minus 3 microseconds or longer. This defect might also be reported if the received signal level drops below the specified threshold.
BIP(B1)/BIP(B2)/BIP(B3)	Bit interleaved parity (BIP). For B1, the BIP error report is calculated by comparing the BIP-8 code with the BIP-8 code extracted from the B1 byte of the following frame. Differences indicate that section-level bit errors have occurred. For B2, the BIP error report is calculated by comparing the BIP-8/24 code with the BIP-8 code extracted from the B2 byte of the following frame. Differences indicate that line-level bit errors have occurred. For B3, the BIP error report is calculated by comparing the BIP-8 code with the BIP-8 code extracted from the B3 byte of the following frame. Differences indicate that path-level bit errors have occurred.
AIS	Alarm indication signal. A line alarm indication signal is sent by the section terminating equipment (STE) to alert the downstream line terminating equipment (LTE) that a loss of signal (LOS) or loss of frame (LOF) defect has been detected on the incoming SONET section. A path alarm indication signal is sent by the LTE to alert the downstream path terminating equipment (PTE) that it has detected a defect on its incoming line signal.
RDI	Remote defect indication. A line remote defect indication is reported by the downstream LTE when it detects LOF, LOS, or AIS. A path remote defect indication is reported by the downstream PTE when it detects a defect on the incoming signal.
FEBE	Far end block errors. Line FEBE (accumulated from the M0 or M1 byte) is reported when the downstream LTE detects BIP(B2) errors. Path FEBE (accumulated from the G1 byte) is reported when the downstream PTE detects BIP(B3) errors.

Table 19-2 show controllers pos Field Descriptions (continued)

Field	Description
LOP	Path loss of pointer is reported as a result of an invalid pointer (H1, H2) or an excess number of new data flag (NDF)-enabled indications.
NEWPTR	Inexact count of the number of times that the SONET framer has validated a new SONET pointer value (H1, H2).
PSE	Inexact count of the number of times that the SONET framer has detected a positive stuff event in the received pointer (H1, H2).
NSE	Inexact count of the number of times that the SONET framer has detected a negative stuff event in the received pointer (H1, H2).
Active Defects	List of all currently active SONET defects.
Active Alarms	List of current alarms as enforced by Sonet Alarm Hierarchy.
Alarm reporting enabled for	List of alarms for which you enabled reporting with the **pos report** interface command.
APS	Automatic protection switching.
COAPS	An inexact count of the number of times that a new APS value has been detected in the K1, K2 bytes.
PSBF	An inexact count of the number of times that a protection switching byte failure has been detected (no three consecutive SONET frames contain identical K1 bytes).
PSBF_state	Protection switching byte failure state.
Rx(K1/K2)/Tx(K1/K2)	Contents of the received and transmitted K1 and K2 bytes.
S1S0	The two S bits received in the last H1 byte.
C2	The value extracted from the SONET path signal label byte (C2).
CLOCK RECOVERY	The SONET clock is recovered using information in the SONET overhead. RDOOL is an inexact count of the number of times that Receive Data Out Of Lock has been detected, which indicates that the clock recovery phased lock loop is unable to lock to the receive stream.
PATH TRACE BUFFER	SONET path trace buffer is used to communicate information regarding the remote host name, interface name and number, and IP address. This is a Cisco-proprietary use of the J1 (path trace) byte.
BER thresholds	List of the bit error rate (BER) thresholds that you configured with the **pos threshold** interface command.
TCA thresholds	List of the threshold crossing alarms (TCAs) that you configured with the **pos threshold** interface command.

Example of the show controllers pos Command on a POS Shared Port Adapter

The following is sample output from the **show controllers pos** command on a Cisco 7600 series router for POS interface 4/3/0 (which is the interface for port 0 of the SPA in subslot 3 of the SIP in chassis slot 4):

```
Router# show controllers pos 4/3/0
POS4/3/0
SECTION
  LOF = 0          LOS    = 0                            BIP(B1) = 65535
LINE
```

```
  AIS = 0          RDI    = 0          FEBE = 65535      BIP(B2) = 16777215
PATH
  AIS = 0          RDI    = 0          FEBE = 65535      BIP(B3) = 65535
  PLM = 0          UNEQ   = 0          TIM  = 0          TIU     = 0
  LOP = 0          NEWPTR = 3          PSE  = 0          NSE     = 0

Active Defects: None
Active Alarms:  None
Alarm reporting enabled for: SF SLOS SLOF B1-TCA B2-TCA PLOP B3-TCA

Framing: SONET
APS

  COAPS = 1          PSBF = 0
  State: PSBF_state = False
  Rx(K1/K2): 00/00  Tx(K1/K2): 00/00
  Rx Synchronization Status S1 = 00
  S1S0 = 00, C2 = CF
  Remote aps status (none); Reflected local aps status (none)
CLOCK RECOVERY
  RDOOL = 0
  State: RDOOL_state = False
PATH TRACE BUFFER: STABLE
  Remote hostname : woodson
  Remote interface: POS3/0/0
  Remote IP addr  : 0.0.0.0
  Remote Rx(K1/K2): 00/00  Tx(K1/K2): 00/00

BER thresholds:  SF = 10e-3  SD = 10e-6
TCA thresholds:  B1 = 10e-6  B2 = 10e-6  B3 = 10e-6

  Clock source:  internal
```

Table 19-2 describes the fields shown in this display.

Example of the show controllers pos alarm Command on the Cisco 7600 Series Router

The following is sample output from the **show controllers pos alarm** command that displays SONET/SDH alarm event counters on a Cisco 7600 series router:

```
Router# show controllers pos3/2/0 alarm
POS3/2/0

Alarm Event Statistics:
SECTION
  LOF = 0          LOS    = 0          B1-TCA = 0
LINE
  AIS = 0          RDI    = 0          RDOOL  = 0
  SF  = 0          SD     = 0          B2-TCA = 0
PATH
  AIS = 0          RDI    = 0          LOP    = 0          B3-TCA = 0
  PLM = 0          UNEQ   = 0
```

Example of the show controllers pos pm Command on the Cisco 12000 Series Router

The following is sample output from the **show controllers pos pm** command that displays performance monitoring statistics on a Cisco 12000 series router:

```
Router# show controllers pos 1/0 pm

POS1/0
Medium is SONET
Line coding is RZ, Line type is LONG SM
Data in current interval (516 seconds elapsed)
```

```
SECTION ( NO DEFECT )
    515 Errored Secs, 515 Severely Err Secs
    0 Coding Violations, 515 Sev Err Framing Secs
LINE ( NO DEFECT )
    0 Errored Secs, 0 Severely Err Secs
    0 Coding Violations, 0 Unavailable Secs
FAR END LINE
    0 Errored Secs, 0 Severely Err Secs
    0 Coding Violations, 0 Unavailable Secs
PATH ( NO DEFECT )
    0 Errored Secs, 0 Severely Err Secs
    0 Coding Violations, 0 Unavailable Secs
FAR END PATH
    0 Errored Secs, 0 Severely Err Secs
    0 Coding Violations, 0 Unavailable Secs
```

Table 19-3 describes the fields shown in the display.

Table 19-3 show controllers pos pm Field Descriptions

Field	Description
POS*x/y*	Slot number of the POS interface.
Line coding	Shows the current line encoding type, either return to zero (RZ) or nonreturn to zero (NRZ).
Line type	Line type for this interface. Optical line types can be either long range (LONG) or short range (SHORT), and either single mode (SM) or multimode (MM).
Data in current interval	Shows the current accumulation period, which rolls into the 24-hour accumulation every 15 minutes. Accumulation period is from 1 to 900 seconds. The oldest 15-minute period falls off the back of the 24-hour accumulation buffer.
Errored Secs	An errored second is a second in which one of the following is detected: • One or more coding violations. • One or more incoming defects (for example, a severely errored frame (SEF) defect, an LOS defect, an AIS defect, or an LOP defect).
Severely Err Secs	A severely errored second (SES) is a second with one of the following errors: • A certain number of coding violations. The number is dependent on the line rate and the BER. • A certain number of incoming defects.
Coding Violations	Number of coding violations for the current interval. Coding violations are defined as BIP errors that are detected in the incoming signal. The coding violations counter is incremented for each BIP error detected.
Sev Err Framing Secs	Severely errored framing seconds (SEFS) are seconds with one or more SEF defects.
Unavailable Secs	Total number of seconds for which the interface is unavailable. The interface is considered to be unavailable after a series of ten consecutive SESs.

Related Commands

Command	Description
pos report	Permits selected SONET alarms to be logged to the console for a POS interface.
pos threshold	Sets the BER threshold values of specified alarms for a POS interface.

show controllers serial

To display serial controller statistics, use the **show controllers serial** command in privileged EXEC mode.

Standard Syntax

show controllers serial [*slot*/*port*]

Cisco 7000 Series Routers with the RSP7000 and RSP7000CI and Cisco 7500 Series Routers

show controllers serial [*slot*/*port-adapter*/*port*]

T3/E3 Shared Port Adapters and 2-Port and 4-Port Channelized T3 SPA in Unchannelized Mode

show controllers serial [*slot*/*subslot*/*port*]

Channelized T3 Shared Port Adapters

show controllers serial [*slot*/*subslot*/*port*/*t1-number*]

Syntax Description

slot	(Optional) Chassis slot number. Refer to the appropriate hardware manual for slot information. For SIPs, refer to the platform-specific SPA hardware installation guide or the corresponding “Identifying Slots and Subslots for SIPs and SPAs” topic in the platform-specific SPA software configuration guide.
port-adapter	(Optional) On Cisco 7500 series routers and Cisco 7000 series routers with the RSP7000 and RSP7000CI, the location of the port adapter on a Versatile Interface Processor (VIP). The value can be 0 or 1.
/subslot	(Optional) Secondary slot number on a SPA interface processor (SIP) where a SPA is installed. Refer to the platform-specific SPA hardware installation guide and the corresponding “Specifying the Interface Address on a SPA” topic in the platform-specific SPA software configuration guide for subslot information.
port	(Optional) Port or interface number. Refer to the appropriate hardware manual for port information. For SPAs, refer to the corresponding “Specifying the Interface Address on a SPA” topics in the platform-specific SPA software configuration guide.
t1-number	(Optional) Logical T1 number in channelized mode. For SPAs, refer to the corresponding “Specifying the Interface Address on a SPA” topics in the platform-specific SPA software configuration guide.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
10.0	This command was introduced.
11.1CA	This command was modified to include support for the PA-E3 and PA-T3 port adapters.
12.2S	This command was integrated into Cisco IOS Release 12.2S.
12.2(18)SXE	This command was integrated into Cisco IOS Release 12.2(18)SXE and introduced a new output for interfaces on the serial SPAs on the Cisco 7600 series routers.
12.0(31)S	This command was integrated into Cisco IOS Release 12.0(31)S.

Usage Guidelines

The output from the **show controllers serial** command provides error and alarm information that is useful in troubleshooting line problems.

The information displayed is generally useful for diagnostic tasks performed by Cisco Systems technical support personnel only. For the PA-E3 or PA-T3 port adapters, the **show controllers serial** command also displays configuration information such as the framing, clock source, bandwidth limit, whether scrambling is enabled, the national bit, the international bits, and DSU mode configured on the interface. Also displayed are the performance statistics for the current interval and last 15-minute interval and whether any alarms exist.

Examples

Example of the show controllers serial Command on the Cisco 4000 Series Router

The following is sample output from the **show controllers serial** command on the Cisco 4000:

```
Router# show controllers serial

MK5 unit 0, NIM slot 1, NIM type code 7, NIM version 1
idb = 0x6150, driver structure at 0x34A878, regaddr = 0x8100300
IB at 0x6045500: mode=0x0108, local_addr=0, remote_addr=0
N1=1524, N2=1, scaler=100, T1=1000, T3=2000, TP=1
buffer size 1524
DTE V.35 serial cable attached


RX ring with 32 entries at 0x45560 : RLEN=5, Rxhead 0
00 pak=0x6044D78  ds=0x6044ED4 status=80 max_size=1524 pak_size=0
01 pak=0x60445F0  ds=0x604474C status=80 max_size=1524 pak_size=0
02 pak=0x6043E68  ds=0x6043FC4 status=80 max_size=1524 pak_size=0
03 pak=0x60436E0  ds=0x604383C status=80 max_size=1524 pak_size=0
04 pak=0x6042F58  ds=0x60430B4 status=80 max_size=1524 pak_size=0
05 pak=0x60427D0  ds=0x604292C status=80 max_size=1524 pak_size=0
06 pak=0x6042048  ds=0x60421A4 status=80 max_size=1524 pak_size=0
07 pak=0x60418C0  ds=0x6041A1C status=80 max_size=1524 pak_size=0
08 pak=0x6041138  ds=0x6041294 status=80 max_size=1524 pak_size=0
09 pak=0x60409B0  ds=0x6040B0C status=80 max_size=1524 pak_size=0
10 pak=0x6040228  ds=0x6040384 status=80 max_size=1524 pak_size=0
11 pak=0x603FAA0  ds=0x603FBFC status=80 max_size=1524 pak_size=0
12 pak=0x603F318  ds=0x603F474 status=80 max_size=1524 pak_size=0
13 pak=0x603EB90  ds=0x603ECEC status=80 max_size=1524 pak_size=0
14 pak=0x603E408  ds=0x603E564 status=80 max_size=1524 pak_size=0
15 pak=0x603DC80  ds=0x603DDDC status=80 max_size=1524 pak_size=0
16 pak=0x603D4F8  ds=0x603D654 status=80 max_size=1524 pak_size=0
17 pak=0x603CD70  ds=0x603CECC status=80 max_size=1524 pak_size=0
18 pak=0x603C5E8  ds=0x603C744 status=80 max_size=1524 pak_size=0
19 pak=0x603BE60  ds=0x603BFBC status=80 max_size=1524 pak_size=0
20 pak=0x603B6D8  ds=0x603B834 status=80 max_size=1524 pak_size=0
```

```
21 pak=0x603AF50  ds=0x603B0AC status=80 max_size=1524 pak_size=0
22 pak=0x603A7C8  ds=0x603A924 status=80 max_size=1524 pak_size=0
23 pak=0x603A040  ds=0x603A19C status=80 max_size=1524 pak_size=0
24 pak=0x60398B8  ds=0x6039A14 status=80 max_size=1524 pak_size=0
25 pak=0x6039130  ds=0x603928C status=80 max_size=1524 pak_size=0
26 pak=0x60389A8  ds=0x6038B04 status=80 max_size=1524 pak_size=0
27 pak=0x6038220  ds=0x603837C status=80 max_size=1524 pak_size=0
28 pak=0x6037A98  ds=0x6037BF4 status=80 max_size=1524 pak_size=0
29 pak=0x6037310  ds=0x603746C status=80 max_size=1524 pak_size=0
30 pak=0x6036B88  ds=0x6036CE4 status=80 max_size=1524 pak_size=0
31 pak=0x6036400  ds=0x603655C status=80 max_size=1524 pak_size=0
TX ring with 8 entries at 0x45790 : TLEN=3, TWD=7
tx_count = 0, tx_head = 7, tx_tail = 7
00 pak=0x000000 ds=0x600D70C status=0x38 max_size=1524 pak_size=22
01 pak=0x000000 ds=0x600D70E status=0x38 max_size=1524 pak_size=2
02 pak=0x000000 ds=0x600D70E status=0x38 max_size=1524 pak_size=2
03 pak=0x000000 ds=0x600D70E status=0x38 max_size=1524 pak_size=2
04 pak=0x000000 ds=0x600D70E status=0x38 max_size=1524 pak_size=2
05 pak=0x000000 ds=0x600D70E status=0x38 max_size=1524 pak_size=2
06 pak=0x000000 ds=0x600D70E status=0x38 max_size=1524 pak_size=2
07 pak=0x000000 ds=0x6000000 status=0x38 max_size=1524 pak_size=0
XID/Test TX desc at 0xFFFFFF, status=0x30, max_buffer_size=0, packet_size=0
XID/Test RX desc at 0xFFFFFF, status=0x0, max_buffer_size=0, packet_size=0
Status Buffer at 0x60459C8: rcv=0, tcv=0, local_state=0, remote_state=0
phase=0, tac=0, currd=0x00000, curxd=0x00000
bad_frames=0, frmrs=0, T1_timeouts=0, rej_rxs=0, runts=0
0 missed datagrams, 0 overruns, 0 bad frame addresses
0 bad datagram encapsulations, 0 user primitive errors
0 provider primitives lost, 0 unexpected provider primitives
0 spurious primitive interrupts, 0 memory errors, 0 tr
%LINEPROTO-5-UPDOWN: Linansmitter underruns
mk5025 registers: csr0 = 0x0E00, csr1 = 0x0302, csr2 = 0x0704
                  csr3 = 0x5500, csr4 = 0x0214, csr5 = 0x0008
```

Example of the show controllers serial Command for a PA-E3 Serial Port Adapter

The following is sample output from the **show controllers serial** command for a PA-E3 serial port adapter installed in slot 2:

```
Router# show controllers serial 2/0

M1T-E3 pa: show controller:
PAS unit 0, subunit 0, f/w version 2-55, rev ID 0x2800001, version 2
idb = 0x6080D54C, ds = 0x6080F304, ssb=0x6080F4F4
Clock mux=0x30, ucmd_ctrl=0x0, port_status=0x1
Serial config=0x8, line config=0x1B0202
maxdgram=4474, bufpool=128Kb, 256 particles

   rxLOS inactive, rxLOF inactive, rxAIS inactive
   txAIS inactive, rxRAI inactive, txRAI inactive

line state: up
E3 DTE cable, received clockrate 50071882

base0 registers=0x3D000000, base1 registers=0x3D002000
mxt_ds=0x608BA654, rx ring entries=128, tx ring entries=256
rxring=0x4B01F480, rxr shadow=0x6081081C, rx_head=26
txring=0x4B01F960, txr shadow=0x60810E48, tx_head=192, tx_tail=192, tx_count=0
throttled=0, enabled=0, disabled=0
rx_no_eop_err=0, rx_no_stp_err=0, rx_no_eop_stp_err=0
rx_no_buf=0, rx_soft_overrun_err=0, dump_err= 1
tx_underrun_err=0, tx_soft_underrun_err=0, tx_limited=0
tx_fullring=0, tx_started=11504
   Framing is g751, Clock Source is Line, Bandwidth limit is 34010.
```

```
   Scrambling is enabled
   National Bit is 0, International Bits are: 0 0
   DSU mode 1
   Data in current interval (213 seconds elapsed):
     0 Line Code Violations, 0 P-bit Coding Violation
     0 C-bit Coding Violation
     0 P-bit Err Secs, 0 P-bit Severely Err Secs
     0 Severely Err Framing Secs, 0 Unavailable Secs
     0 Line Errored Secs, 0 C-bit Errored Secs, 0 C-bit Severely Errored Secs
   Total Data (last 24 hours)
     0 Line Code Violations, 0 P-bit Coding Violation,
     0 C-bit Coding Violation,
     0 P-bit Err Secs, 0 P-bit Severely Err Secs,
     0 Severely Err Framing Secs, 0 Unavailable Secs,
     0 Line Errored Secs, 0 C-bit Errored Secs, 0 C-bit Severely Errored Secs

   No alarms detected.
```

Example of the show controllers serial Command for a PA-T3 Serial Port Adapter

The following is sample output from the **show controllers serial** command that shows serial port 1/0/0 on a 1-port PA-T3 serial port adapter installed on a VIP2 in chassis slot 1:

```
Router# show controllers serial 2/0/1

Serial1/0/0 -
   Mx T3(1) HW Revision 0x3, FW Revision 2.55
   Framing is c-bit, Clock Source is Line
   Bandwidth limit is 35000, DSU mode 1, Cable length is 50

   Data in current interval (325 seconds elapsed):
     0 Line Code Violations, 0 P-bit Coding Violation
     0 C-bit Coding Violation
     0 P-bit Err Secs, 0 P-bit Sev Err Secs
     0 Sev Err Framing Secs, 0 Unavailable Secs
     0 Line Errored Secs, 0 C-bit Errored Secs, 0 C-bit Sev Err Secs
   Total Data (last 24 hours)
     0 Line Code Violations, 0 P-bit Coding Violation,
     0 C-bit Coding Violation,
     0 P-bit Err Secs, 0 P-bit Sev Err Secs,
     0 Sev Err Framing Secs, 0 Unavailable Secs,
     0 Line Errored Secs, 0 C-bit Errored Secs, 0 C-bit Sev Err Secs
No alarms detected.
```

Example of the show controllers serial Command for a Channelized T3 SPA

The following is sample output from the **show controllers serial** command for a 2 or 4-Port CT3 SPA located in slot 3 of a Cisco 7304 router:

```
Router# show controllers serial
Serial3/1/0 -
   Framing is c-bit, Clock Source is Internal
   Bandwidth limit is 44210, DSU mode 0, Cable length is 10
   rx FEBE since last clear counter 0, since reset 0
   Data in current interval (0 seconds elapsed):
     0 Line Code Violations, 0 P-bit Coding Violation
     0 C-bit Coding Violation
     0 P-bit Err Secs, 0 P-bit Sev Err Secs
     0 Sev Err Framing Secs, 0 Unavailable Secs
     0 Line Errored Secs, 0 C-bit Errored Secs, 0 C-bit Sev Err Secs
     0 Severely Errored Line Secs
     0 Far-End Errored Secs, 0 Far-End Severely Errored Secs
     0 CP-bit Far-end Unavailable Secs
     0 Near-end path failures, 0 Far-end path failures
```

```
      0 Far-end code violations, 0 FERF Defect Secs
      0 AIS Defect Secs, 0 LOS Defect Secs

   Transmitter is sending AIS.

   Receiver has loss of signal.
Serial3/1/3 -
   Framing is c-bit, Clock Source is Line
   Bandwidth limit is 44210, DSU mode 0, Cable length is 10
   rx FEBE since last clear counter 0, since reset 0
   Data in current interval (757 seconds elapsed):
     0 Line Code Violations, 0 P-bit Coding Violation
     0 C-bit Coding Violation
     0 P-bit Err Secs, 0 P-bit Sev Err Secs
     0 Sev Err Framing Secs, 0 Unavailable Secs
     0 Line Errored Secs, 0 C-bit Errored Secs, 0 C-bit Sev Err Secs
     0 Severely Errored Line Secs
     0 Far-End Errored Secs, 0 Far-End Severely Errored Secs
     0 CP-bit Far-end Unavailable Secs
     0 Near-end path failures, 0 Far-end path failures
     0 Far-end code violations, 0 FERF Defect Secs
     0 AIS Defect Secs, 0 LOS Defect Secs

   No alarms detected.
```

Table 19-4 describes the fields shown in the **show controllers serial** output.

Note The fields appearing in the ouput will vary depending on card type, controller configuration, and the status of the controller line.

Table 19-4 show controllers serial Field Descriptions

Field	Description
Serial	Name of the serial controller.
Framing	Framing type.
Clock source	Source of the synchronization signal (clock).
Bandwidth limit	The allowable bandwidth for the controller.
DSU mode	The Data Service Unit (DSU) interoperability mode.
Cable length	The distance to the first repeater.
rx FEBE since last clear counter	Number of received far-end block errors. **Note** Line far-end block error (accumulated from the M0 or M1 byte) is reported when the downstream LTE detects BIP(B2) errors. Path far-end block error (accumulated from the G1 byte) is reported when the downstream PTE detects BIP(B3) errors.
rx FEBE since last reset	Number of received far-end block errors.
Line Code Violations	Number of Bipolar Violation (BPV) errors or Excessive Zeros (EXZ) errors.
P-bit Coding Violations	Number of P-bit errors encountered between source and destination.

Table 19-4 show controllers serial Field Descriptions (continued)

Field	Description
C-bit coding violations	Number of C-bit errors encountered between source and destination.
P-bit Err Secs (PES)	Number of seconds with P-bit errors. **Note** A PES is a second with one or more PCVs or one or more Out of Frame defects or a detected incoming AIS. This gauge is not incremented when UASs are counted.
P-bit Sev Err Secs (PSES)	Number of seconds with P-bit severe errors. **Note** A PSES is a second with 44 or more PCVs or one or more Out of Frame defects or a detected incoming AIS. This gauge is not incremented when UASs are counted.
Sev Err Framing Secs	The number of 1-second intervals in which either a Remote Alarm Indication was received or a Loss Of Frame condition occurred.
Unavailable Secs	The number of 1-second intervals in which the controller was down.
Line Errored Secs	The number of 1-second intervals in which a Line Code Violation occurred.
C-bit Errored Secs (CES)	Number of seconds with C-bit errors. **Note** A CES is a second with one or more CCVs or one or more Out of Frame defects or a detected incoming AIS. This count is only for the SYNTRAN and C-bit Parity DS3 applications. This gauge is not incremented when UASs are counted.
C-bit Sev Err Secs (CSES)	Number of seconds with severe C-bit errors. **Note** A CSES is a second with 44 or more CCVs or one or more Out of Frame defects or a detected incoming AIS. This count is only for the SYNTRAN and C-bit Parity DS3 applications. This gauge is not incremented when UASs are counted.
Severely Errored Line Secs	For ESF signals, this is a second in which one of the following defects is detected: • 320 or more Path Code Violation errors. • One or more Out of Frame defects. • An AIS defect. For E1-CRC signals, this is a second with one of the following errors: • 832 or more Path Code Violation errors. • One or more Out of Frame defects. For E1-nonCRC signals, this is a second with 2048 or more Line Code Violations.

Table 19-4 show controllers serial Field Descriptions (continued)

Field	Description
Far-End Errored Secs	Number of seconds of far-end failures.
Far-End Severely Errored Secs	The number of 1-second intervals in which either a Remote Alarm Indication was received or a Loss Of Frame condition occurred.
P-bit Unavailable Secs	Number of seconds the interface is unavailable because of P-bit errors.
CP-bit Unavailable Secs	Number of seconds the interface is unavailable because of CP-bit errors.
CP-bit Far-end Unavailable Secs	Number of seconds the interface is unavailable because of CP-bit errors from the far-end device.
Near-end path failures	
Far-end path failures	
Far-end code violations	
FERF Defect Secs	Number of far-end receive failures detected per second.
AIS Defect Secs	Number of alarm indication signals per second.
LOS Defect Secs	Number of loss of signal alarms per second.
Path Code Violations	Indicates a frame synchronization bit error in the D4 and E1-no CRC formats, or a CRC error in the Extended Superframe (ESF) and E1-CRC formats.
Slip Secs	Indicates the replication or deletion of the payload bits of a domestic trunk interface (DS1) frame. A slip might happen when there is a difference between the timing of a synchronous receiving terminal and the received signal.
Fr Loss Secs	Indicates the number of seconds an Out of Frame (OOF) error is detected.
Line Err Secs	Line Errored Seconds (LES) is a second in which one or more Line Code Violation errors are detected.
Degraded Mins	A degraded minute is one in which the estimated error rate exceeds 1E-6 but does not exceed 1E-3.
Errored Secs	In ESF and E1-CRC links, an errored second is a second in which one of the following defects is detected: • One or more Path Code Violations. • One or more Controlled Slip events. **Note** For SF and E1 no-CRC links, the presence of Bipolar Violations also triggers an errored second.
Bursty Err Secs	A second with more than one but fewer than 320 Path Coding Violation errors, no Severely Errored Frame defects, and no detected incoming AIS defects. Controlled slips are not included in this parameter.

show diag

To display diagnostic information about the controller, interface processor, and port adapters for a networking device, use the **show diag** command in privileged EXEC mode.

show diag [*slot-number* | **subslot** *slot*/*subslot*] [**details** | **summary**]

Syntax Description

slot-number	(Optional) Slot number of the interface. If a slot number is not specified, diagnostic information for all slots is displayed.
subslot *slot*/*subslot*	(Optional) Specifies the display of diagnostic information about the shared port adapter (SPA), where: • *slot*—Chassis slot number. Refer to the appropriate hardware manual for slot information. For SIPs, refer to the platform-specific SPA hardware installation guide or the corresponding “Identifying Slots and Subslots for SIPs and SPAs” topic in the platform-specific SPA software configuration guide. • *subslot*—Secondary slot number on a SIP where a SPA is installed. Refer to the platform-specific SPA hardware installation guide and the corresponding “Specifying the Interface Address on a SPA” topic in the platform-specific SPA software configuration guide for subslot information.
details	(Optional) Displays more details than the normal **show diag** output.
summary	(Optional) Displays a summary (one line per slot) of the chassis.

Command Modes

Privileged EXEC

Command History

Release	Modification
11.2	This command was introduced.
11.2 GS	This command was implemented on the Cisco 12000 series.
12.0	This command was implemented on the Cisco AS5300.
12.0(7)T	This command was implemented on the Cisco 1750 router.
12.2(8)T	This command was implemented for AIC and WIC cards on the Cisco 2600 series and the Cisco 3600 series.
12.2(13)T	This command was implemented for the AIM-VPN/EPII and AIM-VPN/HPII cards on the following platforms: Cisco 2691, Cisco 3660, Cisco 3725, and Cisco 3745.
12.2(15)ZJ	This command was implemented for the AIM-VPN/BPII card on the following platforms: Cisco 2610XM, Cisco 2611XM, Cisco 2620XM, Cisco 2621XM, Cisco 2650XM, and Cisco 2651XM.
12.3(4)T	Support for the AIM-VPN/BPII card on the Cisco 2600XM series was integrated into Cisco IOS Release 12.3(4)T.
12.0(31)S	This command was modified in Cisco IOS Release 12.0(31)S. The **subslot** keyword is added to support slot/subslot addressing for SIPs and SPAs on the Cisco 12000 series routers.

Usage Guidelines

Use this command to determine the type of hardware installed in your networking device. This command displays information for the EEPROM, motherboard, WAN interface cards (WICs), voice interface cards (VICs), ATM interface cards (AICs), and advanced integration modules (AIMs).

Examples

Example for a 1-Port T3 Serial Port Adapter

The following is sample output from the **show diag** command for a 1-port T3 serial port adapter in chassis slot 1 on a Cisco 7200 series router:

```
Router# show diag 1

Slot 1:
        Physical slot 1, ~physical slot 0xE, logical slot 1, CBus 0
        Microcode Status 0x4
        Master Enable, LED, WCS Loaded
        Board is analyzed
        Pending I/O Status: None
        EEPROM format version 1
        VIP2 controller, HW rev 2.4, board revision D0
        Serial number: 04372053  Part number: 73-1684-03
        Test history: 0x00        RMA number: 00-00-00
        Flags: cisco 7000 board; 7500 compatible

        EEPROM contents (hex):
          0x20: 01 15 02 04 00 42 B6 55 49 06 94 03 00 00 00 00
          0x30: 68 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

        Slot database information:
        Flags: 0x4      Insertion time: 0x14A8 (5d02h ago)

        Controller Memory Size: 16 MBytes DRAM, 1024 KBytes SRAM

        PA Bay 0 Information:
                T3 Serial PA, 1 ports
                EEPROM format version 1
                HW rev FF.FF, Board revision UNKNOWN
                Serial number: 4294967295  Part number: 255-65535-255
```

Examples for a Cisco 12000 Series Internet Router

The following is sample output from the **show diag** command on a Cisco 12000 series Internet router:

```
Router# show diag 3

SLOT 3  (RP/LC 3 ): 4 Port Packet Over SONET OC-3c/STM-1 Multi Mode
  MAIN: type 33,  00-0000-00 rev 70 dev 0
        HW config: 0x01    SW key: 00-00-00
  PCA:  73-2147-02 rev 94 ver 2
        HW version 1.0  S/N 04499695
  MBUS: MBUS Agent (1)  73-2146-05 rev 73 dev 0
        HW version 1.1  S/N 04494882
        Test hist: 0x00    RMA#: 00-00-00    RMA hist: 0x00
  DIAG: Test count: 0x05000001    Test results: 0x00000000
  MBUS Agent Software version 01.27 (RAM) using CAN Bus A
  ROM Monitor version 00.0D
  Fabric Downloader version used 00.0D (ROM version is 00.0D)
  Board is analyzed
  Board State is Line Card Enabled (IOS  RUN )
  Insertion time: 00:00:10 (00:04:51 ago)
  DRAM size: 33554432 bytes
  FrFab SDRAM size: 67108864 bytes
  ToFab SDRAM size: 16777216 bytes
```

The following is sample output from the **show diag** command with the **summary** keyword:

```
Router# show diag summary

SLOT 0  (RP/LC 0 ): Route Processor
SLOT 2  (RP/LC 2 ): 4 Port Packet Over SONET OC-3c/STM-1 Single Mode
SLOT 4  (RP/LC 4 ): 4 Port Packet Over SONET OC-3c/STM-1 Single Mode
SLOT 7  (RP/LC 7 ): 4 Port Packet Over SONET OC-3c/STM-1 Single Mode
SLOT 9  (RP/LC 9 ): 4 Port Packet Over SONET OC-3c/STM-1 Single Mode
SLOT 11 (RP/LC 11): 4 Port Packet Over SONET OC-3c/STM-1 Single Mode
SLOT 16 (CSC 0   ): Clock Scheduler Card
SLOT 17 (CSC 1   ): Clock Scheduler Card
SLOT 18 (SFC 0   ): Switch Fabric Card
SLOT 19 (SFC 1   ): Switch Fabric Card
SLOT 20 (SFC 2   ): Switch Fabric Card
SLOT 24 (PS A1   ): AC Power Supply
SLOT 26 (PS B1   ): AC Power Supply
SLOT 28 (TOP FAN ): Blower Module
SLOT 29 (BOT FAN ): Blower Module
```

The following is sample output from the **show diag** command with the **details** keyword:

```
Router# show diag 4 details

SLOT 4  (RP/LC 4): 4 Port Packet Over SONET OC-3c/STM-1 Single Mode
  MAIN: type 33,  800-2389-01 rev 71 dev 16777215
        HW config: 0x00    SW key: FF-FF-FF
  PCA:  73-2275-03 rev 75 ver 3
        HW version 1.1  S/N 04529465
  MBUS: MBUS Agent (1)  73-2146-06 rev 73 dev 0
        HW version 1.1  S/N 04541395
        Test hist: 0xFF    RMA#: FF-FF-FF    RMA hist: 0xFF
  DIAG: Test count: 0x05000001    Test results: 0x00000000
  EEPROM contents (hex):
  00: 01 00 01 00  49 00 08 62  06 03 00 00  00 FF FF FF
  10: 30 34 35 34  31 33 39 35  FF FF FF FF  FF FF FF FF
  20: 01 01 00 00  00 00 00 FF  FF FF FF FF  FF FF FF FF
  30: A5 FF A5 A5  A5 A5 FF A5  A5 A5 A5 A5  A5 A5 A5 A5
  40: 00 21 01 01  00 49 00 08  E3 03 05 03  00 01 FF FF
  50: 03 20 00 09  55 01 01 FF  FF FF 00 FF  FF FF FF FF
  60: 30 34 35 32  39 34 36 35  FF FF FF FF  FF FF FF FF
  70: FF FF FF FF  FF FF FF FF  05 00 00 01  00 00 00 00
  MBUS Agent Software version 01.24 (RAM)
  Fabric Downloader version 00.0D
  Board is analyzed
  Flags: 0x4
  Board State is Line Card Enabled (IOS  RUN)
  Insertion time: 00:00:10 (00:04:51 ago)
  DRAM size: 33554432 bytes
  FrFab SDRAM size: 67108864 bytes
  ToFab SDRAM size: 16777216 bytes
```

Example for an ATM SAR AIM in a Cisco 3660

The following is sample output from the **show diag** command for one ATM Segmentation and Reassembly (SAR) AIM in a Cisco 3660 router:

```
Router# show diag 0

3660 Chassis type: ENTERPRISE

c3600 Backplane EEPROM:
    Hardware Revision        : 1.0
    Top Assy. Part Number    : 800-04740-02
```

```
.
.
.
ATM AIM: 1
    ATM AIM module with SAR only (no DSPs)
    Hardware Revision        : 1.0
    Top Assy. Part Number    : 800-03700-01
    Board Revision           : A0
    Deviation Number         : 0-0
    Fab Version              : 02
    PCB Serial Number        : JAB9801ABCD
```

Example for an NM-AIC-64 Installed in a Cisco 2611

The following is sample output from the **show diag** command for a Cisco 2611 router with the NM-AIC-64 installed.

```
Router# show diag

Slot 0:
C2611 2E Mainboard Port adapter, 2 ports
Port adapter is analyzed
Port adapter insertion time unknown
EEPROM contents at hardware discovery:
Hardware Revision : 2.3
PCB Serial Number : JAD044808SG (1090473337)
Part Number : 73-2840-13
RMA History : 00
RMA Number : 0-0-0-0
Board Revision : C0
Deviation Number : 0-0
EEPROM format version 4
EEPROM contents (hex):
0x00: 04 FF 40 00 92 41 02 03 C1 18 4A 41 44 30 34 34
0x10: 38 30 38 53 47 20 28 31 30 39 30 34 37 33 33 33
0x20: 37 29 82 49 0B 18 0D 04 00 81 00 00 00 00 42 43
0x30: 30 80 00 00 00 00 FF FF FF FF FF FF FF FF FF FF
0x40: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0x50: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0x60: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0x70: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF

Slot 1:
NM_AIC_64 Port adapter, 3 ports
Port adapter is analyzed
Port adapter insertion time unknown
EEPROM contents at hardware discovery:
Hardware Revision : 1.0
Part Number : 74-1923-01
Board Revision : 02
PCB Serial Number : DAN05060012
EEPROM format version 4
EEPROM contents (hex):
0x00: 04 FF 40 02 55 41 01 00 82 4A 07 83 01 42 30 32
0x10: C1 8B 44 41 4E 30 35 30 36 30 30 31 32 FF FF FF
0x20: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0x30: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0x40: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0x50: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0x60: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0x70: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
```

Table 19-5 describes significant fields shown in the display.

Table 19-5 show diag (AIC) Field Descriptions

Field	Description
C2611 2E Mainboard Port adapter, 2 ports	Line card type; number of ports available.
Port adapter is analyzed	The system has identified the port adapter.
Port adapter insertion time	Elapsed time since insertion.
Hardware Revision	Version number of the port adapter.
PCB Serial Number	Serial number of the printed circuit board.
Part Number	Part number of the port adapter.
RMA History	Counter that indicates how many times the port adapter has been returned and repaired.
RMA Number	Return material authorization number, which is an administrative number assigned if the port adapter needs to be returned for repair.
Board Revision	Revision number (signifying a minor revision) of the port adapter.
Deviation Number	Revision number (signifying a minor deviation) of the port adapter.
EEPROM format version	Version number of the EEPROM format.
EEPROM contents (hex)	Dumps of EEPROM programmed data.

Example for an AIM-VPN in a Cisco 2611XM

The following example shows how to obtain hardware information about an installed AIM-VPN on the Cisco 2611XM router.

```
Router# show diag 0

Encryption AIM 1:
        Hardware Revision        :1.0
        Top Assy. Part Number    :800-03700-01
        Board Revision           :A0
        Deviation Number         :0-0
        Fab Version              :02
        PCB Serial Number        :JAB9801ABCD
        RMA Test History         :00
        RMA Number               :0-0-0-0
        RMA History              :00
        EEPROM format version 4
        EEPROM contents (hex):
          0x00:04 FF 40 03 0B 41 01 00 C0 46 03 20 00 0E 74 01
          0x10:42 41 30 80 00 00 00 00 02 02 C1 8B 4A 41 42 39
          0x20:38 30 31 41 42 43 44 03 00 81 00 00 00 00 04 00
          0x30:FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
          0x40:FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
          0x50:FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
          0x60:FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
          0x70:FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
```

Table 19-6 describes significant fields shown in the display.

Table 19-6 show diag (AIM-VPN) Field Descriptions

Field	Description
Hardware Revision	Version number of the port adapter.
Top Assy. Part Number	Part number of the port adapter.
Board Revision	Revision number (signifying a minor revision) of the port adapter.
Deviation Number	Revision number (signifying a minor deviation) of the port adapter.
PCB Serial Number	Serial number of the printed circuit board.
RMA Number	Return material authorization number, which is an administrative number assigned if the port adapter needs to be returned for repair.
RMA History	Counter that indicates how many times the port adapter has been returned and repaired.
EEPROM format version	Version number of the EEPROM format.
EEPROM contents (hex)	Dumps of EEPROM programmed data.

Examples for a Shared Port Adapter on a Cisco 12000 Series Router

The following is sample output from the **show diag subslot** command for the 1-Port OC-192c/STM-64 POS/RPR XFP SPA in subslot 1 of the SIP located in chassis slot 1 on a Cisco 12000 series router:

```
Router# show diag subslot 1/1
SUBSLOT  1/1 (SPA-OC192POS-XFP): 1-port OC192/STM64 POS/RPR XFP Optics Shared Port Adapter
       Product Identifier (PID) : SPA-OC192POS-XFP
       Version Identifier (VID) : V01
       PCB Serial Number        : PRTA1304061
       Top Assy. Part Number    : 68-2190-01
       Top Assy. Revision       : A0
       Hardware Revision        : 2.0
       CLEI Code                : UNASSIGNED
       Insertion Time           : 00:00:10 (13:14:17 ago)
       Operational Status       : ok
```

Table 19-6 describes the significant fields shown in the display.

Table 19-7 show diag subslot Field Descriptions

Field	Description
Product Identifier (PID)	Product number of the SPA.
Version Identifier (VID)	Version number of the SPA.
PCB Serial Number	Serial number of the printed circuit board.
Top Assy. Part Number	Part number of the SPA.
Top Assy. Revision	Revision number (signifying a minor revision) of the SPA.
Hardware Revision	Revision number (signifying a minor revision) of the SPA hardware.
CLEI Code	Common Language Equipment Identification number.

Table 19-7 show diag subslot Field Descriptions (continued)

Field	Description
Insertion Time	Time when the SPA was installed, and elapsed time between that insertion time and the current time.
Operational Status	Current status of the SPA. For more information about the status field descriptions, refer to the **show hw-module subslot oir** command.

The following is sample output from the **show diag subslot details** command for the 1-Port OC-192c/STM-64 POS/RPR XFP SPA in subslot 1 of the SIP located in chassis slot 1 on a Cisco 12000 series router:

```
Router# show diag subslot 1/1 details
SUBSLOT  1/1 (SPA-OC192POS-XFP): 1-port OC192/STM64 POS/RPR XFP Optics Shared Port Adapter
       EEPROM version           : 4
       Compatible Type          : 0xFF
       Controller Type          : 1100
       Hardware Revision        : 2.0
       Boot Timeout             : 400 msecs
       PCB Serial Number        : PRTA1304061
       PCB Part Number          : 73-8546-01
       PCB Revision             : A0        Fab Version              : 01
       RMA Test History         : 00
       RMA Number               : 0-0-0-0
       RMA History              : 00
       Deviation Number         : 0
       Product Identifier (PID) : SPA-OC192POS-XFP
       Version Identifier (VID) : V01
       Top Assy. Part Number    : 68-2190-01
       Top Assy. Revision       : A0        IDPROM Format Revision   : 36
       System Clock Frequency   : 00 00 00 00 00 00 00 00
                                  00 00 00 00 00 00 00 00
                                  00 00 00 00 00 00
       CLEI Code                : UNASSIGNED
       Base MAC Address         : 00 00 00 00 00 00
       MAC Address block size   : 0
       Manufacturing Test Data  : 00 00 00 00 00 00 00 00
       Field Diagnostics Data   : 00 00 00 00 00 00 00 00
       Calibration Data         : Minimum: 0 dBmV, Maximum: 0 dBmV
             Calibration values :
       Power Consumption        : 11000 mWatts (Maximum)
       Environment Monitor Data : 03 30 04 B0 46 32 07 08
                                  46 32 09 C4 46 32 0C E4
                                  46 32 13 88 46 32 07 08
                                  46 32 EB B0 50 3C 00 00
                                  00 00 00 00 00 00 00 00
                                  00 00 00 00 00 00 00 00
                                  00 00 FE 02 F6 AC
       Processor Label          : 00 00 00 00 00 00 00
       Platform features        : 00 00 00 00 00 00 00 00
                                  00 00 00 00 00 00 00 00
                                  00 00 00 00 00 00 00 00
                                  00 00 00 00 00 00 00
       Asset ID                 :
       Asset Alias              :
       Insertion Time           : 00:00:10 (13:14:24 ago)
       Operational Status       : ok
```

Example for a SPA Interface Processor on a Cisco 12000 Series Router

The following is sample output from the **show diag** command for a SIP located in chassis slot 2 on a Cisco 12000 series router:

```
Router# show diag 2

SLOT 2  (RP/LC 2 ): Modular 10G SPA Interface Card
  MAIN: type 149,  800-26270-01 rev 84
        Deviation: 0
        HW config: 0x00    SW key: 00-00-00
  PCA:  73-9607-01 rev 91 ver 1
        Design Release 1.0  S/N SAD08460678
  MBUS: Embedded Agent
        Test hist: 0x00    RMA#: 00-00-00    RMA hist: 0x00
  DIAG: Test count: 0x00000000    Test results: 0x00000000
  FRU:  Linecard/Module: 12000-SIP-650
  FRU:  Linecard/Module: 12000-SIP-650
        Processor Memory: MEM-LC5-1024=(Non-Replaceable)
        Packet Memory: MEM-LC5-PKT-256=(Non-Replaceable)
  L3 Engine: 5 - ISE OC192 (10 Gbps)
  MBUS Agent Software version 1.114 (RAM) (ROM version is 3.4)
  ROM Monitor version 255.255
  Fabric Downloader version used 3.7 (ROM version is 255.255)
  Primary clock is CSC 1
  Board is analyzed
  Board State is Line Card Enabled (IOS  RUN )
  Insertion time: 1d00h (2d08h ago)
  Processor Memory size: 1073741824 bytes
  TX Packet Memory size: 268435456 bytes, Packet Memory pagesize: 32768 bytes
  RX Packet Memory size: 268435456 bytes, Packet Memory pagesize: 32768 bytes
  0 crashes since restart

  SPA Information:
        subslot 2/0: SPA-OC192POS-XFP (0x44C), status is ok
        subslot 2/1: Empty
        subslot 2/2: Empty
        subslot 2/3: Empty
```

Related Commands

Command	Description
dsl operating-mode (ADSL)	Modifies the operating mode of the digital subscriber line for an ATM interface.
show dsl interface atm	Shows all of the ADSL-specific information for a specified ATM interface.

show hw-module all fpd

To display the current versions of all field-programmable devices (FPDs) for all of the supported card types on a router, enter the **show hw-module all fpd** command in privileged EXEC configuration mode.

show hw-module all fpd

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.2(18)SXE	This command was introduced.
12.0(31)S	This command was integrated into Cisco IOS Release 12.0(31)S.

Usage Guidelines

Other than the FPD version information, the output for this command may also contain useful FPD-related notes.

Examples

This example shows FPD image file versions for all SIPs and SPAs in the Cisco 7600 series router:

```
Router# show hw-module all fpd

==== ====================== ====== =============================================
                             H/W   Field Programmable   Current   Min. Required
Slot Card Type               Ver.  Device: "ID-Name"    Version      Version
==== ====================== ====== ================== =========== ==============
   4 7600-SIP-200            0.132 1-I/O FPGA             0.19        0.18
                                   2-EOS FPGA             0.22        0.22
                                   3-PEGASUS TX FPGA      0.121       0.121
                                   4-PEGASUS RX FPGA      0.13        0.13
                                   5-ROMMON               1.1         1.1
---- ---------------------- ------ ------------------ ----------- --------------
 4/0 SPA-4XOC3-ATM           1.0   1-I/O FPGA             0.121       0.121
---- ---------------------- ------ ------------------ ----------- --------------
 4/1 SPA-8XCHT1/E1           0.117 1-ROMMON               2.12        2.12
                                   2-I/O FPGA             0.22        0.22
---- ---------------------- ------ ------------------ ----------- --------------
 4/3 SPA-4XCT3/DS0           0.253 1-ROMMON               2.12        2.12
                                   2-I/O FPGA             0.21        0.21
                                   3-T3 SUBRATE FPGA      0.15        0.15
==== ====================== ====== =============================================
```

This example shows FPD image file versions that require an upgrade (indicated by the asterisk) for two SIPs in the Cisco 7600 series router. The SIPs are disabled due to the version mismatch:

```
Router# show hw-module all fpd

==== ====================== ====== =============================================
                             H/W   Field Programmable   Current   Min. Required
Slot Card Type               Ver.  Device: "ID-Name"    Version      Version
```

```
==== ===================== ====== ================== =========== ==============
   1 7600-SIP... <DISABLED>  0.550 1-I/O FPGA             1.1         1.1
                                   2-EOS FPGA             1.211       1.211
                                   3-PEGASUS TX FPGA      1.129       1.129
                                   4-PEGASUS RX FPGA      1.3         1.3
                                   5-ROMMON               1.1         1.2     *
---- --------------------- ------ ------------------ ----------- --------------
   4 7600-SIP... <DISABLED>  0.550 1-I/O FPGA             1.1         1.1
                                   2-EOS FPGA             1.211       1.211
                                   3-PEGASUS TX FPGA      1.129       1.129
                                   4-PEGASUS RX FPGA      1.3         1.3
                                   5-ROMMON               1.1         1.2     *
==== ===================== ====== ============================================
 NOTES:
       - FPD images that are required to be upgraded are indicated with a '*'
         character in the "Minimal Required Version" field.
       - The following FPD image package file is required for the upgrade:
         "c7600-fpd-pkg.122-18.SXE.pkg"
```

Related Commands

Command	Description
show hw-module slot fpd	Displays the current versions of all FPDs for a SIP in the specified slot location and for all of the SPAs installed in that SIP.
show hw-module subslot fpd	Displays the current versions of all FPDs for a particular SPA or all of the active SPAs on a router.

show hw-module subslot fpd

To display the current versions of all field-programmable devices (FPDs) for a particular SPA or all of the active SPAs on a router, enter the **show hw-module subslot fpd** command in privileged EXEC configuration mode.

Cisco 7304 Router

show hw-module subslot [*slot*/*subslot*] **fpd**

Cisco 7600 and Cisco 12000 Series Routers

show hw-module subslot {*slot*/*subslot* | **all**} **fpd**

Syntax Description

slot	Chassis slot number. Refer to the platform-specific SPA hardware installation guide and the corresponding “Identifying Slots and Subslots for SIPs and SPAs” topic in the platform-specific SPA software configuration guide.
/*subslot*	Secondary slot number on a SPA interface processor (SIP) where a SPA is installed. Refer to the platform-specific SPA hardware installation guide and the corresponding “Specifying the Interface Address” topic in the platform-specific SPA software configuration guide for subslot information.
all	Specifies display of FPD information for all SPAs in the system. **Note** The **all** keyword is not supported for SPAs on the Cisco 7304 router.

Defaults

For the Cisco 7304 router, if no location is specified, the output for this command will show information for all supported card types on the router.

For the Cisco 7600 and Cisco 12000 series routers, there is no default behavior or values.

Command Modes

Privileged EXEC

Command History

Release	Modification
12.2(20)S2	This command was introduced.
12.2(18)SXE	The **all** keyword was added in Cisco IOS Release 12.2(18)SXE on the Cisco 7600 series routers.
12.0(31)S	This command was integrated into Cisco IOS Release 12.0(31)S and introduced on Cisco 12000 series routers.

Usage Guidelines

Other than the FPD version information, the output for this command may also contain useful FPD-related notes.

Cisco 7304 Router

The **all** keyword is not supported on the Cisco 7304 router. The *slot/subslot* arguments are optional, and if you do not specify them, the command displays FPD information for all supported card types on the router.

Cisco 7600 and 12000 Series Routers

If you do not use the **all** keyword, then you must specify the *slot/subslot* arguments to select the location of a particular card. There is no default behavior for this command on the Cisco 7600 series routers.

Examples

Displaying FPD Information for a Particular SPA Example

This example shows the output when using the *slot/subslot* arguments to identify a particular SPA. This SPA meets the minimum FPD requirements with that particular Cisco IOS Release:

```
Router# show hw-module subslot 4/0 fpd

==== ====================== ====== =============================================
                             H/W   Field Programmable   Current   Min. Required
Slot Card Description        Ver.  Device: "ID-Name"    Version      Version
==== ====================== ====== ================== =========== ==============
4/0 SPA-4XOC3-ATM          1.0   1-I/O FPGA             0.121       0.121
==== ====================== ====== =============================================
```

Displaying FPD Information for all SPAs in the System Example

This example shows FPD image file versions for all SPAs in the system:

```
Router# show hw-module subslot all fpd

==== ====================== ====== =============================================
                             H/W   Field Programmable   Current   Min. Required
Slot Card Type               Ver.  Device: "ID-Name"    Version      Version
==== ====================== ====== ================== =========== ==============
 4/0 SPA-4XOC3-ATM           1.0   1-I/O FPGA             0.121       0.121
---- ---------------------- ------ ------------------ ----------- --------------
 4/1 SPA-8XT1/E1             0.143 1-ROMMON               2.12        2.12
                                   2-I/O FPGA             0.22        0.22
---- ---------------------- ------ ------------------ ----------- --------------
 4/3 SPA-4XOC3-POS           0.100 1-I/O FPGA             3.4         3.4
---- ---------------------- ------ ------------------ ----------- --------------
 7/0 SPA-8XCHT1/E1           0.117 1-ROMMON               2.12        2.12
                                   2-I/O FPGA             0.22        0.22
---- ---------------------- ------ ------------------ ----------- --------------
 7/1 SPA-4XOC3-ATM           0.205 1-I/O FPGA             0.121       0.121
==== ====================== ====== =============================================
```

Displaying Information for all SPAs in the System Example (Cisco 7304 only)

The **all** keyword is not supported on the Cisco 7304 router.

To display all FPD image file versions for all SPAs on a Cisco 7304 router, enter the **show hw-module subslot fpd** command without specifying a slot and subslot. The following example shows all FPD image file versions on a Cisco 7304 router:

```
Router# show hw-module subslot fpd

==== ====================== ====== =============================================
                             H/W   Field Programmable   Current   Min. Required
Slot Card Description        Ver.  Device:"ID-Name"     Version      Version
==== ====================== ====== ================== =========== ==============
 2/0 SPA-4FE-7304            0.32  1-Data & I/O FPGA      4.13        4.13
```

```
---- ---------------------- ------ ------------------ ----------- --------------
 2/1 SPA-2GE-7304            0.15  1-Data & I/O FPGA      4.13        4.13
==== ====================== ====== =============================================
```

Related Commands

Command	Description
show hw-module all fpd	Displays the current versions of all FPDs for all of the supported card types on a router.
show hw-module slot fpd	Displays the current versions of all FPDs for a SIP in the specified slot location on a router, and for all of the SPAs installed in that SIP.

show hw-module subslot oir

To display the operational status of a shared port adapter (SPA), use the **show hw-module subslot oir** command in privileged EXEC configuration mode. The command does not have a **no** form.

show hw-module subslot {*slot*/*subslot* | **all**} **oir** [**internal**]

Syntax Description

slot	Chassis slot number. Refer to the appropriate hardware manual for slot information. For SIPs, refer to the platform-specific SPA hardware installation guide or the corresponding "Identifying Slots and Subslots for SIPs and SPAs" topic in the platform-specific SPA software configuration guide.
/subslot	Secondary slot number on a SPA interface processor (SIP) where a SPA is installed. Refer to the platform-specific SPA hardware installation guide and the corresponding "Specifying the Interface Address on a SPA" topic in the platform-specific SPA software configuration guide for subslot information.
all	Displays OIR status for all supported card types in the system.
internal	(Optional) Displays detailed diagnostic information. This option is intended for internal diagnostic use with Cisco Systems technical support personnel.

Defaults

No default behavior or values

If no location is specified, the output for this command will show information for all SPAs in the router.

Command Modes

Privileged EXEC

Command History

Release	Modification
12.2(25)S3	This command was introduced.
12.2(18)SXE	This command was integrated into Cisco IOS Release 12.2(18)SXE.
12.0(31)S	This command was integrated into Cisco IOS Release 12.0(31)S.

Usage Guidelines

Use the **show hw-module subslot oir** command to obtain operational status information about one or all SPAs. To display information for a specific SPA, specify the slot number of the SIP and the subslot number of the SPA about which you want information. To display information for all SPAs in the router, do not specify the *slot*/*subslot* arguments and use the **all** keyword.

The optional **internal** keyword displays detailed diagnostic information that is recommended only for use with Cisco Systems technical support personnel.

Note The following status descriptions are not applicable to every SPA and can be platform-specific.

Examples

The following example shows the operational status of all of the SPAs installed in a router where two of the SPAs are in an out-of-service condition:

```
Router# show hw-module subslot all oir
Module         Model              Operational Status
-------------- ------------------ -------------------------
subslot 4/0    SPA-4XOC3-POS      booting
subslot 4/1    SPA-4XOC3-ATM      out of service(FPD upgrade failed)
subslot 4/2    SPA-4XOC3-POS      ok
subslot 4/3    SPA-1XTENGE-XFP    out of service(SPA unrecognized)
```

Table 19-8 describes the possible values for the Operational Status field in the output.

Table 19-8 Operational Status Field Descriptions

Operational Status	Description
admin down	SPA is administratively disabled by the **hw-module subslot shutdown** global configuration command.
booting	SPA is initializing.
missing	SPA is not present in the SIP subslot.
ok	SPA is operational.

Table 19-8 Operational Status Field Descriptions (continued)

Operational Status	Description
out of service (*reason*)	The SPA is out of service for one of the following reasons: **Note** The following reasons are not applicable to every SPA and can be platform-specific. • Analyze failed—Failed to create a SPA data structure, most likely due to a memory allocation problem. • Authentication failed—SPA has failed hardware validation. • Data structure create error—Failed to create a SPA data structure, most likely due to a memory allocation problem. • Event corrupt—A SPA online insertion and removal (OIR) event has been corrupted. This could be caused by a corrupted message between the SIP and the route processor (RP) or some other software or hardware problem. • Event sequence error—A SPA OIR event was received out of sequence. This could be caused by a corrupted message between the SIP and the route processor (RP) or some other software or hardware problem. • Fail code not set—Failure code could not be read from a SPA OIR event message. This could be caused by a corrupted message between the SIP and the RP or some other software or hardware problem. • Failed too many times—SPA is disabled because it has failed more than the allowable limit on the platform. • FPD upgrade failed—A field-programmable device, such as the Field-Programmable Gate Array (FPGA), failed to automatically upgrade. • H/W signal deasserted—The SPA_OK or PWR_OK hardware signal indicating that the SPA is accessible are no longer asserted. • Heartbeat failed—Occurs when intelligent SPAs encounter heartbeat failures. • Incompatible FPD—An FPGA version mismatch with the Cisco IOS software has been detected for the SPA.

Table 19-8 Operational Status Field Descriptions (continued)

Operational Status	Description
out of service (*reason*)—CONTINUED	• Init timeout—Time limit has been reached during initialization of a SPA. • Read SPA type failed—A read from the hardware for the SPA type failed. • Reload request—SPA reload is in progress from the **hw-module subslot reload** command. • SPA h/w error—The SPA software driver has detected a hardware error. • SPA ready timeout—A timeout ocurred on the RP while waiting for the SPA to become operational. • SPA type mismatch—Occurs when you have pre-configured a SPA of one type, but have inserted a SPA of a different type. **Note** This reason code only applies to those platforms that support pre-configuration. This is not applicable to a Cisco 12000 Series Router. • SPA unrecognized—SPA is not supported by the Cisco IOS software release. • Start failed—Failed to start interfaces on SPA. • Unexpected inserted event—The SPA OIR software has received a SPA insertion event when the OIR software considered the SPA already present. • Wait h/w ok timeout—A timeout occurred while waiting for the SPA_OK and PWR_OK hardware signals to be asserted. • Wait start timeout—A timeout occurred on the SIP while waiting for permission from the RP to bring up the SPA.
stopped	SPA has been gracefully deactivated using the **hw-module subslot stop** privileged EXEC command on the Cisco 7304 router.

The following example shows the operational status of all of the SPAs installed in a router where all SPAs are running successfully:

```
Router# show hw-module subslot all oir
Module        Model                Operational Status
------------- -------------------- ------------------------
subslot 1/1   SPA-2XOC3-ATM        ok
subslot 4/0   SPA-2XT3/E3          ok
subslot 4/1   SPA-4XOC3-POS        ok
subslot 4/2   SPA-8XCHT1/E1        ok
```

The following example shows sample output when using the optional **internal** keyword:

```
Router# show hw-module subslot 4/0 oir internal
WARNING: This command is not intended for production use
and should only be used under the supervision of
Cisco Systems technical support personnel.
```

```
sm(spa_oir_tsm subslot 4/0 TSM), running yes, state ready
Admin Status: admin enabled,  Operational Status: ok(1)
Last reset Reason: manual
TSM Context:
    configured_spa_type 0x483
    soft remove fail code 0x0(none)
    last_fail_code 0x110E(SPA unrecognized)
    fail_count 0
    timed_fail_count 0, failed_spa_type 0x483
    recovery_action 6
    associated_fail_code 0x110E(SPA unrecognized)
    sequence numbers: next from tsm 4, last to tsm 2
    flags 0x0
Subslot:
    spa type 0x483, active spa type 0x483
    subslot flags 0x0, plugin flags 0x0
TSM Parameters:
    wait_psm_ready_timeout 360000 ms, init_timeout 240000 ms
    short_recovery_delay 5000 ms, long_recovery_delay 120000 ms
    ok_up_time 1200000 ms, bad_fail_count 10
    fail_time_period 600000 ms, max_fail_count 5
    does not support pre-configuration
SPA OIR state machine audit statistics
                In-sync poll-count  qry-fail resp-fail  restarts fail-count
subslot 4/0         yes          1         0         0         0          0
```

Related Commands

Command	Description
hw-module subslot reload	Restarts a SPA and its interfaces.
hw-module subslot shutdown	Shuts down a SPA with or without power.

show interface sdcc

To display configuration information and statistics for a sections data communications channel (SDCC) interface, use the **show interface sdcc** command in privileged EXEC mode. The command does not have a **no** form.

show interface sdcc *slot*/*subslot*/*port*

Syntax Description

slot	Chassis slot number. Refer to the appropriate hardware manual for slot information. For SIPs, refer to the platform-specific SPA hardware installation guide or the corresponding "Identifying Slots and Subslots for SIPs and SPAs" topic in the platform-specific SPA software configuration guide.
/subslot	Secondary slot number on a SPA interface processor (SIP) where a SPA is installed. Refer to the platform-specific SPA hardware installation guide and the corresponding "Specifying the Interface Address on a SPA" topic in the platform-specific SPA software configuration guide for subslot information.
/port	(Optional) Port or interface number. Refer to the appropriate hardware manual for port information. For SPAs, refer to the corresponding "Specifying the Interface Address on a SPA" topics in the platform-specific SPA software configuration guide.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.2(11)BC3	This command was introduced.
12.2(25)S3	This command was integrated into Cisco IOS Release 12.2(25)S3 to support POS SPAs on the Cisco 7304 router.
12.2(18)SXE	This command was integrated into Cisco IOS Release 12.2(18)SXE to support POS SPAs on the Cisco 7600 series routers.
12.0(31)S	This command was integrated into Cisco IOS Release 12.0(31)S to support POS SPAs on the Cisco 12000 series routers.

Examples

Cisco 7600 Series Router Example

The following command displays configuration information and statistics for SDCC interface 7/0/0:

```
Router# show interface sdcc 7/0/0
SDCC7/0/0 is up, line protocol is up
  Hardware is SDCC
  Internet address is 10.11.11.10/8
```

```
MTU 1500 bytes, BW 192 Kbit, DLY 20000 usec,
   reliability 255/255, txload 1/255, rxload 1/255
Encapsulation HDLC, crc 16, loopback not set
Keepalive not set
Last input 00:00:38, output 00:00:38, output hang never
Last clearing of "show interface" counters 00:00:48
Input queue:0/75/0/0 (size/max/drops/flushes); Total output drops:0
Queueing strategy:fifo
Output queue:0/40 (size/max)
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
   5 packets input, 520 bytes, 0 no buffer
   Received 0 broadcasts (0 IP multicast)
   0 runts, 0 giants, 0 throttles
   0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
   5 packets output, 520 bytes, 0 underruns
   0 output errors, 0 collisions, 0 interface resets
   0 output buffer failures, 0 output buffers swapped out
   0 carrier transitions
```

Cisco 12000 Series Router Example

The following is sample output from the **show interface sdcc** command on a Cisco 12000 series router for POS interface 1/1/0 (which is the interface for port 0 of the SPA in subslot 1 of the SIP in chassis slot 1):

```
Router# show interface sdcc 1/1/0
SDCC1/1/0 is administratively down, line protocol is down
  Hardware is SDCC
  MTU 1500 bytes, BW 192 Kbit, DLY 20000 usec, rely 255/255, load 1/255
  Encapsulation HDLC, crc 32, loopback not set
  Keepalive set (10 sec)
  Last input never, output never, output hang never
  Last clearing of "show interface" counters 00:01:55
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     0 packets input, 0 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     0 packets output, 0 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions
```

Table 19-9 describes the significant fields shown in these displays.

Table 19-9 show interface sdcc Field Descriptions

Field	Description
SDCCx/y/z is up, line protocol is up	Indicates whether the interface hardware is currently active and can transmit and receive or whether it has been taken down by an administrator.
Hardware is. . .	Hardware type: • SDCC— Section Data Communications Channel
Internet address is	Internet address and subnet mask.
MTU	Maximum transmission unit of the interface.

Table 19-9 show interface sdcc Field Descriptions (continued)

Field	Description
BW	Bandwidth of the interface, in kilobits per second.
DLY	Delay of the interface, in microseconds.
rely	Reliability of the interface as a fraction of 255 (255/255 is 100 percent reliability), calculated as an exponential average over 5 minutes.
load	Load on the interface as a fraction of 255 (255/255 is completely saturated), calculated as an exponential average over 5 minutes. The calculation uses the value from the **bandwidth** interface configuration command.
Encapsulation	Encapsulation method assigned to interface.
crc	Cyclic redundancy check size (16 or 32 bits).
Loopback	Indicates whether loopback is set.
Keepalive	Indicates whether keepalives are set.
Last input	Number of hours, minutes, and seconds since the last packet was successfully received by an interface and processed locally on the router. Useful for knowing when a dead interface failed. This counter is updated only when packets are process-switched, not when packets are fast-switched.
(Last) output	Number of hours, minutes, and seconds since the last packet was successfully transmitted by an interface. This counter is updated only when packets are process-switched, not when packets are fast-switched.
(Last) output hang	Number of hours, minutes, and seconds (or never) since the interface was last reset because of a transmission that took too long. When the number of hours in any of the "last" fields exceeds 24 hours, the number of days and hours is printed. If that field overflows, asterisks are printed.
Last clearing	Time at which the counters that measure cumulative statistics (such as number of bytes transmitted and received) shown in this report were last reset to zero. Note that variables that might affect routing (for example, load and reliability) are not cleared when the counters are cleared. *** indicates the elapsed time is too large to be displayed. 0:00:00 indicates the counters were cleared more than 22^{31} ms (and less than 2^{32} ms) ago.
Queueing strategy	First-in, first-out (FIFO) queueing strategy (other queueing strategies you might see are priority-list, custom-list, and weighted fair).
Output queue, drops input queue, drops	Number of packets in output and input queues. Each number is followed by a slash, the maximum size of the queue, and the number of packets dropped because a queue was full.
5 minute input rate 5 minute output rate	Average number of bits and packets received or transmitted per second in the last 5 minutes.

Table 19-9 show interface sdcc Field Descriptions (continued)

Field	Description
packets input	Total number of error-free packets received by the system.
bytes (input)	Total number of bytes, including data and MAC encapsulation, in the error-free packets received by the system.
no buffer	Number of received packets discarded because there was no buffer space in the main system. Compare with ignored count. Broadcast storms on Ethernets and bursts of noise on serial lines are often responsible for no input buffer events.
broadcasts	Total number of broadcast or multicast packets received by the interface.
runts	Number of packets that are discarded because they are smaller than the minimum packet size of the medium.
giants	Number of packets that are discarded because they exceed the maximum packet size of the medium.
throttles	Not supported for POS interfaces.
parity	Report of the parity errors on the interface.
input errors	Total number of no buffer, runts, giants, CRCs, frame, overrun, ignored, and abort counts. Other input-related errors can also increment the count, so that this sum might not balance with the other counts.
CRC	Cyclic redundancy checksum generated by the originating LAN station or far-end device does not match the checksum calculated from the data received. On a LAN, this usually indicates noise or transmission problems on the LAN interface or the LAN bus itself. A high number of CRCs is usually the result of collisions or a station transmitting bad data. On a serial link, CRCs usually indicate noise, gain hits or other transmission problems on the data link.
frame	Number of packets received incorrectly having a CRC error and a noninteger number of octets. On a serial line, this is usually the result of noise or other transmission problems.
overrun	Number of times the serial receiver hardware was unable to hand received data to a hardware buffer because the input rate exceeded the receiver's ability to handle the data.
ignored	Number of received packets ignored by the interface because the interface hardware ran low on internal buffers. These buffers are different than the system buffers mentioned previously in the buffer description. Broadcast storms and bursts of noise can cause the ignored count to be incremented.
abort	Illegal sequence of one bits on the interface.
packets output	Total number of messages transmitted by the system.
bytes (output)	Total number of bytes, including data and MAC encapsulation, transmitted by the system.

Table 19-9 show interface sdcc Field Descriptions (continued)

Field	Description
underruns	Number of times that the far-end transmitter has been running faster than the near-end router's receiver can handle.
output errors	Sum of all errors that prevented the final transmission of datagrams out of the interface being examined. Note that this might not balance with the sum of the enumerated output errors, as some datagrams can have more than one error, and others can have errors that do not fall into any of the specifically tabulated categories.
collisions	Not supported for POS interfaces.
interface resets	Number of times an interface has been completely reset. This can happen if packets queued for transmission were not sent within a certain interval. If the system notices that the carrier detect line of an interface is up, but the line protocol is down, it periodically resets the interface in an effort to restart it. Interface resets can also occur when an unrecoverable interface processor error occurred, or when an interface is looped back or shut down.
output buffer failures	Not supported for POS interfaces.
output buffers swapped out	Not supported for POS interfaces.
carrier transitions	Number of times the carrier detect signal of the interface has changed state.

show interfaces gigabitethernet

To display information about the Gigabit Ethernet interfaces, use the **show interfaces gigabitethernet** command in privileged EXEC configuration mode.

show interfaces gigabitethernet *slot/subslot/port*

Syntax Description

slot	Number of the slot where the jacket card that contains the SPA is installed.
subslot	Number of the secondary slot on the jacket card where the SPA that you want to select is installed. For double-height SPAs, the subslot is 0.
port	Number of the interface that you want to select.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
11.1 CC	This command was introduced.
12.1(3a)E	Support for the Cisco 7200-I/O-GE+E controller was introduced.
12.1(5)T	This command was integrated into Cisco IOS Release 12.1(5)T.
12.2(14)S	This command was integrated into Cisco IOS Release 12.2(14)S.
12.2(20)S2	This command was integrated into Cisco IOS Release 12.2(20)S2 and introduced a new address format and output for interfaces on the 2-Port 10/100/1000 Gigabit Ethernet SPA on the Cisco 7304 router.
12.0(31)S	This command was introduced for the Gigabit Ethernet SPAs on the Cisco 12000 series routers. Since SPAs need to be specified using the *subslot* option, the *subslot* option was introduced.

Examples

The following is sample output from the **show interfaces gigabitethernet** command for the first interface (port 0) in a 2-Port 10/100/1000 Gigabit Ethernet SPA located in the top subslot (0) of the MSC that is installed in slot 4 on a Cisco 7304 router:

```
Router# show interfaces gigabitethernet 4/0/0
GigabitEthernet4/0/0 is up, line protocol is down
  Hardware is SPA-2GE-7304, address is 00b0.64ff.5a80 (bia 00b0.64ff.5a80)
  MTU 1500 bytes, BW 1000000 Kbit, DLY 10 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  Half-duplex, 1000Mb/s, link type is auto, media type is RJ45
  output flow-control is unsupported, input flow-control is unsupported
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input never, output 00:00:09, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
```

```
Queueing strategy: fifo
Output queue: 0/40 (size/max)
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
   0 packets input, 0 bytes, 0 no buffer
   Received 0 broadcasts (0 IP multicast)
   0 runts, 0 giants, 0 throttles
   0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
   0 watchdog, 0 multicast, 0 pause input
   109 packets output, 6540 bytes, 0 underruns
   0 output errors, 0 collisions, 2 interface resets
   0 babbles, 0 late collision, 0 deferred
   1 lost carrier, 0 no carrier, 0 PAUSE output
   0 output buffer failures, 0 output buffers swapped out
```

Note There are variations in the output for the **show interfaces** commands on Cisco Systems routers depending on the platform, type of interface, and also other features that you might have configured, such as Quality of Service (QoS). Therefore, some additional output fields might appear in your **show** command output. For more information about these fields, see the **show interfaces** command description in the *Cisco IOS Interface Command Reference,* Release 12.2.

Table 19-10 describes the fields shown in the display.

Table 19-10 show interfaces gigabitethernet Field Descriptions—Gigabit Ethernet SPA

Field	Description
GigabitEthernet...is up ...is administratively down	Indicates whether the interface hardware is currently active and if it has been taken down by an administrator.
line protocol is	Indicates whether the software processes that handle the line protocol consider the line usable or if it has been taken down by an administrator.
Hardware	Hardware type (for example, SPA-2GE-7304) and MAC address.
Description	Alphanumeric string identifying the interface. This only appears if the **description** interface configuration command has been configured on the interface.
Internet address	Internet address followed by subnet mask.
MTU	Maximum transmission unit of the interface. The default is 1500 bytes for the 2-Port 10/100/1000 Gigabit Ethernet SPA.
BW	Bandwidth of the interface in kilobits per second.
DLY	Delay of the interface in microseconds.
reliability	Reliability of the interface as a fraction of 255 (255/255 is 100 percent reliability), calculated as an exponential average over 5 minutes.
txload, rxload	Load on the interface (in the transmit "tx" and receive "rx" directions) as a fraction of 255 (255/255 is completely saturated), calculated as an exponential average over 5 minutes.
Encapsulation	Encapsulation method assigned to the interface.
loopback	Indicates whether or not loopback is set.
Keepalive	Indicates whether or not keepalives are set, and the time interval.
Half-duplex, Full-duplex	Indicates the duplex mode for the interface.

Table 19-10 show interfaces gigabitethernet Field Descriptions—Gigabit Ethernet SPA (continued)

Field	Description
1000Mb/s, 100Mb/s, 10Mb/s	Speed of the interface in megabits per second.
link type	Specifies whether or not autonegotiation is being used on the link.
media type	Interface port media type: RJ45, SX, LX, or ZX.
100BaseTX/FX	Media protocol standard.
ARP type:	Type of Address Resolution Protocol (ARP) assigned and the timeout period.
Last input	Number of hours, minutes, and seconds since the last packet was successfully received by an interface and processed locally on the router. Useful for knowing when a dead interface failed. This field is not updated by fast-switched traffic.
output	Number of hours, minutes, and seconds since the last packet was successfully transmitted by the interface. Useful for knowing when a dead interface failed.
output hang	Number of hours, minutes, and seconds (or never) since the interface was last reset because of a transmission that took too long. When the number of hours in any of the "last" fields exceeds 24 hours, the number of days and hours is displayed. If that field overflows, asterisks are printed. **Note** This field does not apply to SPA interfaces.
Last clearing	Time at which the counters that measure cumulative statistics (such as number of bytes transmitted and received) shown in this report were last reset to zero. Note that variables that might affect routing (for example, load and reliability) are not cleared when the counters are cleared. A series of asterisks (***) indicates the elapsed time is too large to be displayed. 0:00:00 indicates the counters were cleared more than 2^{31} ms (and less than 2^{32} ms) ago.
Input queue (size/max/drops/flushes)	Packet statistics on the input queue reported as: • Size—Number of packets in the input queue. • Max—Maximum size of the queue. • Drops—Number of packets dropped because of a full input queue. • Flushes—Number of packets dropped as part of selective packet discard (SPD). SPD implements a selective packet drop policy on the router's IP process queue. Therefore, it only applies to process-switched traffic.
Total output drops	Total number of packets dropped because of a full output queue.
Queueing strategy	Type of Layer 3 queueing active on this interface. The default is first-in, first-out (FIFO).
Output queue (size/max)	Number of packets in the output queue (size), and the maximum size of the queue (max).

Table 19-10 show interfaces gigabitethernet Field Descriptions—Gigabit Ethernet SPA (continued)

Field	Description
5 minute input rate, 5 minute output rate	Average number of bits and packets transmitted per second in the last 5 minutes. If the interface is not in promiscuous mode, it senses network traffic it sends and receives (rather than all network traffic). The 5-minute input and output rates should be used only as an approximation of traffic per second during a given 5-minute period. These rates are exponentially weighted averages with a time constant of 5 minutes. A period of four time constants must pass before the average will be within two percent of the instantaneous rate of a uniform stream of traffic over that period.
packets input	Total number of error-free packets received by the system.
bytes	Total number of bytes, including data and MAC encapsulation, in the error-free packets received by the system.
Received...broadcasts	Total number of broadcast or multicast packets received by the interface.
runts	Number of packets that are discarded because they are smaller than the minimum packet size of the medium. For instance, any Ethernet packet that is smaller than 64 bytes is considered a runt.
giants	Number of packets that are discarded because they exceed the maximum packet size of the medium. For example, any Ethernet packet that is larger than 1536 bytes is considered a giant. **Note** For the 2-Port 10/100/1000 Gigabit Ethernet SPA, the default is that a giant is any packet greater than 1536 bytes. However, if you modify the maximum transmission unit (MTU) for the interface, this counter increments when you exceed the specified MTU for the interface.
throttles	Number of times the receiver on the port was disabled, possibly because of buffer or processor overload.
input errors	Includes runts, giants, no buffer, CRC, frame, overrun, and ignored counts. Other input-related errors can also cause the input errors count to be increased, and some datagrams may have more than one error; therefore, this sum may not balance with the sum of enumerated input error counts.
CRC	Cyclic redundancy check generated by the originating LAN station or far-end device does not match the checksum calculated from the data received. On a LAN, this usually indicates noise or transmission problems on the LAN interface or the LAN bus itself. A high number of CRCs is usually the result of collisions or a station transmitting bad data.
frame	Number of packets received incorrectly having a CRC error and a noninteger number of octets. On a LAN, this is usually the result of collisions or a malfunctioning Ethernet device.
overrun	Number of times the receiver hardware was unable to hand received data to a hardware buffer because the input rate exceeded the receiver's ability to handle the data.

Table 19-10 show interfaces gigabitethernet Field Descriptions—Gigabit Ethernet SPA (continued)

Field	Description
ignored	Number of received packets ignored by the interface because the interface hardware ran low on internal buffers. These buffers are different than the system buffers. Broadcast storms and bursts of noise can cause the ignored count to be increased.
watchdog	Number of times the watchdog receive timer expired. Expiration happens when receiving a packet with a length greater than 2048 bytes.
input packets with dribble condition detected	Dribble bit error indicates that a frame is slightly too long. This frame error counter is incremented for informational purposes only; the router accepts the frame.
packets output	Total number of messages transmitted by the system.
bytes	Total number of bytes, including data and MAC encapsulation, transmitted by the system.
underruns	Number of times that the transmitter has been running faster than the router can handle.
output errors	Sum of all errors that prevented the final transmission of datagrams out of the interface being examined. Note that this may not balance with the sum of the enumerated output errors, as some datagrams may have more than one error and others may have errors that do not fall into any of the specifically tabulated categories.
collisions	Number of messages retransmitted because of an Ethernet collision. This is usually the result of an overextended LAN (Ethernet or transceiver cable too long, more than two repeaters between stations, or too many cascaded multiport transceivers). A packet that collides is counted only once in output packets.
interface resets	Number of times an interface has been completely reset. This can happen if packets queued for transmission were not sent within several seconds. Interface resets can occur when an interface is looped back or shut down.
babbles	Transmit jabber timer expired.
late collision	Number of late collisions. Late collision happens when a collision occurs after transmitting the preamble.
deferred	Number of times that the interface had to defer while ready to transmit a frame because the carrier was asserted.
lost carrier	Number of times the carrier was lost during transmission.
no carrier	Number of times the carrier was not present during the transmission. **Note** This field does not apply to SPA interfaces.
output buffer failures, output buffers swapped out	These counters are not used by the 2-Port 10/100/1000 Gigabit Ethernet SPA on the Cisco 7304 router.

Related Commands

Command	Description
show interfaces[1]	Displays statistics for the interfaces configured on a router or access server.
show controllers gigabitethernet	Displays Gigabit Ethernet interface information, transmission statistics and errors, and applicable MAC destination address and VLAN filtering tables.

1. Refer to the Cisco IOS Release 12.2 command reference and master index publications.

show interfaces pos

To display configuration information and statistics for a Packet over SONET (POS) interface, use the **show interfaces pos** command in user EXEC or privileged EXEC configuration mode.

Cisco 7000 and Cisco 7500 Series with VIPs

show interfaces pos [*slot***/***port-adapter***/***port*]

POS Shared Port Adapters

show interfaces pos *slot***/***subslot***/***port*[**/***sub_int*]

Syntax Description

slot	Chassis slot number. Refer to the appropriate hardware manual for slot information. For SIPs, refer to the platform-specific SPA hardware installation guide or the corresponding "Identifying Slots and Subslots for SIPs and SPAs" topic in the platform-specific SPA software configuration guide.
/port-adapter	Port adapter number. Refer to the appropriate hardware manual for information about port adapter compatibility.
/subslot	Secondary slot number on a SPA interface processor (SIP) where a SPA is installed. Refer to the platform-specific SPA hardware installation guide and the corresponding "Specifying the Interface Address on a SPA" topic in the platform-specific SPA software configuration guide for subslot information.
/port	Port or interface number. Refer to the appropriate hardware manual for port information. For SPAs, refer to the corresponding "Specifying the Interface Address" topics in the platform-specific SPA software configuration guide.
/sub_int	(Optional) Subinterface number.

Command Modes

User EXEC
Privileged EXEC

Command History

Release	Modification
11.2	The **show interface posi** command was introduced.
11.3	The name of the command was modified from **show interface posi** to **show interfaces pos**, and the sample output was updated.
12.2(25)S3	This command was integrated into Cisco IOS Release 12.2(25)S3 to support SPAs on the Cisco 7304 router. The command was modified to support a new addressing format for SPAs.
12.2(18)SXE	This command was integrated into Cisco IOS Release 12.2(18)SXE to support SPAs on the Cisco 7600 series routers.
12.0(31)S	This command was integrated into Cisco IOS Release 12.0(31)S to support SPAs on the Cisco 12000 series routers.

Examples

Cisco 7513 Example

The following is sample output from the **show interfaces pos** command on a Cisco 7513 router with one Packet OC-3 Interface Processor (POSIP):

```
Router# show interfaces pos 2/0/0

POS2/0/0 is up, line protocol is up
  Hardware is cyBus Packet over Sonet
  Description: PRI-T1 net to zippy (4K) to Pac-Bell
  Internet address is 10.1.1.1/27
  MTU 4470 bytes, BW 1000 Kbit, DLY 40000 usec, rely 255/255, load 1/255
  Encapsulation HDLC, loopback not set, keepalive set (3 sec)
  Last input 00:00:00, output 00:00:00, output hang never
  Last clearing of "show interface" counters 00:23:09
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
  5 minute input rate 0 bits/sec, 1 packets/sec
  5 minute output rate 1000 bits/sec, 1 packets/sec
     1046 packets input, 54437 bytes, 0 no buffer
     Received 485 broadcasts, 0 runts, 0 giants, 0 parity
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     4013 packets output, 1357412 bytes, 0 underruns
     0 output errors, 0 applique, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions
```

Cisco 7600 Series Router POS Shared Port Adapter Example

The following is sample output from the **show interfaces pos** command on a Cisco 7600 series router for POS interface 4/3/0 (which is the interface for port 0 of the SPA in subslot 3 of the SIP in chassis slot 4):

```
Router# show interfaces pos 4/3/0

POS4/3/0 is up, line protocol is up  (APS working - active)
  Hardware is Packet over SONET
  Internet address is 10.0.0.1/8
  MTU 4470 bytes, BW 622000 Kbit, DLY 100 usec, rely 255/255, load 1/255
  Encapsulation HDLC, crc 16, loopback not set
  Keepalive not set
  Scramble disabled
  Last input 00:00:34, output 04:09:06, output hang never
  Last clearing of "show interface" counters never
  Queueing strategy:fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
        Available Bandwidth 622000 kilobits/sec
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     782 packets input, 226563 bytes, 0 no buffer
     Received 0 broadcasts, 1 runts, 0 giants, 0 throttles
              0 parity
     1 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     271 packets output, 28140 bytes, 0 underruns
     0 output errors, 0 applique, 2 interface resets
     0 output buffer failures, 0 output buffers swapped out
     2 carrier transitions
```

Cisco 12000 Series Router POS Shared Port Adapter Example

The following is sample output from the **show interfaces pos** command on a Cisco 12000 series router for POS interface 1/1/0 (which is the interface for port 0 of the SPA in subslot 1 of the SIP in chassis slot 1):

```
Router# show interfaces pos 1/1/0
POS1/1/0 is up, line protocol is up
  Hardware is Packet over SONET
  Internet address is 10.41.41.2/24
  MTU 4470 bytes, BW 9952000 Kbit, DLY 100 usec, rely 255/255, load 1/255
  Encapsulation HDLC, crc 32, loopback not set
  Keepalive not set
  Scramble enabled
  Last input 00:00:59, output 00:00:11, output hang never
  Last clearing of "show interface" counters 00:00:14
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
        Available Bandwidth 9582482 kilobits/sec
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     0 packets input, 0 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
              0 parity
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     1 packets output, 314 bytes, 0 underruns
     0 output errors, 0 applique, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions
```

Table 19-9 describes the significant fields shown in these displays.

Table 19-11 show interfaces pos Field Descriptions

Field	Description
POSx/y/z is up, line protocol is up	Indicates whether the interface hardware is currently active and can transmit and receive or whether it has been taken down by an administrator.
Hardware is. . .	Hardware type: • For POSIP— cyBus Packet over Sonet • For POS SPAs—Packet over SONET
Internet address is	Internet address and subnet mask.
MTU	Maximum transmission unit of the interface.
BW	Bandwidth of the interface, in kilobits per second.
DLY	Delay of the interface, in microseconds.
rely	Reliability of the interface as a fraction of 255 (255/255 is 100 percent reliability), calculated as an exponential average over 5 minutes.
load	Load on the interface as a fraction of 255 (255/255 is completely saturated), calculated as an exponential average over 5 minutes. The calculation uses the value from the **bandwidth** interface configuration command.
Encapsulation	Encapsulation method assigned to interface.
Loopback	Indicates whether loopbacks are set.

Table 19-11 show interfaces pos Field Descriptions (continued)

Field	Description
Keepalive	Indicates whether keepalives are set.
Scramble	Indicates whether or not SONET payload scrambling is enabled. SONET scrambling is disabled by default. For the POS SPAs on the Cisco 12000 series routers, scrambling is enabled by default.
Last input	Number of hours, minutes, and seconds since the last packet was successfully received by an interface and processed locally on the router. Useful for knowing when a dead interface failed. This counter is updated only when packets are process-switched, not when packets are fast-switched.
(Last) output	Number of hours, minutes, and seconds since the last packet was successfully transmitted by an interface. This counter is updated only when packets are process-switched, not when packets are fast-switched.
(Last) output hang	Number of hours, minutes, and seconds (or never) since the interface was last reset because of a transmission that took too long. When the number of hours in any of the "last" fields exceeds 24 hours, the number of days and hours is printed. If that field overflows, asterisks are printed.
Last clearing	Time at which the counters that measure cumulative statistics (such as number of bytes transmitted and received) shown in this report were last reset to zero. Note that variables that might affect routing (for example, load and reliability) are not cleared when the counters are cleared. *** indicates the elapsed time is too large to be displayed. 0:00:00 indicates the counters were cleared more than 22^{31} ms (and less than 2^{32} ms) ago.
Queueing strategy	First-in, first-out (FIFO) queueing strategy (other queueing strategies you might see are priority-list, custom-list, and weighted fair).
Output queue, drops input queue, drops	Number of packets in output and input queues. Each number is followed by a slash, the maximum size of the queue, and the number of packets dropped because a queue was full.
5 minute input rate 5 minute output rate	Average number of bits and packets received or transmitted per second in the last 5 minutes.
packets input	Total number of error-free packets received by the system.
bytes (input)	Total number of bytes, including data and MAC encapsulation, in the error-free packets received by the system.
no buffer	Number of received packets discarded because there was no buffer space in the main system. Compare with ignored count. Broadcast storms on Ethernets and bursts of noise on serial lines are often responsible for no input buffer events.
broadcasts	Total number of broadcast or multicast packets received by the interface.

Table 19-11 show interfaces pos Field Descriptions (continued)

Field	Description
runts	Number of packets that are discarded because they are smaller than the minimum packet size of the medium.
giants	Number of packets that are discarded because they exceed the maximum packet size of the medium.
throttles	Not supported for POS interfaces.
parity	Report of the parity errors on the interface.
input errors	Total number of no buffer, runts, giants, CRCs, frame, overrun, ignored, and abort counts. Other input-related errors can also increment the count, so that this sum might not balance with the other counts.
CRC	Cyclic redundancy checksum generated by the originating LAN station or far-end device does not match the checksum calculated from the data received. On a LAN, this usually indicates noise or transmission problems on the LAN interface or the LAN bus itself. A high number of CRCs is usually the result of collisions or a station transmitting bad data. On a serial link, CRCs usually indicate noise, gain hits or other transmission problems on the data link.
frame	Number of packets received incorrectly having a CRC error and a noninteger number of octets. On a serial line, this is usually the result of noise or other transmission problems.
overrun	Number of times the serial receiver hardware was unable to hand received data to a hardware buffer because the input rate exceeded the receiver's ability to handle the data.
ignored	Number of received packets ignored by the interface because the interface hardware ran low on internal buffers. These buffers are different than the system buffers mentioned previously in the buffer description. Broadcast storms and bursts of noise can cause the ignored count to be incremented.
abort	Illegal sequence of one bits on the interface.
packets output	Total number of messages transmitted by the system.
bytes (output)	Total number of bytes, including data and MAC encapsulation, transmitted by the system.
underruns	Number of times that the far-end transmitter has been running faster than the near-end router's receiver can handle.
output errors	Sum of all errors that prevented the final transmission of datagrams out of the interface being examined. Note that this might not balance with the sum of the enumerated output errors, as some datagrams can have more than one error, and others can have errors that do not fall into any of the specifically tabulated categories.
applique	Indicates an unrecoverable error has occurred on the POSIP applique. The system then invokes an interface reset.

Table 19-11 show interfaces pos Field Descriptions (continued)

Field	Description
interface resets	Number of times an interface has been completely reset. This can happen if packets queued for transmission were not sent within a certain interval. If the system notices that the carrier detect line of an interface is up, but the line protocol is down, it periodically resets the interface in an effort to restart it. Interface resets can also occur when an unrecoverable interface processor error occurred, or when an interface is looped back or shut down.
output buffer failures	Not supported for POS interfaces.
output buffers swapped out	Not supported for POS interfaces.
carrier transitions	Number of times the carrier detect signal of the interface has changed state.

Related Commands

Command	Description
interface	Configures an interface type and enters interface configuration mode.

show interfaces serial

To display information about a serial interface, use the **show interfaces serial** command in privileged EXEC mode. When using Frame Relay encapsulation, use the **show interfaces serial** command in user EXEC or privileged EXEC mode to display information about the multicast data-link connection identifier (DLCI), the DLCIs used on the interface, and the DLCI used for the Local Management Interface (LMI).

Cisco 4000 Series

show interfaces serial [*number*[**:***channel-group*]] [**accounting**]

Cisco 7000 and Cisco 7500 Series with the RSP7000, RSP7000CI, or Ports on VIPs

show interfaces serial [*slot***/***port-adapter***/***port*]

Cisco 7500 Series

show interfaces serial [*slot***/***port*[**:***channel-group*]] [**accounting**]

Cisco 7500 Series with a CT3IP

show interfaces serial [*slot***/***port-adapter***/***port*][**:***t1-channel*] [**accounting** | **crb**]

Cisco AS5350 and Cisco AS5400 Universal Gateways

show interfaces serial *slot***/***port*

Cisco AS5800 Access Servers

show interfaces serial *dial-shelf***/***slot***/***t3-port***:***t1-num***:***chan-group*

T3/E3 Shared Port Adapters and 2-Port and 4-Port Channelized T3 SPA in Unchannelized Mode

show interfaces serial [*slot***/***subslot***/***port*]

Channelized T3 Shared Port Adapters

show interfaces serial [*slot***/***subslot***/***port***/***t1-num***:***channel-group*]

Syntax Description

number	(Optional) Number of the port being displayed.
:*channel-group*	(Optional) On the Cisco 4000 series with a Network Management Processor (NPM) or the Cisco 7500 series routers with a MultiChannel Interface Processor (MIP), specifies the T1 channel-group number in the range of 0 to 23 defined with the **channel-group** controller configuration command. For channelized T3 SPAs, number 0–23 of the DS0 link on the T1 channel.
accounting	(Optional) Displays the number of packets of each protocol type that have been sent through the interface.

slot	(Optional) Chassis slot number. Refer to the appropriate hardware manual for slot information. For SIPs, refer to the platform-specific SPA hardware installation guide or the corresponding “Identifying Slots and Subslots for SIPs and SPAs” topic in the platform-specific SPA software configuration guide.
port	(Optional) Number of the port being displayed. Refer to the appropriate hardware manual for slot and port information.
port-adapter	(Optional) Number of the port adapter being displayed. Refer to the appropriate hardware manual for information about port adapter compatibility.
subslot	Secondary slot number on a SPA interface processor (SIP) where a SPA is installed. Refer to the platform-specific SPA hardware installation guide and the corresponding “Specifying the Interface Address on a SPA” topic in the platform-specific SPA software configuration guide for subslot information.
:*t1-channel*	(Optional) T1 channel number. For the CT3IP, the T1 channel is a number between 1 and 28. T1 channels on the CT3IP are numbered 1 to 28 rather than the more traditional zero-based scheme (0 to 27) used with other Cisco products. This scheme ensures consistency with telco numbering schemes for T1 channels within channelized T3 equipment.
crb	(Optional) Displays interface routing and bridging information.
dial-shelf	Dial-shelf chassis in the Cisco AS5800 access server that contains the CT3 interface card.
slot	Location of the CT3 interface card in the dial shelf chassis.
t3-port	T3 port number. The only valid value is 0.
:*t1-num*	T1 time slot in the T3 line. The value can be from 1 to 28.
:*chan-group*	Channel group identifier.

Defaults

No default behavior or values

Command Modes

User EXEC when Frame Relay encapsulation is used
Privileged EXEC

Command History

Release	Modification
10.0	This command was introduced on the Cisco 4000 series routers.
11.0	This command was implemented on the Cisco 7000 series routers.
11.1CA	This command was modified to include sample output for the PA-2JT2, PA-E3, and PA-T3 serial port adapters.
11.3	This command was modified to include the CT3IP.
12.0(3)T	This command was implemented on the Cisco AS5800 access servers. This command was modified to include support for flow-based WRED.

Release	Modification
12.0(4)T	This command was modified to include enhanced display information for dialer bound interfaces.
12.0(7)T	This command was modified to include dialer as an interface type, and to reflect the default behavior.
12.2(11)T	This command was implemented on the Cisco AS5350 and Cisco AS5400.
12.2(13)T	This command was modified to display information about Frame Relay interface queueing and fragmentation.
12.2S	This command was integrated into Cisco IOS Release 12.2S.
12.2(18)SXE	This command was integrated into Cisco IOS Release 12.2(18)SXE to support SPAs on the Cisco 7600 series routers.
12.0(31)S	This command was integrated into Cisco IOS Release 12.0(31)S.

Usage Guidelines

Frame Relay

Use this command to determine the status of the Frame Relay link. This display also indicates Layer 2 status if switched virtual circuits (SVCs) are configured.

Channel Groups as Virtual Serial Interfaces

To find out about channel groups configured as virtual serial interfaces, to verify that the router has High-Level Data Link Control (HDLC) encapsulation on the interface, and to verify that the interface sees the loopback, use the **show interfaces serial** command in privileged EXEC mode.

Examples

Example of Synchronous Serial Interface

The following is sample output from the **show interfaces serial** command for a synchronous serial interface:

```
Router# show interfaces serial

Serial 0 is up, line protocol is up
   Hardware is MCI Serial
   Internet address is 192.168.10.203, subnet mask is 255.255.255.0
   MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec, rely 255/255, load 1/255
   Encapsulation HDLC, loopback not set, keepalive set (10 sec)
   Last input 0:00:07, output 0:00:00, output hang never
   Output queue 0/40, 0 drops; input queue 0/75, 0 drops
   Five minute input rate 0 bits/sec, 0 packets/sec
   Five minute output rate 0 bits/sec, 0 packets/sec
       16263 packets input, 1347238 bytes, 0 no buffer
       Received 13983 broadcasts, 0 runts, 0 giants
       2 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 2 abort
1 carrier transitions

     22146 packets output, 2383680 bytes, 0 underruns
     0 output errors, 0 collisions, 2 interface resets, 0 restarts
```

Table 19-12 describes significant fields shown in the display.

Table 19-12 show interfaces serial Field Descriptions—Synchronous Serial Interface

Field	Description
Serial ... is {up | down} ... is administratively down	Indicates whether the interface hardware is currently active (whether carrier detect is present), is currently inactive, or has been taken down by an administrator.
line protocol is {up | down}	Indicates whether the software processes that handle the line protocol consider the line usable (that is, whether keepalives are successful) or whether the line has been taken down by an administrator.
Hardware is	Specifies the hardware type.
Internet address is	Specifies the Internet address and subnet mask.
MTU	Maximum transmission unit of the interface.
BW	Indicates the value of the bandwidth parameter that has been configured for the interface (in kbps). If the interface is attached to a serial line with a line speed that does not match the default (1536 or 1544 kbps for T1 and 56 kbps for a standard synchronous serial line), use the **bandwidth** command to specify the correct line speed for this serial line.
DLY	Delay of the interface, in microseconds.
rely	Reliability of the interface as a fraction of 255 (255/255 is 100 percent reliability), calculated as an exponential average over 5 minutes.
load	Load on the interface as a fraction of 255 (255/255 is completely saturated), calculated as an exponential average over 5 minutes.
Encapsulation	Encapsulation method assigned to interface.
loopback	Indicates whether or not loopback is set.
keepalive	Indicates whether or not keepalives are set.
Last input	Number of hours, minutes, and seconds since the last packet was successfully received by an interface and processed locally on the router. Useful for knowing when a dead interface failed. This counter is updated only when packets are process-switched, not when packets are fast-switched.
Last output	Number of hours, minutes, and seconds since the last packet was successfully transmitted by an interface. This counter is updated only when packets are process-switched, not when packets are fast-switched.
output hang	Number of hours, minutes, and seconds (or never) since the interface was last reset because of a transmission that took too long. When the number of hours in any of the "last" fields exceeds 24 hours, the number of days and hours is printed. If that field overflows, asterisks are printed.
Output queue, drops input queue, drops	Number of packets in output and input queues. Each number is followed by a slash, the maximum size of the queue, and the number of packets dropped because of a full queue.

Table 19-12 show interfaces serial Field Descriptions—Synchronous Serial Interface (continued)

Field	Description
5 minute input rate 5 minute output rate	Average number of bits and packets transmitted per second in the last 5 minutes. The 5-minute input and output rates should be used only as an approximation of traffic per second during a given 5-minute period. These rates are exponentially weighted averages with a time constant of 5 minutes. A period of four time constants must pass before the average will be within two percent of the instantaneous rate of a uniform stream of traffic over that period.
packets input	Total number of error-free packets received by the system.
bytes	Total number of bytes, including data and MAC encapsulation, in the error-free packets received by the system.
no buffer	Number of received packets discarded because there was no buffer space in the main system. Compare with ignored count. Broadcast storms on Ethernet networks and bursts of noise on serial lines are often responsible for no input buffer events.
Received... broadcasts	Total number of broadcast or multicast packets received by the interface.
runts	Number of packets that are discarded because they are smaller than the minimum packet size of the medium.
giants	Number of packets that are discarded because they exceed the maximum packet size of the medium.
input errors	Total number of no buffer, runts, giants, CRCs, frame, overrun, ignored, and abort counts. Other input-related errors can also increment the count, so that this sum might not balance with the other counts.
CRC	Cyclic redundancy checksum generated by the originating station or far-end device does not match the checksum calculated from the data received. On a serial link, CRCs usually indicate noise, gain hits, or other transmission problems on the data link.
frame	Number of packets received incorrectly having a CRC error and a noninteger number of octets. On a serial line, this is usually the result of noise or other transmission problems.
overrun	Number of times the serial receiver hardware was unable to hand received data to a hardware buffer because the input rate exceeded the receiver's ability to handle the data.
ignored	Number of received packets ignored by the interface because the interface hardware ran low on internal buffers. Broadcast storms and bursts of noise can cause the ignored count to be increased.
abort	Illegal sequence of one bits on a serial interface. This usually indicates a clocking problem between the serial interface and the data link equipment.
carrier transitions	Number of times the carrier detect signal of a serial interface has changed state. For example, if data carrier detect (DCD) goes down and comes up, the carrier transition counter will increment two times. Indicates modem or line problems if the carrier detect line is changing state often.
packets output	Total number of messages transmitted by the system.

Table 19-12 show interfaces serial Field Descriptions—Synchronous Serial Interface (continued)

Field	Description
bytes output	Total number of bytes, including data and MAC encapsulation, transmitted by the system.
underruns	Number of times that the transmitter has been running faster than the router can handle. This might never be reported on some interfaces.
output errors	Sum of all errors that prevented the final transmission of datagrams out of the interface from being examined. Note that this might not balance with the sum of the enumerated output errors because some datagrams can have more than one error, and others can have errors that do not fall into any of the specifically tabulated categories.
collisions	Number of messages retransmitted because of an Ethernet collision. Some collisions are normal. However, if your collision rate climbs to around 4 or 5 percent, you should consider verifying that there is no faulty equipment on the segment and/or moving some existing stations to a new segment. A packet that collides is counted only once in output packets.
interface resets	Number of times an interface has been completely reset. This can happen if packets queued for transmission were not sent within several seconds' time. On a serial line, this can be caused by a malfunctioning modem that is not supplying the transmit clock signal or by a cable problem. If the system notices that the carrier detect line of a serial interface is up, but the line protocol is down, it periodically resets the interface in an effort to restart it. Interface resets can also occur when an interface is looped back or shut down.
restarts	Number of times the controller was restarted because of errors.
alarm indications, remote alarms, rx LOF, rx LOS	Number of CSU/DSU alarms and number of occurrences of receive loss of frame and receive loss of signal.
BER inactive, NELR inactive, FELR inactive	Status of G.703-E1 counters for bit -error rate (BER) alarm, near-end loop remote (NELR), and far-end loop remote (FELR). Note that you cannot set the NELR or FELR.

Example of PA-2JT2 Serial Interface

The following is sample output from the **show interfaces serial** command for a PA-2JT2 serial interface:

```
Router# show interfaces serial 3/0/0

Serial3/0/0 is up, line protocol is up
  Hardware is cyBus Serial
  Internet address is 10.0.0.1/8
  MTU 1500 bytes, BW 6312 Kbit, DLY 20000 usec, rely 255/255, load 26/255
  Encapsulation HDLC, loopback not set, keepalive not set
  Last input 00:04:31, output 00:04:31, output hang never
  Last clearing of "show interface" counters 00:06:07
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
  5 minute input rate 162000 bits/sec, 8 packets/sec
  5 minute output rate 162000 bits/sec, 8 packets/sec
     20005 packets input, 20080520 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     20005 packets output, 20080520 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
```

```
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions
     0 cv errors, 0 crc5 errors, 0 frame errors
     rxLOS inactive, rxLOF inactive, rxPAIS inactive
     rxAIS inactive, rxRAI inactive, rxHBER inactive
```

Table 19-13 describes significant fields shown in the display that are different from the fields described in Table 19-12.

Table 19-13 show interfaces serial Field Descriptions—PA-2JT2 Serial Interface

Field	Description
Last clearing of “show interface” counters	Time the counters were last cleared.
Queueing strategy	First-in, first-out queueing strategy (other queueing strategies that you might see are priority-list, custom-list, and weighted fair).
output buffer failures	Number of “no resource” errors received on the output.
output buffers swapped out	Number of packets swapped to DRAM.
carrier transitions	Number of times the carrier detect signal of a serial interface has changed state. For example, if data carrier detect (DCD) goes down and comes up, the carrier transition counter will increment two times. Indicates modem or line problems if the carrier detect line is changing state often.
cv errors	B8ZS/B6ZS (zero suppression) coding violation counter.
crc5 errors	CRC-5 error counter.
frame errors	Framing error counter.
rxLOS	Receive loss of signal alarm. Values are active or inactive.
rxLOF	Receive loss of frame alarm. Values are active or inactive.
rxPAIS	Receive loss of payload alarm indication signal (AIS). Values are active or inactive.
rxAIS	Receive loss of physical AIS. Values are active or inactive.
rxRAI	Receive remote AIS. Values are active or inactive.
rxHBER	Receive high bit-error rate alarm. Values are active or inactive.

Example of PA-E3 Serial Port Adapter

The following is sample output from the **show interfaces serial** command for a PA-E3 serial port adapter installed in chassis slot 2:

```
Router# show interfaces serial 2/0

Serial2/0 is up, line protocol is up
  Hardware is M1T-E3 pa
  Internet address is 172.17.1.1/24
  MTU 4470 bytes, BW 34010 Kbit, DLY 200 usec, rely 128/255, load 1/255
  Encapsulation HDLC, loopback not set, keepalive not set
  Last input 1w0d, output 00:00:48, output hang never
  Last clearing of "show interface" counters 1w0d
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
```

```
     20 packets input, 2080 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 parity
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     11472 packets output, 3824748 bytes, 0 underruns
     0 output errors, 0 applique, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions
   rxLOS inactive, rxLOF inactive, rxAIS inactive
   txAIS inactive, rxRAI inactive, txRAI inactive
```

Table 19-14 describes significant fields shown in the display that are different from the fields described in Table 19-12 on page 19-89.

Table 19-14 show interfaces serial Field Descriptions—PA-E3

Field	Description
Last clearing of "show interface" counters	Time the counters were last cleared.
Queueing strategy	First-in, first-out queueing strategy (other queueing strategies that you might see are priority-list, custom-list, and weighted fair).
parity	Number of the parity errors on the interface.
applique	Indicates that an unrecoverable error has occurred on the E3 applique. The router then invokes an interface reset.
output buffer failures	Number of "no resource" errors received on the output.
output buffers swapped out	Number of packets swapped to DRAM.
rxLOS, rxLOF, rxAIS	Receive loss of signal, loss of frame, and alarm indication signal status. Values are inactive or active.
txAIS, rxRAI, txRAI	Transmit alarm indication signal, receive remote alarm indicator, and transmit remote alarm indicator status. Values are inactive or active. When the router receives an LOS, LOF, or AIS, the txRAI is active. When the remote router receives an LOS, LOF, or AIS, the rxRAI is active.

Example of 1-Port PA-T3 Serial Port Adapter Installed in a VIP2

The following is sample output from the **show interfaces serial** command for a 1-port PA-T3 serial port adapter installed in a VIP2 in chassis slot 1, in port adapter slot 0:

```
Router# show interfaces serial 1/0/0

Serial1/0/0 is up, line protocol is up
  Hardware is cyBus PODS3 Serial
  Internet address is 172.18.1.1/24
  MTU 4470 bytes, BW 44736 Kbit, DLY 200 usec, rely 255/255, load 1/255
  Encapsulation HDLC, loopback not set, keepalive set (10 sec)
  Last input 00:00:05, output 00:00:02, output hang never
  Last clearing of "show interface" counters 5d02h
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 27269 drops
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     79039 packets input, 14195344 bytes, 0 no buffer
     Received 84506 broadcasts, 0 runts, 0 giants
              0 parity
     9574 input errors, 6714 CRC, 0 frame, 1 overrun, 0 ignored, 2859 abort
     62472 packets output, 13751644 bytes, 0 underruns
```

```
     0 output errors, 0 applique, 10 interface resets
     0 output buffer failures, 0 output buffers swapped out
     16 carrier transitions
   rxLOS inactive, rxLOF inactive, rxAIS inactive
   txAIS inactive, rxRAI inactive, txRAI inactive
```

Table 19-15 describes significant fields shown in the display that are different from the fields described in Table 19-12 on page 19-89.

Table 19-15 show interfaces serial Field Descriptions—PA-T3

Field	Description
Last clearing of "show interface" counters	Time the counters were last cleared.
Queueing strategy	First-in, first-out queueing strategy (other queueing strategies that you might see are priority-list, custom-list, and weighted fair).
parity	Number of the parity errors on the interface.
applique	Indicates that an unrecoverable error has occurred on the T3 applique. The router then invokes an interface reset.
output buffer failures	Number of "no resource" errors received on the output.
output buffers swapped out	Number of packets swapped to DRAM.
rxLOS, rxLOF, rxAIS	Receive loss of signal, loss of frame, and alarm indication signal status. Values are inactive or active.
txAIS, rxRAI, txRAI	Transmit alarm indication signal, receive remote alarm indicator, and transmit remote alarm indicator status. Values are inactive or active. When the router receives an LOS, LOF, or AIS, the txRAI is active. When the remote router receives an LOS, LOF, or AIS, the rxRAI is active.

Example of CT3IP Serial Interface

The following is sample output from the **show interfaces serial** command for the CT3IP serial interface:

```
Router# show interfaces serial 3/0/0:25

Serial3/0/0:25 is up, line protocol is up
  Hardware is cyBus T3
  Internet address is 10.25.25.2/24
  MTU 1500 bytes, BW 1536 Kbit, DLY 20000 usec, rely 255/255, load 12/255
  Encapsulation HDLC, loopback not set, keepalive not set
  Last input 00:19:01, output 00:11:49, output hang never
  Last clearing of "show interface" counters 00:19:39
  Input queue: 0/75/0 (size/max/drops); Total output drops: 0
  Queueing strategy: weighted fair
  Output queue: 0/64/0 (size/threshold/drops)
     Conversations 0/1 (active/max active)
     Reserved Conversations 0/0 (allocated/max allocated)
  5 minute input rate 69000 bits/sec, 90 packets/sec
  5 minute output rate 71000 bits/sec, 90 packets/sec
     762350 packets input, 79284400 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants
     150 input errors, 0 CRC, 0 frame, 150 overrun, 0 ignored, 0 abort
     763213 packets output, 80900472 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions no alarm present
```

```
  Timeslot(s) Used:1-24, Transmitter delay is 0 flags, transmit queue length 5
  non-inverted data
```

Table 19-16 describes significant fields relevant to the CT3IP shown in the display that are different from the fields described in Table 19-12 on page 19-89.

Table 19-16 show interfaces serial Field Descriptions—CT3IP

Field	Description
Timeslot(s) Used	Number of time slots assigned to the T1 channel.
Transmitter delay	Number of idle flags inserted between each HDLC frame.
transmit queue length	Number of packets allowed in the transmit queue.
non-inverted data	Indicates whether or not the interface is configured for inverted data.

Example of an HDLC Synchronous Serial Interface on a Cisco 7500 Series Router

The following is sample output from the **show interfaces serial** command for an HDLC synchronous serial interface on a Cisco 7500 series router:

```
Router# show interfaces serial 1/0

Serial1/0 is up, line protocol is up
  Hardware is cxBus Serial
  Internet address is 172.19.190.203, subnet mask is 255.255.255.0
  MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec, rely 255/255, load 1/255
  Encapsulation HDLC, loopback not set, keepalive set (10 sec)
  Last input 0:00:07, output 0:00:00, output hang never
  Last clearing of "show interface" counters 2w4d
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
  Five minute input rate 0 bits/sec, 0 packets/sec
  Five minute output rate 0 bits/sec, 0 packets/sec
     16263 packets input, 1347238 bytes, 0 no buffer
     Received 13983 broadcasts, 0 runts, 0 giants
     2 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 2 abort
     22146 packets output, 2383680 bytes, 0 underruns
     0 output errors, 0 collisions, 2 interface resets, 0 restarts
     1 carrier transitions
```

Table 19-12 on page 19-89 describes significant fields shown in the display.

Example of HDLC Encapsulation

The following example displays High-Level Data Link Control (HDLC) encapsulation on serial interface 0:

```
Router# show interfaces serial 0

Serial0 is up, line protocol is up (looped)
Hardware is HD64570
Internet address is 10.1.1.1, subnet mask is 255.255.255.0
MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec, rely 255/255, load 1/255
Encapsulation HDLC, loopback set, keepalive set (10 sec)
```

Table 19-12 on page 19-89 describes significant fields shown in the display.

Example of a G.703 Interface with Framing

The following is sample output from the **show interfaces serial** command for a G.703 interface on which framing is enabled:

```
Router# show interfaces serial 2/3

Serial2/3 is up, line protocol is up
  Hardware is cxBus Serial
  Internet address is 10.4.4.1, subnet mask is 255.255.255.0
  MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec, rely 255/255, load 1/255
  Encapsulation HDLC, loopback not set, keepalive not set
  Last input 0:00:21, output 0:00:21, output hang never
  Last clearing of "show interface" counters never
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
  Five minute input rate 0 bits/sec, 0 packets/sec
  Five minute output rate 0 bits/sec, 0 packets/sec
     53 packets input, 7810 bytes, 0 no buffer
     Received 53 broadcasts, 0 runts, 0 giants
     2 input errors, 2 CRC, 0 frame, 0 overrun, 0 ignored, 2 abort
     56 packets output, 8218 bytes, 0 underruns
     0 output errors, 0 collisions, 2 interface resets, 0 restarts
     1 carrier transitions
```

```
  2 alarm indications, 333 remote alarms, 332 rx LOF, 0 rx LOS
  RTS up, CTS up, DTR up, DCD up, DSR up
  BER inactive, NELR inactive, FELR inactive
```

Table 19-12 on page 19-89 describes significant fields shown in the display.

Example with Frame Relay Encapsulation

When using Frame Relay encapsulation, use the **show interfaces serial** command to display information on the multicast data-link connection identifier (DLCI), the DLCI of the interface, and the DLCI used for the Local Management Interface (LMI).

The multicast DLCI and the local DLCI can be set using the **frame-relay multicast-dlci** and **frame-relay local-dlci** configuration commands. The status information is taken from the LMI, when active.

The following is sample output from the **show interfaces serial** command when Frame Relay encapsulation and LMI are enabled:

```
Router# show interfaces serial

Serial 2 is up, line protocol is up
   Hardware type is MCI Serial
   Internet address is 172.20.122.1, subnet mask is 255.255.255.0
   MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec, rely 255/255, load 1/255
   Encapsulation FRAME-RELAY, loopback not set, keepalive set (10 sec)
   multicast DLCI 1022, status defined, active
   source DLCI    20, status defined, active
   LMI DLCI 1023, LMI sent 10, LMI stat recvd 10, LMI upd recvd 2
   Last input 7:21:29, output 0:00:37, output hang never
   Output queue 0/100, 0 drops; input queue 0/75, 0 drops
   Five minute input rate 0 bits/sec, 0 packets/sec
   Five minute output rate 0 bits/sec, 0 packets/sec
       47 packets input, 2656 bytes, 0 no buffer
       Received 5 broadcasts, 0 runts, 0 giants
       5 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 57 abort
       518 packets output, 391205 bytes
       0 output errors, 0 collisions, 0 interface resets, 0 restarts
       1 carrier transitions
```

In this display, the multicast DLCI has been changed to 1022 using the **frame-relay multicast-dlci** interface configuration command.

The display shows the statistics for the LMI as the number of status inquiry messages sent (LMI sent), the number of status messages received (LMI recvd), and the number of status updates received (upd recvd). Refer to the *Frame Relay Interface* specification for additional explanations of this output.

Example with Frame Relay Queueing and Fragmentation at the Interface

The following is sample output from the **show interfaces serial** command when low-latency queueing and FRF.12 end-to-end fragmentation are configured on a Frame Relay interface:

```
Router# show interfaces serial 3/2

Serial3/2 is up, line protocol is up
  Hardware is M4T
  MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation FRAME-RELAY, crc 16, loopback not set
  Keepalive set (10 sec)
  LMI enq sent  0, LMI stat recvd 0, LMI upd recvd 0, DTE LMI up
  LMI enq recvd 0, LMI stat sent  0, LMI upd sent  0
  LMI DLCI 1023  LMI type is CISCO  frame relay DTE
```

```
Fragmentation type: end-to-end, size 80, PQ interleaves 0
Broadcast queue 0/64, broadcasts sent/dropped 0/0, interface broadcasts 0
Last input 2d15h, output 2d15h, output hang never
Last clearing of "show interface" counters 00:01:31
Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
Queueing strategy: weighted fair
Output queue: 0/1000/64/0 (size/max total/threshold/drops)
   Conversations  0/0/256 (active/max active/max total)
   Reserved Conversations 0/0 (allocated/max allocated)
   Available Bandwidth 1094 kilobits/sec
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
   0 packets input, 0 bytes, 0 no buffer
   Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
   0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
   0 packets output, 0 bytes, 0 underruns
   0 output errors, 0 collisions, 1 interface resets
   0 output buffer failures, 0 output buffers swapped out
   1 carrier transitions     DCD=up  DSR=up  DTR=up  RTS=up  CTS=up
```

Table 19-17 describes significant fields shown in the display that are different from the fields described in Table 19-12 on page 19-89.

Table 19-17 show interfaces serial Field Descriptions—Frame Relay Interface Queueing and Fragmentation

Field	Description
txload	Interface load in the transmit direction.
rxload	Interface load in the receive direction.
crc	Number of Layer 1 checksum errors during reception.
LMI enq sent	Number of Frame Relay status inquiry messages sent.
LMI stat recvd	Number of Frame Relay status request messages received.
LMI upd recvd	Number of single PVC asynchronous status messages received.
DTE LMI up	LMI peers are synchronized.
LMI enq recvd	Number of Frame Relay status inquiry messages received.
LMI stat sent	Number of Frame Relay status request messages sent.
LMI upd sent	Number of single PVC asynchronous status messages sent.
Fragmentation type	Type of fragmentation: end-to-end, Cisco, or VoFR
size	Fragmentation size.
PQ interleaves	Number of priority queue frames that have interleaved data fragments.
Broadcast queue	Number on queue/queue depth.
broadcasts sent/dropped	Number of broadcasts sent and dropped.
interface broadcasts	Number of broadcasts sent on interface.
Input queue	size—Current size of the input queue. max—Maximum size of the queue. drops—Number of messages discarded. flushes—Number of times that data on queue has been discarded.
Queueing strategy	Type of queueing configured on the interface.

Table 19-17 show interfaces serial Field Descriptions—Frame Relay Interface Queueing and Fragmentation (continued)

Field	Description
Output queue	size—Current size of the output queue. max total—Maximum number of frames that can be queued. threshold—Congestive-discard threshold. Number of messages in the queue after which new messages for high-bandwidth conversations are dropped. drops—Number of dropped messages.
Conversations	active—Number of currently active conversations. max active—Maximum number of conversations that have ever occurred at one time. max total—Maximum number of active conversations allowed.
throttles	Number of times the receiver on the port was disabled, possibly because of processor or buffer overload.
output buffer failures	Number of "no resource" errors received on the output.
output buffers swapped out	Number of packets swapped to DRAM.

Example with ANSI LMI

For a serial interface with the ANSI Local Management Interface (LMI) enabled, use the **show interfaces serial** command to determine the LMI type implemented. The following is sample output from the **show interfaces serial** command for a serial interface with the ANSI LMI enabled:

```
Router# show interfaces serial

Serial 1 is up, line protocol is up
   Hardware is MCI Serial
   Internet address is 172.18.121.1, subnet mask is 255.255.255.0
   MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec, rely 255/255, load 1/255
   Encapsulation FRAME-RELAY, loopback not set, keepalive set
   LMI DLCI    0, LMI sent 10, LMI stat recvd 10
   LMI type is ANSI Annex D
   Last input 0:00:00, output 0:00:00, output hang never
   Output queue 0/40, 0 drops; input queue 0/75, 0 drops


   Five minute input rate 0 bits/sec, 1 packets/sec
   Five minute output rate 1000 bits/sec, 1 packets/sec
       261 packets input, 13212 bytes, 0 no buffer
       Received 33 broadcasts, 0 runts, 0 giants
       0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
       238 packets output, 14751 bytes, 0 underruns
       0 output errors, 0 collisions, 0 interface resets, 0 restarts
```

Notice that the **show interfaces serial** output for a serial interface with ANSI LMI shown in this display is very similar to that for encapsulation set to Frame Relay, as shown in the previous display. Table 19-18 describes the few differences that exist.

Table 19-18 show interfaces serial Field Descriptions—ANSI LMI

Field	Description
LMI DLCI	Identifies the DLCI used by the LMI for this interface. The default is 1023.
LMI sent	Number of LMI packets that the router sent.
LMI type is ANSI Annex D	Indicates that the interface is configured for the ANSI-adopted Frame Relay specification T1.617 Annex D.

Example with LAPB Encapsulation

Use the **show interfaces serial** command to display operation statistics for an interface that uses Link Access Procedure, Balanced (LAPB) encapsulation. The following is partial sample output from the **show interfaces serial** command for a serial interface that uses LAPB encapsulation:

```
Router# show interfaces serial 1

LAPB state is SABMSENT, T1 3000, N1 12056, N2 20, k7,Protocol ip
VS 0, VR 0, RCNT 0, Remote VR 0, Retransmissions 2
IFRAMEs 0/0 RNRs 0/0 REJs 0/0 SABMs 3/0 FRMRs 0/0 DISCs 0/0
```

Table 19-19 shows the fields relevant to all LAPB connections.

Table 19-19 show interfaces serial Field Descriptions—LAPB

Field	Description
LAPB state is	State of the LAPB protocol.
T1 3000, N1 12056, ...	Current parameter settings.
Protocol	Protocol encapsulated on a LAPB link; this field is not present on interfaces configured for multiprotocol LAPB or X.25 encapsulations.
VS	Modulo 8 frame number of the next outgoing information frame.
VR	Modulo 8 frame number of the next information frame expected to be received.
RCNT	Number of received information frames that have not yet been acknowledged.
Remote VR	Number of the next information frame that the remote device expects to receive.
Retransmissions	Count of current retransmissions because of expiration of T1.
Window is closed	No more frames can be transmitted until some outstanding frames have been acknowledged. This message should be displayed only temporarily.
IFRAMEs	Count of information frames in the form of sent/received.
RNRs	Count of Receiver Not Ready frames in the form of sent/received.
REJs	Count of Reject frames in the form of sent/received.
SABMs	Count of Set Asynchronous Balanced Mode commands in the form of sent/received.
FRMRs	Count of Frame Reject frames in the form of sent/received.
DISCs	Count of Disconnect commands in the form of sent/received.

Example with PPP Encapsulation

The output for an interface configured for synchronous PPP encapsulation differs from the standard **show interfaces serial** output. An interface configured for PPP might include the following information:

```
Router# show interfaces serial 1

lcp state = OPEN
ncp ipcp state = OPEN   ncp osicp state = NOT NEGOTIATED
ncp ipxcp state = NOT NEGOTIATED   ncp deccp state = NOT NEGOTIATED
ncp bridgecp state = NOT NEGOTIATED   ncp atalkcp state = NOT NEGOTIATED
```

Table 19-20 show the fields relevant to PPP connections.

Table 19-20 show interfaces serial Field Descriptions—PPP Encapsulation

Field	Description
lcp state	Link Control Protocol.
ncp ipcp state	Network Control Protocol Internet Protocol Control Protocol.
ncp osicp state	Network Control Protocol OSI (CLNS) Control Protocol.
ncp ipxcp state	Network Control Protocol IPX (Novell) Control Protocol.
ncp deccp state	Network Control Protocol DECnet Control Protocol.
ncp bridgecp state	Network Control Protocol Bridging Control Protocol.
ncp atalkcp state	Network Control Protocol AppleTalk Control Protocol.

Example with SDLC Connections

Use the **show interfaces serial** command to display the Synchronous Data Link Control (SDLC) information for a given SDLC interface. The following is sample output from the **show interfaces serial** command for an SDLC primary interface that supports the SDLLC function:

```
Router# show interfaces serial

Serial 0 is up, line protocol is up
Hardware is MCI Serial
MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec, rely 255/255, load 1/255
Encapsulation SDLC-PRIMARY, loopback not set
    Timers (msec): poll pause 100 fair poll 500. Poll limit 1
    [T1 3000, N1 12016, N2 20, K 7] timer: 56608 Last polled device: none
    SDLLC [ma: 0000.0C01.14--, ring: 7 bridge: 1, target ring: 10
             largest token ring frame 2052]
SDLC addr C1 state is CONNECT
     VS 6, VR 3, RCNT 0, Remote VR 6, Current retransmit count 0
     Hold queue: 0/12 IFRAMEs 77/22 RNRs 0/0 SNRMs 1/0 DISCs 0/0
     Poll: clear, Poll count: 0, chain: p: C1 n: C1
     SDLLC [largest SDLC frame: 265, XID: disabled]
 Last input 00:00:02, output 00:00:01, output hang never
 Output queue 0/40, 0 drops; input queue 0/75, 0 drops
 Five minute input rate 517 bits/sec, 30 packets/sec
 Five minute output rate 672 bits/sec, 20 packets/sec
     357 packets input, 28382 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     926 packets output, 77274 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets, 0 restarts
     2 carrier transitions
```

Table 19-21 shows the fields relevant to all SDLC connections.

Table 19-21 show interfaces serial Field Descriptions—SDLC Enabled

Field	Description
Timers (msec): poll pause, fair poll, Poll limit	Current values of these timers for the primary SDLC interface.
T1, N1, N2, K	Values for these parameters for the primary SDLC interface.

Table 19-22 shows other data given for each SDLC secondary interface configured to be attached to the serial interface.

Table 19-22 SDLC Secondary Interface Descriptions

Field	Description
addr	Address of this SDLC secondary interface.
state is	Current state of this connection, which is one of the following: • DISCONNECT—No communication is being attempted to this secondary. • CONNECT—A normal connect state exists between this router and this secondary. • DISCSENT—This router has sent a disconnect request to this secondary and is awaiting its response. • SNRMSENT—This router has sent a connect request (SNRM) to this secondary and is awaiting its response. • THEMBUSY—This secondary has told this router that it is temporarily unable to receive any more information frames. • USBUSY—This router has told this secondary that it is temporarily unable to receive any more information frames. • BOTHBUSY—Both sides have told each other that they are temporarily unable to receive any more information frames. • ERROR—This router has detected an error and is waiting for a response from the secondary acknowledging this.
VS	Sequence number of the next information frame that this station sends.
VR	Sequence number of the next information frame from this secondary that this station expects to receive.
Remote VR	Last frame transmitted by this station that has been acknowledged by the other station.
Current retransmit count:	Number of times the current I-frame or sequence of I-frames has been retransmitted.
Hold queue	Number of frames in hold queue and maximum size of hold queue.
IFRAMEs, RNRs, SNRMs, DISCs	Sent/received count for these frames.

Table 19-22 SDLC Secondary Interface Descriptions (continued)

Field	Description
Poll	"Set" if this router has a poll outstanding to the secondary; "clear" if it does not.
Poll count	Number of polls in a row that have been given to this secondary at this time.
chain	Shows the previous (p) and next (n) secondary address on this interface in the *round robin loop* of polled devices.

Example with SDLLC

Use the **show interfaces serial** command to display the SDLLC statistics for SDLLC-configured interfaces. The following is sample output from the **show interfaces serial** command for a serial interface configured for SDLLC:

```
Router# show interfaces serial

Serial 0 is up, line protocol is up
   Hardware is MCI Serial
   MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec, rely 255/255, load 1/255
   Encapsulation SDLC-PRIMARY, loopback not set
       Timers (msec): poll pause 100 fair poll 500. Poll limit 1
       [T1 3000, N1 12016, N2 20, K 7] timer: 56608 Last polled device: none
       SDLLC [ma: 0000.0C01.14--, ring: 7 bridge: 1, target ring: 10
             largest token ring frame 2052]
   SDLC addr C1 state is CONNECT
       VS 6, VR 3, RCNT 0, Remote VR 6, Current retransmit count 0
       Hold queue: 0/12 IFRAMEs 77/22 RNRs 0/0 SNRMs 1/0 DISCs 0/0
       Poll: clear, Poll count: 0, chain: p: C1 n: C1
       SDLLC [largest SDLC frame: 265, XID: disabled]
   Last input 00:00:02, output 00:00:01, output hang never
   Output queue 0/40, 0 drops; input queue 0/75, 0 drops
   Five minute input rate 517 bits/sec, 30 packets/sec
   Five minute output rate 672 bits/sec, 20 packets/sec
       357 packets input, 28382 bytes, 0 no buffer
       Received 0 broadcasts, 0 runts, 0 giants
       0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
       926 packets output, 77274 bytes, 0 underruns
       0 output errors, 0 collisions, 0 interface resets, 0 restarts
       6608 Last polled device: none
       SDLLC [ma: 0000.0C01.14--, ring: 7 brid2 carrier transitions
```

Most of the output shown in the display is generic to all SDLLC-encapsulated interfaces and is described in the *Cisco IOS Bridging and IBM Networking Command Reference*, Volume 2 of 2: IBM Networking. Table 19-23 shows the parameters specific to SDLLC.

Table 19-23 SDLLC Parameter Descriptions

Field	Description
SDLLC ma	Lists the MAC address configured for this interface. The last byte is shown as "--" to indicate that it is filled in with the SDLC address of the connection.
ring, bridge, target ring	Lists the parameters as configured by the **sdllc traddr** command.
largest token ring frame	Shows the largest Token Ring frame that is accepted on the Logical Link control, type 2 (LLC2) side of the connection.

Table 19-23 SDLLC Parameter Descriptions (continued)

Field	Description
largest SDLC frame	Shows the largest SDLC frame that is accepted and will be generated on the SDLC side of the connection.
XID	Enabled or disabled: Shows whether XID processing is enabled on the SDLC side of the connection. If enabled, it will show the XID value for this address.

Example with X.25

The following is partial sample output from the **show interfaces serial** command for a serial X.25 interface:

```
Router# show interfaces serial 1

X25 address 000000010100, state R1, modulo 8, idle 0, timer 0, nvc 1
  Window size: input 2, output 2, Packet size: input 128, output 128
  Timers: T20 180, T21 200, T22 180, T23 180, TH 0
  Channels: Incoming-only none, Two-way 1-1024, Outgoing-only none
(configuration on RESTART: modulo 8,
  Window size: input 2 output 2, Packet size: input 128, output 128
  Channels: Incoming-only none, Two-way 5-1024, Outgoing-only none)
  RESTARTs 3/2 CALLs 1000+2/1294+190/0+0/ DIAGs 0/0
```

The stability of the X.25 protocol requires that some parameters not be changed without a restart of the protocol. Any change to these parameters is held until a restart is sent or received. If any of these parameters changes, information about the router configuration at restart will be displayed as well as the values that are currently in effect.

Table 19-24 describes significant fields shown in the display.

Table 19-24 show interfaces serial Field Descriptions—X.25 Enabled

Field	Description
X25 address	Address used to originate and accept calls.
state	State of the interface. Possible values follow: • R1 is the normal ready state. • R2 is the DTE restarting state. • R3 is the DCE restarting state. If the state is R2 or R3, the interface is awaiting acknowledgment of a Restart packet.
modulo	Modulo value; determines the packet sequence numbering scheme used.
idle	Number of minutes for which the Cisco IOS software waits before closing idle virtual circuits that it originated or accepted.
timer	Value of the interface timer, which is zero unless the interface state is R2 or R3.
nvc	Default maximum number of simultaneous virtual circuits permitted to and from a single host for a particular protocol.

Table 19-24 show interfaces serial Field Descriptions—X.25 Enabled (continued)

Field	Description
Window size: input, output	Default window sizes (in packets) for the interface. The **x25 facility** interface configuration command can be used to override these default values for the switched virtual circuits originated by the router.
Packet size: input, output	Default maximum packet sizes (in bytes) for the interface. The **x25 facility** interface configuration command can be used to override these default values for the switched virtual circuits originated by the router.
Timers:	Values of the X.25 timers: • T10 through T13 for a DCE device • T20 through T23 for a DTE device
TH	Packet acknowledgment threshold (in packets). This value determines how many packets are received before an explicit acknowledgment is sent. The default value (0) sends an explicit acknowledgment only when the incoming window is full.
Channels: Incoming-only, Two-way, Outgoing-only	Displays the virtual circuit ranges for this interface.
RESTARTs	Shows Restart packet statistics for the interface using the format Sent/Received.
CALLs	Successful calls sent + failed calls/calls received + calls failed/calls forwarded + calls failed. Calls forwarded are counted as calls sent.
DIAGs	Diagnostic messages sent and received.

Example with Accounting Option

The following example illustrates the **show interfaces serial** command with the **accounting** option on a Cisco 7500 series routers:

```
Router# show interfaces serial 1/0 accounting

Serial1/0
       Protocol    Pkts In   Chars In   Pkts Out  Chars Out
             IP       7344    4787842       1803    1535774
      Appletalk      33345    4797459      12781    1089695
        DEC MOP          0          0        127       9779
            ARP          7        420         39       2340
```

Table 19-25 describes the fields shown in the display.

Table 19-25 show interfaces serial Field Descriptions—Accounting

Field	Description
Protocol	Protocol that is operating on the interface.
Pkts In	Number of packets received for that protocol.
Chars In	Number of characters received for that protocol.
Pkts Out	Number of packets transmitted for that protocol.
Chars Out	Number of characters transmitted for that protocol.

Example with Cisco AS5800 Access Server

The following example shows the activity that occurred on the serial interface in shelf 1, slot 4, port 0 for time slot 2 in group 23:

```
Router# show interfaces serial 1/4/0:2:23

Serial1/4/0:2:23 is up, line protocol is up (spoofing)
 Hardware is DS-T1
 MTU 1500 bytes, BW 64 Kbit, DLY 20000 usec, rely 255/255, load 1/255
 Encapsulation HDLC, loopback not set
 Last input 00:00:01, output 00:00:01, output hang never
 Last clearing of "show interface" counters 22:24:30
 Queueing strategy: fifo
 Output queue 0/40, 0 drops; input queue 0/75, 0 drops
 5 minute input rate 0 bits/sec, 0 packets/sec

 5 minute output rate 0 bits/sec, 0 packets/sec
     5274 packets input, 20122 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     5274 packets output, 30836 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
     2 carrier transitions no alarm present
 Timeslot(s) Used:24, subrate: 64Kb/s, transmit delay is 0 flags
```

Table 19-26 describes the significant fields shown in the display that are different from the fields described in Table 19-12 on page 19-89.

Table 19-26 show interfaces serial Field Descriptions—Cisco AS5800

Field	Description
Last clearing of "show interface" counters	Time at which the counters that measure cumulative statistics (such as number of bytes transmitted and received) were last reset to zero.
Queueing strategy	Displays the type of queueing configured for this interface. In the example output, the type of queueing configured is FIFO.
throttles	Number of times that the receiver on the port was disabled, possibly because of buffer or processor overload.
output buffer failures	Number of times that the output buffer has failed.
output buffer swapped out	Number of times that the output buffer has been swapped out.
Timeslot(s) Used	Number of time slots assigned to the T1 channel.

Table 19-26 show interfaces serial Field Descriptions—Cisco AS5800 (continued)

Field	Description
subrate	Bandwidth of each time slot.
transmit delay is ...	Number of idle flags inserted between each frame.

Example with a T3/E3 Shared Port Adapter

The following example shows the interface statistics on the first port of a T3/E3 SPA installed in subslot 0 of the SIP located in chassis slot 5.

```
Router# show interfaces serial

Serial5/0/0 is up, line protocol is up
  Hardware is SPA-4T3E3
  Internet address is 110.1.1.2/24
  MTU 4470 bytes, BW 44210 Kbit, DLY 200 usec,
     reliability 255/255, txload 234/255, rxload 234/255
  Encapsulation HDLC, crc 16, loopback not set
  Keepalive set (10 sec)
  Last input 00:00:05, output 00:00:00, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 40685000 bits/sec, 115624 packets/sec
  5 minute output rate 40685000 bits/sec, 115627 packets/sec
     4653081241 packets input, 204735493724 bytes, 0 no buffer
     Received 4044 broadcasts (0 IP multicast)
     0 runts, 0 giants, 0 throttles
              0 parity
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     4652915555 packets output, 204728203520 bytes, 0 underruns
     0 output errors, 0 applique, 4 interface resets
     0 output buffer failures, 0 output buffers swapped out
     2 carrier transitions
     rxLOS inactive, rxLOF inactive, rxAIS inactive
     txAIS inactive, rxRAI inactive, txRAI inactive
```

Table 19-27 describes the fields shown in the **show interfaces serial** output.

Note The fields appearing in the ouput will vary depending on card type, interface configuration, and the status of the interface.

Table 19-27 T3/E3 SPA—Command Field Descriptions

Field	Description
Serial	Name of the serial interface.
line protocol is	If the line protocol is up, the local router has received keepalive packets from the remote router. If the line protocol is down, the local router has not received keepalive packets form the remote router.
Hardware is	Designates the specific hardware type of the interface.
Internet address is	The IP address of the interface.

Table 19-27 T3/E3 SPA—Command Field Descriptions (continued)

Field	Description
MTU	The maximum packet size set for the interface.
BW	Bandwidth in kilobits per second.
DLY	Interface delay in microseconds.
reliability	Reliability of the interface as a fraction of 255 (255/255 is 100 percent reliability), calculated as an exponential average over 5 minutes.
txload	Transmit load on the interface as a fraction of 255 (255/255 is completely saturated), calculated as an exponential average over 5 minutes.
rxload	Receive load on the interface as a fraction of 255 (255/255 is completely saturated), calculated as an exponential average over 5 minutes.
encapsulation	Encapsulation method.
crc	CRC size in bits.
loopback	Indicates whether loopback is set or not.
keepalive	Indicates whether keepalives are set or not.
Last input	Number of hours, minutes, and seconds since the last packet was successfully received by an interface and processed locally on the router. Useful for knowing when a dead interface failed. This counter is updated only when packets are process switched, not when packets are fast switched.
Last ouput	Number of hours, minutes, and seconds since the last packet was successfully transmitted by an interface. Useful for knowing when a dead interface failed. This counter is updated only when packets are process-switched, not when packets are fast-switched.
output hang	Number of hours, minutes, and seconds (or never) since the interface was last reset because of a transmission that took too long. When the number of hours in any of the “last” fields exceeds 24 hours, the number of days and hours is printed. If that field overflows, asterisks are printed.
Last clearing of show interface	Time at which the counters that measure cumulative statistics (such as number of bytes transmitted and received) shown in this report were last reset to zero. Note that variables that might affect routing (for example, load and reliability) are not cleared when the counters are cleared. *** indicates the elapsed time is too large to be displayed. 0:00:00 indicates the counters were cleared more than 231 ms (and less than 232 ms) ago.

Table 19-27 T3/E3 SPA—Command Field Descriptions (continued)

Field	Description
Input queue	*size*—Current size of the input queue. *max*—Maximum size of the input queue. *drops*—Packets dropped because the queue was full. *flushes*—Number of times that data on queue has been discarded.
Total output drops	Total number of dropped packets.
Queueing strategy	First-in, first-out queueing strategy (other queueing strategies you might see are priority-list, custom-list, and weighted fair).
Output queue	*size*—Current size of the output queue. *max*—Maximum size of the ouput queue.
5-minute input rate	Average number of bits and packets received per second in the last 5 minutes. If the interface is not in promiscuous mode, it senses network traffic it sends and receives (rather than all network traffic). The 5-minute input and output rates should be used only as an approximation of traffic per second during a given 5-minute period. These rates are exponentially weighted averages with a time constant of 5 minutes. A period of four time constants must pass before the average will be within two percent of the instantaneous rate of a uniform stream of traffic over that period.
5-minute output rate	Average number of bits and packets transmitted per second in the last 5 minutes. If the interface is not in promiscuous mode, it senses network traffic it sends and receives (rather than all network traffic). The 5-minute input and output rates should be used only as an approximation of traffic per second during a given 5-minute period. These rates are exponentially weighted averages with a time constant of 5 minutes. A period of four time constants must pass before the average will be within two percent of the instantaneous rate of a uniform stream of traffic over that period.
rxLOS	Receive loss of signal status. Values are inactive or active.
rxLOF	Receive loss of frame status. Values are inactive or active.
rxAIS	Receive alarm indication signal status. Values are inactive or active.
txAIS	Transmit alarm indication signal status. Values are inactive or active.
rxRAI	Receive remote alarm indication signal status. Values are inactive or active.
txRAI	Transmit remote alarm indication signal status. Values are inactive or active.

Related Commands

Command	Description
show controllers serial	Displays controller statistics.

show upgrade fpd file

To display the contents of an FPD image package file, enter the **show upgrade fpd file** command in privileged EXEC configuration mode.

show upgrade fpd file *file-url* [**detail**]

Syntax Description

file-url	Specifies the location of the FPD image package file, beginning with the location or type of storage device (examples include disk0, slot0, tftp, or ftp) and followed by the path to the FPD image.
detail	(Optional) Displays detailed information about the contents of the FPD image package file. This option is intended for use by customer support personnel only.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.2(20)S6	This command was introduced and replaced the **show upgrade file** command on the Cisco 7304 router.
12.2(25)S3	The output of the **show upgrade fpd file** *file-url* command was changed to only display brief versioning information. The output generated from this command in previous Cisco IOS releases can still be generated in this release by entering the **show upgrade fpd** *file-url* **detail** command. The **detail** option is also new in this release.
12.2(18)SXE	This command was integrated into Cisco IOSRelease 12.2(18)SXE.
12.0(31)S	This command was integrated into Cisco IOS Release 12.0(31)S.

Usage Guidelines

This command provides information related to the FPD image package file. Most of the information in this command is useful for customer support purposes only.

Examples

The output in the following example shows the show upgrade file command on a Cisco 7600 series router:

```
Router# show upgrade fpd file
tftp://mytftpserver/myname/myfpdpkg/c7600-fpd-pkg.122-18.SXE.pkg
Loading myname/myfpdpkg/c7600-fpd-pkg.122-18.SXE.pkg from 124.0.0.0 (via FastEthernet0):
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
[OK]
Cisco Field Programmable Device Image Package for IOS
```

```
C7600 Family FPD Image Package (c7600-fpd-pkg.122-18.SXE.pkg), Version 12.2(SXE)
Copyright (c) 2004-2005 by cisco Systems, Inc.
Built Fri 25-Mar-2005 09:12 by integ


=============================== ================================================
                                        Bundled FPD Image Version Matrix
                                ================================================
                                                                      Min. Req.
Supported Card Types            ID  Image Name                Version  H/W Ver.
=============================== == ======================== ========= =========
2-port T3/E3 Serial SPA          1 T3E3 SPA ROMMON             2.12      0.0
                                 2 T3E3 SPA I/O FPGA           0.24      0.0
                                 3 T3E3 SPA E3 FPGA            0.6       0.0
                                 4 T3E3 SPA T3 FPGA            0.14      0.0
------------------------------- -- ------------------------ --------- ---------
4-port T3/E3 Serial SPA          1 T3E3 SPA ROMMON             2.12      0.0
                                 2 T3E3 SPA I/O FPGA           0.24      0.0
                                 3 T3E3 SPA E3 FPGA            0.6       0.0
                                 4 T3E3 SPA T3 FPGA            0.14      0.0
------------------------------- -- ------------------------ --------- ---------
8-port Channelized T1/E1 SPA     1 CTE1 SPA ROMMON             2.12      0.140
                                 1 CTE1 SPA ROMMON NP          2.12      0.0
                                 2 CTE1 SPA I/O FPGA           1.2       0.0
------------------------------- -- ------------------------ --------- ---------
2-port Channelized T3 SPA        1 CT3 SPA ROMMON              2.12      0.100
                                 2 CT3 SPA I/O FPGA            1.1       0.100
                                 3 CT3 SPA T3 FPGA R1          0.11      0.100
                                 3 CT3 SPA T3 FPGA R2          0.15      0.200
------------------------------- -- ------------------------ --------- ---------
4-port Channelized T3 SPA        1 CT3 SPA ROMMON              2.12      0.100
                                 2 CT3 SPA I/O FPGA            1.1       0.100
                                 3 CT3 SPA T3 FPGA R1          0.11      0.100
                                 3 CT3 SPA T3 FPGA R2          0.15      0.200
------------------------------- -- ------------------------ --------- ---------
2-port OC3 POS SPA               1 POS SPA IOFPGA P1           3.4       0.0
                                 1 POS SPA IOFPGA P2           3.4       0.200
------------------------------- -- ------------------------ --------- ---------
4-port OC3 POS SPA               1 POS SPA IOFPGA P1           3.4       0.0
                                 1 POS SPA IOFPGA P2           3.4       0.200
------------------------------- -- ------------------------ --------- ---------
1-port OC12 POS SPA              1 POS SPA IOFPGA P1           3.4       0.0
                                 1 POS SPA IOFPGA P2           3.4       0.200
------------------------------- -- ------------------------ --------- ---------
2-port OC3 ATM SPA               1 KATM SPA IOFPGA             1.24      0.0
------------------------------- -- ------------------------ --------- ---------
4-port OC3 ATM SPA               1 KATM SPA IOFPGA             1.24      0.0
------------------------------- -- ------------------------ --------- ---------
1-port OC12 ATM SPA              1 KATM SPA IOFPGA             1.24      0.0
------------------------------- -- ------------------------ --------- ---------
SIP-200                          1 SIP-200 I/O FPGA P1         1.1       0.100
                                 1 SIP-200 I/O FPGA P4         1.1       0.400
                                 1 SIP-200 I/O FPGA P6         1.1       0.600
                                 2 SIP-200 EOS FPGA P1         0.27      0.100
                                 2 SIP-200 EOS FPGA P450       1.211     0.450
                                 2 SIP-200 EOS FPGA P5         0.27      0.500
                                 2 SIP-200 EOS FPGA P550       1.211     0.550
                                 2 SIP-200 EOS FPGA P6         1.211     0.600
                                 3 SIP-200 PEG TX FPGA P1      1.129     0.100
                                 3 SIP-200 PEG TX FPGA P6      1.129     0.600
                                 4 SIP-200 PEG RX FPGA P1      1.3       0.100
                                 4 SIP-200 PEG RX FPGA P4      1.3       0.400
                                 4 SIP-200 PEG RX FPGA P6      1.3       0.600
                                 5 SIP-200 ROMMON              1.2       0.100
```

```
------------------------------ -- ------------------------ --------- ---------
SIP-400                         1 SIP-400 ROMMON             1.1       0.1
                                2 SIP-400 I/O FPGA           0.82      0.1
                                3 SIP-400 SWITCH FPGA        0.25      0.1
------------------------------ -- ------------------------ --------- ---------
CWPA2                           1 CWPA2 I/O FPGA P1          0.37      0.1
                                2 CWPA2 EOS FPGA P1          0.28      0.1
                                3 CWPA2 ROMMON               1.1       0.1
============================== ==============================================
```

Related Commands

Command	Description
upgrade hw-module subslot	Manually upgrades the current FPD image on the specified SPA.
upgrade fpd auto	Configures the router to automatically upgrade the FPD image when an FPD version incompatability is detected.
upgrade fpd path	Specifies the location from where the FPD image package should be loaded when an automatic FPD upgrade is initiated by the router.
show hw-module slot fpd	Displays the current versions of FPD image files for all of the active SIPs on a router.
show hw-module subslot fpd	Displays the FPD version on each SPA in the router.
show upgrade fpd package default	Displays which FPD image package is needed for the router to properly support the SPAs.
show upgrade fpd progress	Displays the progress of the FPD upgrade while an FPD upgrade is taking place.
show upgrade fpd table	Displays various information used by the Cisco IOS software to manage the FPD image package file.

show upgrade fpd package default

To display which FPD image package is needed for the router to properly support the SPAs for the running Cisco IOS software release, enter the **show upgrade fpd package default** command in privileged EXEC configuration mode.

show upgrade fpd package default

Syntax Description

This command has no arguments or keywords.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.2(20)S6	This command was introduced and replaced the **show upgrade package default** command on the Cisco 7304 router.
12.2(18)SXE	This command was integrated into Cisco IOS Release 12.2(18)SXE.
12.0(31)S	This command was integrated into Cisco IOS Release 12.0(31)S.

Usage Guidelines

It is important to note that the output from this command is generated from the Cisco IOS image and provides information regarding the default FPD image package file that is needed for your particular Cisco IOS release. This command also lists the SPAs supported by the default FPD image package file for the running Cisco IOS image.

Examples

In the following example, the original form of the **show upgrade package default** command output shows that the spa_fpd.122-20-S3.pkg FPD image package file is required if you install the SPA-4FE-7304 or the SPA-2GE-7304 on this particular router with this particular Cisco IOS release:

```
Router# show upgrade package default

*************************************************************************
This IOS release supports the following default FPD Image Package(s) for
automatic upgrade:
*************************************************************************

SPA FPD Image Package:spa_fpd.122-20.S3.pkg

        List of SPAs supported in this package:

                                   Minimal
                No. SPA Name           HW Ver.
                ---- ------------------ -------
                  1) SPA-4FE-7304         0.0
                  2) SPA-2GE-7304         0.0
                ---- ------------------ -------
```

Related Commands

Command	Description
upgrade hw-module subslot	Manually upgrades the current FPD image on the specified SPA.
upgrade fpd auto	Configures the router to automatically upgrade the FPD image when an FPD version incompatability is detected.
upgrade fpd path	Specifies the location from where the FPD image package should be loaded when an automatic FPD upgrade is initiated by the router.
show hw-module slot fpd	Displays the current versions of FPD image files for all of the active SIPs on a router.
show hw-module subslot fpd	Displays the FPD version on each SPA in the router.
show upgrade fpd file	Displays the contents of an FPD image package file.
show upgrade fpd progress	Displays the progress of the FPD upgrade while an FPD upgrade is taking place.
show upgrade fpd table	Displays various information used by the Cisco IOS software to manage the FPD image package file.

show upgrade fpd progress

To view the progress of an FPD upgrade while an FPD upgrade is taking place, enter the **show upgrade fpd progress** command in privileged EXEC configuration mode.

show upgrade fpd progress

Syntax Description

This command has no arguments or keywords.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.2(20)S6	This command was introduced and replaced the **show upgrade progress** command on the Cisco 7304 router.
12.2(18)SXE	This command was integrated into Cisco IOS Release 12.2(18)SXE.
12.0(31)S	This command was integrated into Cisco IOS Release 12.0(31)S.

Examples

The following example shows the status of FPD updates on the SPAs located in subslots 0 and 1:

```
Router# show upgrade fpd progress

FPD Image Upgrade Progress Table:

 ==== =================== ====================================================
                          Field Programmable    Time
 Slot Card Description    Device :"ID-Name"    Needed   Time Left  State
 ==== =================== ================== ========== ========== ===========
  2/0 SPA-2GE-7304        1-4FE/2GE FPGA      00:06:00   00:05:17  Updating...
 ---- ------------------- ------------------ ----------- --------- -----------
  2/1 SPA-4FE-7304        1-4FE/2GE FPGA      --:--:--   --:--:--  Waiting...
 ==== =================== ====================================================
```

Related Commands

Command	Description
upgrade hw-module subslot	Manually upgrades the current FPD image on the specified SPA.
upgrade fpd auto	Configures the router to automatically upgrade the FPD image when an FPD version incompatability is detected.
upgrade fpd path	Specifies the location from where the FPD image package should be loaded when an automatic FPD upgrade is initiated by the router.
show hw-module slot fpd	Displays the current versions of FPD image files for all of the active SIPs on a router.
show hw-module subslot fpd	Displays the FPD version on each SPA in the router.

Command	Description
show upgrade fpd file	Displays the contents of an FPD image package file.
show upgrade fpd package default	Displays which FPD image package is needed for the router to properly support the SPAs.
show upgrade fpd table	Displays various information used by the Cisco IOS software to manage the FPD image package file.

show upgrade fpd table

To view various information used by the Cisco IOS software to manage the FPD image package file, enter the **show upgrade fpd table** command in privileged EXEC configuration mode.

show upgrade fpd table

Syntax Description

This command has no arguments or keywords.

Defaults

No default behavior or values

Command Modes

Privileged EXEC

Command History

Release	Modification
12.2(20)S6	This command was introduced and replaced the **show upgrade table** command on the Cisco 7304 router.
12.2(18)SXE	This command was integrated into Cisco IOS Release 12.2(18)SXE.
12.0(31)S	This command was integrated into Cisco IOS Release 12.0(31)S.

Usage Guidelines

This command provides version information used by the Cisco IOS image to manage the FPD image package file and to locate the correct FPD image within the FPD image package file to perform an FPD upgrade. Most of the information provided by this command is useful for customer support purposes.

Examples

The following example displays various FPD information for Cisco IOS Release 12.2(20)S5:

```
Router# show upgrade fpd table

Field Programmable Devices (FPD) Bundle Information Table:
==========================================================


Table Entry #1:

       Bundle Card Type:SPA-4FE-7304 (0x435)
        Platform Family:0x0
     Bundle Name Prefix:spa_4fe2ge
         Bundle Version:0.5
    Minimal H/W Version:0.0
        FPD Image Count:1
     FPD Image Required:
                                                   Min. Required
                         FPD ID FPD Name                Version
                         ------ ----------------------- -------------
                            1   Data & I/O FPGA            4.17
                         ------ ----------------------- -------------
```

```
Table Entry #2:

       Bundle Card Type:SPA-2GE-7304 (0x436)
        Platform Family:0x0
     Bundle Name Prefix:spa_4fe2ge
         Bundle Version:0.5
    Minimal H/W Version:0.0
        FPD Image Count:1
     FPD Image Required:
                                                           Min. Required
                         FPD ID FPD Name                      Version
                         ------ ------------------------ -------------
                            1   Data & I/O FPGA               4.17
                         ------ ------------------------ -------------
```

Related Commands

Command	Description
upgrade hw-module subslot	Manually upgrades the current FPD image on the specified SPA.
upgrade fpd auto	Configures the router to automatically upgrade the FPD image when an FPD version incompatability is detected.
upgrade fpd path	Specifies the location from where the FPD image package should be loaded when an automatic FPD upgrade is initiated by the router.
show hw-module slot fpd	Displays the current versions of FPD image files for all of the active SIPs on a router.
show hw-module subslot fpd	Displays the FPD version on each SPA in the router.
show upgrade fpd file	Displays the contents of an FPD image package file.
show upgrade fpd package default	Displays which FPD image package is needed for the router to properly support the SPAs.
show upgrade fpd progress	Displays the progress of the FPD upgrade while an FPD upgrade is taking place.

speed

To configure the speed for a Fast Ethernet interface, use the **speed** command in interface configuration mode. To return to the default setting, use the **no** form of this command.

speed {**10** | **100** | **auto**}

no speed

Syntax Description

10	Configures the interface to transmit at 10 Mbps.
100	Configures the interface to transmit at 100 Mbps.
auto	Enables autonegotiation. The interface automatically operates at 10 Mbps or 100 Mbps depending on environmental factors, such as the type of media and transmission speeds for the peer routers, hubs, and switches used in the network configuration. This is the default.

Defaults

Auto

Command Modes

Interface configuration

Command History

Release	Modification
11.2(10)P	This command was introduced.
12.2(20)S1	This command was integrated into Cisco IOS Release 12.2(20)S1 and the default value was modified to Auto.
12.0(32)S	This command was integrated into Cisco IOS Release 12.2(32)S for the Cisco 12000 Series Router.

Usage Guidelines

To enable the autonegotiation capability on an interface, you must set either the **speed** command or the **duplex** command to **auto**. The default configuration is that both commands are set to **auto**.

Table 28 describes the interface behavior for different combinations of the **duplex** and **speed** command settings. The specified **duplex** command configured with the specified **speed** command produces the resulting system action.

If you specify both a **duplex** and **speed** setting on an interface other than **auto**, then autonegotiation is disabled for the interface.

Note If you need to force an interface port to operate with certain settings and therefore disable autonegotiation, you must be sure that the remote link is configured for compatible link settings for proper transmission. This includes support of flow control on the link.

Note Every interface on a 4-Port 10/100 Fast Ethernet SPA and 2-Port 10/100/1000 Gigabit Ethernet SPA automatically supports transmission of pause frames to stop packet flow when the MSC is full. You cannot disable flow control for an interface on the 4-Port 10/100 Fast Ethernet SPA or 2-Port 10/100/1000 Gigabit Ethernet SPA. Therefore, flow control support is not configurable, but it is advertised during autonegotiaton.

If you disable autonegotiation, then you must be sure that the remote device is configured to support flow control because flow control is automatically enabled for all interfaces on the 4-Port 10/100 Fast Ethernet SPA and the 2-Port 10/100/1000 Gigabit Ethernet SPA.

Table 28 Relationship Between duplex and speed Commands

duplex Command	speed Command	Resulting System Action
duplex auto	**speed auto**	Autonegotiates both speed and duplex mode. The interface advertises capability for the following link settings: • 10 Mbps and half duplex • 10 Mbps and full duplex • 100 Mbps and half duplex • 100 Mbps and full duplex
duplex auto	**speed 100** or **speed 10**	Autonegotiates the duplex mode. The interface advertises capability for the configured speed with capability for both half-duplex or full-duplex mode. For example, if the **speed 100** command is configured with **duplex auto**, then the interface advertises the following capability: • 100 Mbps and half duplex • 100 Mbps and full duplex
duplex half or **duplex full**	**speed auto**	Autonegotiates the speed. The interface advertises capability for the configured duplex mode with capability for both 10 Mbps or 100 Mbps operation. For example, if the **duplex full** command is configured with the **speed auto** command, then the interface advertises the following capability: • 10 Mbps and full duplex • 100 Mbps and full duplex
duplex half	**speed 10**	Forces 10 Mbps and half-duplex operation, and disables autonegotiation on the interface.
duplex full	**speed 10**	Forces 10 Mbps and full-duplex operation, and disables autonegotiation on the interface.

Table 28 Relationship Between duplex and speed Commands (continued)

duplex Command	speed Command	Resulting System Action
duplex half	**speed 100**	Forces 100 Mbps and half-duplex operation, and disables autonegotiation on the interface.
duplex full	**speed 100**	Forces 100 Mbps and full-duplex operation, and disables autonegotiation on the interface.

Examples

The following example specifies advertisement of 10 Mbps operation only, and either full-duplex or half-duplex capability during autonegotiation for the second interface (port 1) on the SPA located in the bottom (1) subslot of the MSC that is installed in slot 2 of the Cisco 7304 router:

```
Router# configure terminal
Router(config)# interface fastethernet 2/1/1
Router(config-if)# speed 10
Router(config-if)# duplex auto
```

With this configuration, the interface advertises the following capabilities during autonegotiation:

- 10 Mbps and half duplex
- 10 Mbps and full duplex

Note Recall that flow control support is always advertised when autonegotiation is enabled.

Related Commands

Command	Description
duplex	Configures the duplex operation on an interface.
interface fastethernet	Selects a particular Fast Ethernet interface for configuration.
show controllers fastethernet	Displays interface information, transmission statistics and errors, and the MAC destination address and VLAN filtering table on a Fast Ethernet interface on the Cisco 7304 router.
show interfaces fastethernet	Displays information about the Fast Ethernet interfaces.

t1 framing

To specify the type of framing used by T1 channels, use the **t1 framing** command in controller configuration mode.

Cisco 7500 Series Routers with Channelized T3 Interface Processor

t1 *channel* **framing** {**esf** | **sf**}

Channelized T3/E3 Shared Port Adapters

t1 *channel* **framing** {**esf** | **sf** [**hdlc-idle** {**0x7e** | **0xff**}] [**mode** {**j1**}]}

no t1 *channel* **framing** {**esf** | **sf** [**hdlc-idle** {**0x7e** | **0xff**}] [**mode** {**j1**}]}

Syntax Description

channel	Number indicating the T1 channel. • On the CT3IP—1 to 28 • On the CT3 SPA—0 to 23
esf	Specifies that Extended Super Frame (ESF) is used as the T1 framing type. This is the default for the CT3IP.
sf	Specifies that Super Frame (SF) is used as the T1 framing type. This is the default for the T3/E3 SPA.
hdlc-idle {**0x7e** | **0xff**}	(Optional) Sets the idle pattern for the T1 interface to either **0x7e** (the default) or **0xff**.
mode {**j1**}	(Optional) Specifies the JT-G704 Japanese frame type.

Defaults

esf (for C3TIP)

sf (for T3/E3 SPA)

Command Modes

Controller configuration

Command History

Release	Modification
11.3	This command was introduced.
12.0(14)S	This command was integrated into Cisco IOS Release 12.0(14)S. The **hdlc-idle** keyword option was added.
12.2S	This command was integrated into Cisco IOS Release 12.2S.
12.2(18)SXE	This command was integrated into Cisco IOS Release 12.2(18)SXE to support SPAs on the Cisco 7600 series routers. The **mode** keyword option was added.
12.0(31)S	This command was integrated into Cisco IOS Release 12.0(31)S.

Usage Guidelines

If you do not specify the **t1 framing** command, the default ESF is used.

> **Note** T1 channels on the CT3IP are numbered 1 to 28 rather than the more traditional zero-based scheme (0 to 27) used with other Cisco products. This numbering scheme ensures consistency with telco numbering schemes for T1 channels within channelized T3 equipment.

To return to the default mode, use the **no** form of this command. This command does not have a **no** form on the Cisco 7500 series router with the CT3IP.

Examples

The following example shows how to set the framing for the T1 6 and T1 8 on the CT3IP to Super Frame:

```
Router(config)# controller t3 9/0/0
Router(config-controller)# t1 6 framing sf
Router(config-controller)# t1 8 framing sf
```

Related Commands

Command	Description
controller	Configures a T1, E1, or T3 controller and enters controller configuration mode.
show controller	Displays controller configuration.

ttb

To send a trace trail buffer in E3 g832 framing mode, use the **ttb** command in interface configuraton mode. To disable the trace, use the **no** form of this command.

ttb {**country** | **rnode** | **serial** | **snode** | **soperator** | **x**} *line*

no ttb {**country** | **rnode** | **serial** | **snode** | **soperator** | **x**} *line*

Syntax Description

country *line*	Two-character country code.
rnode *line*	Receive node code.
serial *line*	M.1400 Serial
snode *line*	Sending Town/Node ID code.
soperator *line*	Sending Operator code.
x *line*	XO

Defaults

No default behavior or values

Command Modes

Interface configuration

Command History

Release	Modification
12.2S	This command was introduced.
12.2(18)SXE	This command was integrated into Cisco IOS Release 12.2(18)SXE.
12.0(31)S	This command was integrated into Cisco IOS Release 12.0(31)S.

Usage Guidelines

Use the **ttb** command to attach a header that contains fields to send to a remote device.

Examples

The following example starts a TTB message on the first port on slot 5.

```
Router# configure terminal
Router(config)# int serial 5/0/0
Router(config-if)# ttb country us
Router(config-if)# ttb snode 123
Router(config-if)# ttb rnode rn
Router(config-if)# ttb x 9
Router(config-if)# ttb serial 432
```

Related Commands

Command	Description
show controller serial	Displays controller statistics.

upgrade fpd auto

To configure the router to automatically upgrade the current FPD images on a SPA when an FPD version incompatibly is detected, enter the **upgrade fpd auto** global configuration command. To disable automatic FPD image upgrades, use the **no** form of this command.

upgrade fpd auto

no upgrade fpd auto

Syntax Description

This command has no arguments or keywords.

Defaults

This command is enabled by default if your router has any installed SPAs. The router will check the SPA FPD image during bootup or after an insertion of a SPA into a SIP subslot. If the router detects an incompatibility between an FPD image and a SPA, an automatic FPD upgrade attempt will occur unless the user has disabled automatic FPD upgrades by entering the **no upgrade fpd auto** command.

On all platforms except the Cisco 7304 router, the router will, by default, search all of it's Flash file systems for the FPD image package when an FPD incompatability is detected and **upgrade fpd auto** is enabled. The **upgrade fpd path** command can be used to direct the router to search for the FPD image package at another location (such as an FTP or TFTP server) when an FPD incompatability is detected.

The Cisco 7304 defaults are different. By default, the **upgrade fpd auto** will search the router's primary Flash file system (disk0:) for the FPD image package file. If you would like the router to search for the FPD image package file in a location other than the router's primary Flash file system when an FPD incompatibility is detected, enter the **upgrade fpd path** *fpd-pkg-dir-url* command to specify the location where the router should search for the FPD image package file. Once the FPD image package file is successfully located, the FPD upgrade process begins automatically.

Command Modes

Global configuration

Command History

Release	Modification
12.2(20)S2	This command was introduced.
12.2(18)SXE	This command was integrated into Cisco IOS Release 12.2(18)SXE.
12.0(31)S	This command was integrated into Cisco IOS Release 12.0(31)S.

Usage Guidelines

This command is enabled by default. In most cases, this default configuration should be retained.

Note that the default behavior is different on the Cisco 7304 than on other routers. For information on default behavior, see the Defaults section of this command reference.

If this command is disabled but an FPD upgrade is required, the **upgrade hw-module subslot** command can be used to upgrade the SPA FPD image manually after the SPA is disabled because of the existing FPD incompatibility.

Upgrading the FPD image on a SPA places the SPA offline while the upgrade is taking place. The time required to complete an FPD image upgrade can be lengthy. The **show upgrade fpd progress** command can be used to gather more information about estimated FPD download times for a particular SPA.

Examples

The following example shows the output displayed when a SPA requires an FPD image upgrade and the **upgrade fpd auto** command is *enabled*. The incompatible FPD image is automatically upgraded.

```
% Uncompressing the bundle ...  [OK]
*Jan 13 22:38:47:%FPD_MGMT-3-INCOMP_FPD_VER:Incompatible 4FE/2GE FPGA (FPD ID=1) image
version detected for SPA-4FE-7304 card in subslot 2/0. Detected version = 4.12, minimal
required version = 4.13. Current HW version = 0.32.
*Jan 13 22:38:47:%FPD_MGMT-5-FPD_UPGRADE_ATTEMPT:Attempting to automatically upgrade the
FPD image(s) for SPA-4FE-7304 card in subslot 2/0 ...

*Jan 13 22:38:47:%FPD_MGMT-6-BUNDLE_DOWNLOAD:Downloading FPD image bundle for SPA-4FE-7304
card in subslot 2/0 ...
*Jan 13 22:38:49:%FPD_MGMT-6-FPD_UPGRADE_TIME:Estimated total FPD image upgrade time for
SPA-4FE-7304 card in subslot 2/0 = 00:06:00.
*Jan 13 22:38:49:%FPD_MGMT-6-FPD_UPGRADE_START:4FE/2GE FPGA (FPD ID=1) image upgrade in
progress for SPA-4FE-7304 card in subslot 2/0. Updating to version 4.13. PLEASE DO NOT
INTERRUPT DURING THE UPGRADE PROCESS (estimated upgrade completion time = 00:06:00)
...[..................................................................................
(part of the output has been removed for brevity)
..........................................................................................
..........................................................................................
........]
SUCCESS - Completed XSVF execution.

*Jan 13 22:44:33:%FPD_MGMT-6-FPD_UPGRADE_PASSED:4FE/2GE FPGA (FPD ID=1) image upgrade for
SPA-4FE-7304 card in subslot 2/0 has PASSED. Upgrading time = 00:05:44.108
*Jan 13 22:44:33:%FPD_MGMT-6-OVERALL_FPD_UPGRADE:All the attempts to upgrade the required
FPD images have been completed for SPA-4FE-7304 card in subslot 2/0. Number of
successful/failure upgrade(s):1/0.
*Jan 13 22:44:33:%FPD_MGMT-5-CARD_POWER_CYCLE:SPA-4FE-7304 card in subslot 2/0 is being
power cycled for the FPD image upgrade to take effect.
```

Related Commands

Command	Description
upgrade hw-module subslot	Manually upgrades the current FPD image on the specified SPA.
upgrade fpd path	Specifies the location from where the FPD image package should be loaded when an automatic FPD upgrade is initiated by the router.
show hw-module slot fpd	Displays the current versions of FPD image files for all of the active SIPs on a router.
show hw-module subslot fpd	Displays the FPD version on each SPA in the router.
show upgrade fpd file	Displays the contents of an FPD image package file.
show upgrade fpd package default	Displays which FPD image package is needed for the router to properly support the SPAs.
show upgrade fpd progress	Displays the progress of the FPD upgrade while an FPD upgrade is taking place.
show upgrade fpd table	Displays various information used by the Cisco IOS software to manage the FPD image package file.

upgrade fpd path

To configure the router to search for an FPD image package file in a location other than the router's primary Flash file system during an automatic FPD upgrade, enter the **upgrade fpd path** global configuration command to specify the new location that should be searched for an FPD image package file when an automatic FPD upgrade occurs. To return to the default setting of the router searching for the FPD image package file in the router's Flash file systems when an automatic FPD upgrade is triggered, use the **no** form of this command.

upgrade fpd path *fpd-pkg-dir-url*

no upgrade fpd path *fpd-pkg-dir-url*

Syntax Description

fpd-pkg-dir-url	Specifies the location of the FPD image package file, beginning with the location or type of storage device (examples include disk0, slot0, tftp, or ftp) and followed by the path to the FPD image package file. It is important to note that the name of the FPD image package file should not be specified as part of *fpd-pkg-dir-url*; the Cisco IOS will automatically download the correct FPD image package file once directed to the proper location. It is important to note that the last character of the *fpd-pkg-dir-url* is always a "/".

Defaults

Non-Cisco 7304 Routers

By default, the router checks all of it's Flash file systems for an FPD image package file when an incompatibility between an FPD image on the SPA and the running Cisco IOS image is detected. The **upgrade fpd path** command is used to specify a new location for a router to locate the FPD image package file if you want to store the FPD image package file in a location other than the router's Flash file systems for automatic FPD upgrades.

Cisco 7304 Router Only

By default, the router checks its primary Flash file system for an FPD image package file when an incompatibility between an FPD image on the SPA and the running Cisco IOS image is detected. The **upgrade fpd path** command is used to specify a new location for a router to locate the FPD image package file if you want to store the FPD image package file in a location other than the router's default Flash file system for automatic FPD upgrades.

Command Modes

Global configuration

Command History

Release	Modification
12.2(20)S2	This command was introduced.
12.2(18)SXE	This command was integrated into Cisco IOS Release 12.2(18)SXE.
12.0(31)S	This command was integrated into Cisco IOS Release 12.0(31)S.

Usage Guidelines

It is important to note that the last character of the *fpd-pkg-dir-url* is always a "/". This path points users to the directory that stores the file, but not the file itself. See the Examples section of this command reference for examples of how to properly enter this command.Examples

When specifying the path to the location of the new FPD image package file, do not include the filename in the path. The Cisco IOS will automatically download the correct FPD image package file once directed to the proper location, even if multiple FPD image package files of different versions are stored in the same location.

If the **upgrade fpd path** command is not entered, the router will search the default primary Flash file system for the FPD image.

Examples

In the following example, the FPD image package file that is stored on the TFTP server using the path johnstftpserver/fpdfiles will now be scanned for the latest FPD image package file when an automatic FPD upgrade occurs.

```
upgrade fpd path tftp://johnstftpserver/fpdfiles/
```

In the following example, the FPD package file that is stored on the FTP server using the path johnsftpserver/fpdfiles will now be scanned for the latest FPD image package when an automatic FPD upgrade occurs. In this example, john is the username and XXXXXXX is the FTP password.

```
upgrade fpd path ftp://john:XXXXXXX@johnsftpserver/fpdfiles/
```

Related Commands

Command	Description
upgrade hw-module subslot	Manually upgrades the current FPD image on the specified SPA.
upgrade fpd auto	Configures the router to automatically upgrade the FPD image when an FPD version incompatability is detected.
show hw-module slot fpd	Displays the current versions of FPD image files for all of the active SIPs on a router.
show hw-module subslot fpd	Displays the FPD version on each SPA in the router.
show upgrade fpd file	Displays the contents of an FPD image package file.
show upgrade fpd package default	Displays which FPD image package is needed for the router to properly support the SPAs.
show upgrade fpd progress	Displays the progress of the FPD upgrade while an FPD upgrade is taking place.
show upgrade fpd table	Displays various information used by the Cisco IOS software to manage the FPD image package file.

upgrade hw-module slot

To manually upgrade the current FPD image package on a SIP, enter the **upgrade hw-module slot** command in privileged EXEC configuration mode. The command does not have a **no** form.

upgrade hw-module slot *slot* **file** *file-url* [**force**]

Syntax Description

slot	Chassis slot number. Refer to the appropriate hardware manual for slot information. For SIPs, refer to the platform-specific SPA hardware installation guide or the corresponding "Identifying Slots and Subslots for SIPs and SPAs" topic in the platform-specific SPA software configuration guide.
file	Specifies that a file will be downloaded.
file-url	Specifies the location of the FPD image package file, beginning with the location or type of storage device (examples include disk0, slot0, tftp, or ftp) and followed by the path to the FPD image package file.
force	(Optional) Forces the update of all compatible FPD images in the indicated FPD image package on the SPA that meet the minimal version requirements. Without this option, the manual upgrade will only upgrade incompatible FPD images.

Defaults

No default behavior or values, although it is important to note that the router containing the SIP is configured, by default, to upgrade the FPD images when it detects a version incompatibility between a the FPD image on the SIP and the FPD image required to run the SPA with the running Cisco IOS image. The **upgrade hw-module slot** command is used to manually upgrade the FPD images; therefore, the **upgrade hw-module slot** command should only be used when the automatic upgrade default configuration fails to find a compatible FPD image for one of the SPAs or when the automatic upgrade default configuration has been manually disabled. The **no upgrade fpd auto** command can be entered to disable automatic FPD upgrades.

If no FPD incompatibility is detected, this command will not upgrade SPA FPD images unless the **force** option is entered.

Command Modes

Privileged EXEC

Command History

Release	Modification
12.2(18)SXE	This command was introduced.

Usage Guidelines

This command is used to manually upgrade the FPD images on a SIP. In most cases, the easiest and recommended method of upgrading FPD images is the automatic FPD upgrade, which is enabled by default. The automatic FPD upgrade will detect and automatically upgrade all FPD images when an FPD incompatibility is detected.

A manual FPD upgrade is usually used in the following situations:

- The target SIP was disabled by the system because of an incompatible FPD image (the system could not find the required FPD image package file).
- A recovery upgrade must be performed.
- A special bug fix to an FPD image is provided in the FPD image package file.

The FPD image upgrade process places the SIP and all the SPAs in the SIP offline. The time required to complete an FPD image upgrade can be lengthy. The **show upgrade progress** command can be used to gather more information about estimated FPD download times for a particular SIP.

Examples

The following example shows a sample manual FPD upgrade:

```
Router#upgrade hw-module slot 4 file disk0:c7600-fpd-pkg.122-18.SXE.pkg

% The following FPD(s) will be upgraded for 7600-SIP-200 (H/W ver = 0.550) in slot 4:

    ================== =========== =========== ============
    Field Programmable   Current     Upgrade   Estimated
    Device:"ID-Name"    Version     Version   Upgrade Time
    ================== =========== =========== ============
    5-ROMMON              1.1         1.2       00:02:00
    ================== =========== =========== ============


% Are you sure that you want to perform this operation? [no]:y
% Restarting the target card in slot 4 for FPD image upgrade. Please wait ...

Router#
Mar 25 16:39:37:%CWAN_RP-6-CARDRELOAD:Module reloaded on slot 4/0
SLOT 4:00:00:06:%SSA-5-FABRICSYNC_DONE:Fabric sync on Primary channel done.
Mar 25 16:39:40:%MLS_RATE-4-DISABLING:The Layer2 Rate Limiters have been disabled.
Mar 25 16:39:40:%FPD_MGMT-6-UPGRADE_TIME:Estimated total FPD image upgrade time for
7600-SIP-200 card in slot 4 = 00:02:00.
Mar 25 16:39:40:%FPD_MGMT-6-UPGRADE_START:ROMMON (FPD ID=5) image upgrade in progress for
7600-SIP-200 card in slot 4. Updating to version 1.2. PLEASE DO NOT INTERRUPT DURING THE
UPGRADE PROCESS (estimated upgrade completion time = 00:02:00) ...
Mar 25 16:39:39:%DIAG-SP-6-RUN_COMPLETE:Module 4:Running Complete Diagnostics...
Mar 25 16:39:40:%DIAG-SP-6-DIAG_OK:Module 4:Passed Online Diagnostics
SLOT 1:Mar 26 00:39:40:%SSA-5-FABRICSYNC_DONE:Fabric sync on Primary channel done.
Mar 25 16:39:40:%OIR-SP-6-INSCARD:Card inserted in slot 4, interfaces are now online
Mar 25 16:39:46:%FPD_MGMT-6-UPGRADE_PASSED:ROMMON (FPD ID=5) image in the 7600-SIP-200
card in slot 4 has been successfully updated from version 1.1 to version 1.2. Upgrading
time = 00:00:06.000
Mar 25 16:39:46:%FPD_MGMT-6-OVERALL_UPGRADE:All the attempts to upgrade the required FPD
images have been completed for 7600-SIP-200 card in slot 4. Number of successful/failure
upgrade(s):1/0.
Mar 25 16:39:47:%FPD_MGMT-5-CARD_POWER_CYCLE:7600-SIP-200 card in slot 4 is being power
cycled for the FPD image upgrade to take effect.
Mar 25 16:39:47:%OIR-6-REMCARD:Card removed from slot 4, interfaces disabled
Mar 25 16:39:47:%C6KPWR-SP-4-DISABLED:power to module in slot 4 set off (Reset)
Mar 25 16:40:38:%CWAN_RP-6-CARDRELOAD:Module reloaded on slot 4/0
SLOT 4:00:00:06:%SSA-5-FABRICSYNC_DONE:Fabric sync on Primary channel done.
Mar 25 16:40:41:%MLS_RATE-4-DISABLING:The Layer2 Rate Limiters have been disabled.
Mar 25 16:40:40:%DIAG-SP-6-RUN_COMPLETE:Module 4:Running Complete Diagnostics...
Mar 25 16:40:41:%DIAG-SP-6-DIAG_OK:Module 4:Passed Online Diagnostics
SLOT 1:Mar 26 00:40:41:%SSA-5-FABRICSYNC_DONE:Fabric sync on Primary channel done.
Mar 25 16:40:41:%OIR-SP-6-INSCARD:Card inserted in slot 4, interfaces are now online
```

Related Commands

Command	Description
upgrade fpd auto	Configures the router to automatically upgrade the FPD image when an FPD version incompatability is detected.
upgrade fpd path	Specifies the location from where the FPD image package should be loaded when an automatic FPD upgrade is initiated by the router.
show hw-module slot fpd	Displays the current versions of FPD image files for all of the active SIPs on a router.
show hw-module subslot fpd	Displays the FPD version on each SPA in the router.
show upgrade fpd file	Displays the contents of an FPD image package file.
show upgrade fpd package default	Displays which FPD image package is needed for the router to properly support the SPAs.
show upgrade fpd progress	Displays the progress of the FPD upgrade while an FPD upgrade is taking place.
show upgrade fpd table	Displays various information used by the Cisco IOS software to manage the FPD image package file.
upgrade hw-module subslot	Manually performs an FPD upgrade for a specific SPA.

upgrade hw-module subslot

To manually upgrade the current FPD image package on a SPA, enter the **upgrade hw-module subslot** command in privileged EXEC configuration mode. The command does not have a **no** form.

upgrade hw-module subslot *slot/subslot* **file** *file-url* [**force**]

Syntax Description

slot	Chassis slot number. Refer to the appropriate hardware manual for slot information. For SIPs, refer to the platform-specific SPA hardware installation guide or the corresponding "Identifying Slots and Subslots for SIPs and SPAs" topic in the platform-specific SPA software configuration guide.
/subslot	Secondary slot number on a SPA interface processor (SIP) where a SPA is installed. Refer to the platform-specific SPA hardware installation guide and the corresponding "Specifying the Interface Address on a SPA" topic in the platform-specific SPA software configuration guide for subslot information.
file	Specifies that a file will be downloaded.
file-url	Specifies the location of the FPD image package file, beginning with the location or type of storage device (examples include disk0, slot0, tftp, or ftp) and followed by the path to the FPD image package file.
force	(Optional) Forces the update of all compatible FPD images in the indicated FPD image package on the SPA that meet the minimal version requirements. Without this option, the manual upgrade will only upgrade incompatible FPD images.

Defaults

No default behavior or values, although it is important to note that the router containing the SPA is configured, by default, to upgrade the FPD images when it detects a version incompatibility between a the FPD image on the SPA and the FPD image required to run the SPA with the running Cisco IOS image. The **upgrade hw-module subslot** command is used to manually upgrade the FPD images; therefore, the **upgrade hw-module subslot** command should only be used when the automatic upgrade default configuration fails to find a compatible FPD image for one of the SPAs or when the automatic upgrade default configuration has been manually disabled. The **no upgrade fpd auto** command can be entered to disable automatic FPD upgrades.

If no FPD incompatibility is detected, this command will not upgrade SPA FPD images unless the **force** option is entered.

Command Modes

Privileged EXEC

Command History

Release	Modification
12.2(20)S2	This command was introduced.
12.2(18)SXE	This command was integrated into Cisco IOS release 12.2(18)SXE.

Usage Guidelines

This command is used to manually upgrade the FPD images on a SPA. In most cases, the easiest and recommended method of upgrading FPD images is the automatic FPD upgrade, which is enabled by default. The automatic FPD upgrade will detect and automatically upgrade all FPD images when an FPD incompatibility is detected.

A manual FPD upgrade is usually used in the following situations:

- The target SPA was disabled by the system because of an incompatible FPD image (the system could not find the required FPD image package file).
- A recovery upgrade must be performed.
- A special bug fix to an FPD image is provided in the FPD image package file.

The FPD image upgrade process places the SPA offline. The time required to complete an FPD image upgrade can be lengthy. The **show upgrade progress** command can be used to gather more information about estimated FPD download times for a particular SPA.

Examples

The following example shows a sample manual FPD upgrade:

```
Router# upgrade hw-module subslot 2/0 file disk0:spa_fpd.122-20.S2.pkg
% Uncompressing the bundle ...  [OK]


% The following FPD(s) will be upgraded for card in subslot 2/0 :

         ================== =========== =========== ============
         Field Programmable   Current     Upgrade   Estimated
         Device:"ID-Name"     Version     Version   Upgrade Time
         ================== =========== =========== ============
         1-Data & I/O FPGA     4.12        4.13      00:06:00
         ================== =========== =========== ============


% Are you sure that you want to perform this operation? [no]:y
% Restarting the target card (subslot 2/0) for FPD image upgrade. Please wait ...

Router#
*Jan 14 00:37:17:%FPD_MGMT-6-FPD_UPGRADE_TIME:Estimated total FPD image upgrade time for
SPA-4FE-7304 card in subslot 2/0 = 00:06:00.
*Jan 14 00:37:17:%FPD_MGMT-6-FPD_UPGRADE_START:4FE/2GE FPGA (FPD ID=1) image upgrade in
progress for SPA-4FE-7304 card in subslot 2/0. Updating to version 4.13. PLEASE DO NOT
INTERRUPT DURING THE UPGRADE PROCESS (estimated upgrade completion time = 00:06:00)
...[.........................(part of the output has been removed for brevity)....
.................................................................................]
SUCCESS - Completed XSVF execution.

*Jan 14 00:42:59:%FPD_MGMT-6-FPD_UPGRADE_PASSED:4FE/2GE FPGA (FPD ID=1) image upgrade for
SPA-4FE-7304 card in subslot 2/0 has PASSED. Upgrading time = 00:05:42.596
*Jan 14 00:42:59:%FPD_MGMT-6-OVERALL_FPD_UPGRADE:All the attempts to upgrade the required
FPD images have been completed for SPA-4FE-7304 card in subslot 2/0. Number of
successful/failure upgrade(s):1/0.
*Jan 14 00:42:59:%FPD_MGMT-5-CARD_POWER_CYCLE:SPA-4FE-7304 card in subslot 2/0 is being
power cycled for the FPD image upgrade to take effect.
```

Related Commands

Command	Description
upgrade fpd auto	Configures the router to automatically upgrade the FPD image when an FPD version incompatability is detected.
upgrade fpd path	Specifies the location from where the FPD image package should be loaded when an automatic FPD upgrade is initiated by the router.
show hw-module slot fpd	Displays the current versions of FPD image files for all of the active SIPs on a router.
show hw-module subslot fpd	Displays the FPD version on each SPA in the router.
show upgrade fpd file	Displays the contents of an FPD image package file.
show upgrade fpd package default	Displays which FPD image package is needed for the router to properly support the SPAs.
show upgrade fpd progress	Displays the progress of the FPD upgrade while an FPD upgrade is taking place.
show upgrade fpd table	Displays various information used by the Cisco IOS software to manage the FPD image package file.

GLOSSARY

B

blank filler plate An empty panel used to fill vacant subslots on a SIP. For proper operation, a SIP should be fully installed with either functional SPAs or blank filler plates.

D

double height Describes the dimension of a SPA that occupies two, vertically-aligned SIP subslots.

F

FPD Field-programmable device. General term for any hardware component implemented on router cards that supports separate software upgrades. SIPs and SPAs must have the right FPD version to function properly; an FPD incompatibility will disable all interfaces on the SPA or all SPAs within the SIP.

FPD image package An FPD image package is used to upgrade FPD images. Whenever a Cisco IOS image is released that supports SPAs, a companion SPA FPD image package is also released for that Cisco IOS software release.

O

OIR Online insertion and removal. Feature supported by SIPs and SPAs allowing removal of the cards while the router and the cards are activated, without affecting the operation of other cards or the router. Although this removal can be done while the SIP or SPA is activated, it is generally recommended that you gracefully deactivate the hardware using the appropriate commands for your platform prior to removal of the hardware.

S

SFP Small form-factor pluggable optical transceiver. A type of fiber optic receptacle device that mounts flush with the front panel to provide network connectivity.

single height Describes the dimension of a SPA that occupies a single SIP subslot, or half of the SIP.

SIP SPA interface processor. A SIP is a platform-specific carrier card that inserts into a router slot like a line card. A SIP can hold one or more SPAs in its subslots, depending on the SIP type. The SPA provides the network interface. The SIP provides the connection between the route processor (RP) and the SPA.

SPA Shared port adapter. A SPA is a modular, platform-independent port adapter that inserts into a subslot of a compatible SIP carrier card to provide network connectivity and increased interface port density. The SPA provides the interface between the network and the SIP.

subslot Secondary slot on a SIP where a SPA is installed. The primary slot is the chassis slot on the router.

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