CISCO SYSTEMS

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Asynchronous Transfer Mode Interface Processor (AIP) Installation and Configuration

Product Numbers: CX-AIP-TM=, CX-AIP-SM=, CX-AIP-SS=, CX-AIP-E3=, CX-AIP-DS3=, CLIP-E3-EMI=, and CAB-ATM-DS3/E3=

This configuration note contains instructions for installing and configuring the Asynchronous Transfer Mode (ATM) Interface Processor (AIP) in a Cisco 7000 series or Cisco 7500 series router. Included are basic configuration steps and examples.

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For additional descriptions of interface subcommands and additional configuration options available for ATM interfaces, refer to the publications listed in the section "If You Need More Information" on page 2.

If You Need More Information

The Cisco IOS software running your router contains extensive features and functionality. The effective use of many interface processor features is easier if you have more information at hand. For additional information on configuring the Cisco 7000 series and Cisco 7500 series routers and interface processors, the following documentation resources are available:

- Cisco documentation and additional literature are available in a CD-ROM package, which ships with your product. The Documentation CD-ROM, a member of the Cisco Connection Family, is updated monthly. Therefore, it might be more up to date than printed documentation. To order additional copies of the Documentation CD-ROM, contact your local sales representative or call customer service. The CD-ROM package is available as a single package or as an annual subscription. You can also access Cisco documentation on the World Wide Web at http://www.cisco.com, http://www-china.cisco.com, or http://www-europe.cisco.com.

- Refer to the following modular configuration and modular command reference publications, as appropriate for your configuration:

  — *Configuration Fundamentals Configuration Guide*

  — *Configuration Fundamentals Command Reference*

  — *Security Configuration Guide*

  — *Security Command Reference*

  — *Wide-Area Networking Configuration Guide*

  — *Wide-Area Networking Command Reference*

  — *Network Protocols Configuration Guide,* Parts 1, 2, and 3

  — *Network Protocols Command Reference,* Parts 1, 2, and 3

  — *Bridging and IBM Networking Configuration Guide*

  — *Bridging and IBM Networking Command Reference*

  — *Configuration Builder Getting Started Guide*

  — *Troubleshooting Internetworking Systems*

  — *Debug Command Reference*

  — *System Error Messages*

  — *Cisco IOS Software Command Summary*

  — *Cisco Management Information Base (MIB) User Quick Reference*

- For hardware installation and maintenance information on the Cisco 7000 series and Cisco 7500 series routers, refer to the hardware installation and configuration documentation that shipped with your router.

- To obtain general information about documentation, refer to one of the following:

  — The Documentation CD-ROM.

  — The section "Cisco Information Online" on page 53.

  — Customer Service at 800 553-6387 or 408 526-7208. Customer Service hours are 5:00 a.m. to 6:00 p.m. Pacific time, Monday through Friday (excluding company holidays). You can also send e-mail to cs-rep@cisco.com.

  — The *Cisco Information Packet* that shipped with your router.

ATM Terms and Acronyms

The following are common ATM terms and acronyms for your reference:

AAL—ATM Adaptation Layer. An AAL defines the conversion of user information into cells. AAL1 and AAL2 handle isochronous traffic, such as voice and video; AAL3/4 and AAL5 pertain to data communications through the segmentation and reassembly of packets.

ATM—Asynchronous transfer mode. A cell-switching and multiplexing technology combining the benefits of circuit switching (constant transmission delay, guaranteed capacity) with those of packet switching (flexibility, efficiency for intermittent traffic). ATM is defined by ITU-T standards.

Average-rate—The average rate, in kilobits per second (kbps), at which a given virtual circuit (VC) will transmit data.

BISDN—Broadband Integrated Services Digital Network. A set of standards under development by the ITU-T for services based on ATM switching and SONET/SDH transmission.

CCITT—Consultative Committee for International Telegraph and Telephone (Although commonly referred to as the CCITT, this international standards body recently adopted the name *International Telecommunication Union Telecommunication Standardization Sector* [ITU-T].)

CLP—Cell loss priority.

DXI—Data exchange interface.

ILMI—Interim Local Management Interface—Described in the ATM Forum's UNI specification, ILMI allows end users to retrieve a basic set of information, such as status and configuration about virtual connections and addresses, for a particular UNI.

ITU-T—International Telecommunications Union Telecommunication Standardization Sector (formerly the Consultative Committee for International Telegraph and Telephone [CCITT]).

MIB—Management Information Base.

MIC—Media interface connector.

MID—Message identifier—In AAL3/4 encapsulation, the 2-byte MID field allows multiplexing of streams of cells on one virtual channel.

NSAP—Network service access point.

OAM—Operation, Administration, and Maintenance (cells).

PDU—Protocol data unit—An OSI term for a packet.

Peak rate—The maximum rate, in kbps, at which a VC can transmit data.

PMD—Physical medium dependent. The lower half of BISDN Layer 1.

PLIM—Physical layer interface module. The PLIM contains the interface to the ATM cable. (See the section "AIP Interface Types" on page 6.)

PVC—Permanent virtual circuit.

QOS—Quality of service.

Rate queues—Rate queues define the speed at which the individual VCs will transmit data to the remote end. Every VC *must* be associated with one rate queue. After attachment to this rate queue, the VC is assumed to have its peak rate set to that of the rate queue. Each rate queue can be configured independently to a portion of the overall bandwidth available on the ATM link. The combined bandwidths of all rate queues should not exceed the total bandwidth available. For E3, rate queues greater than 34 are disallowed. For DS3, rate queues greater than 45 are disallowed.

SAR—Segmentation and reassembly.

SDH—Synchronous Digital Hierarchy. International standard for optical digital transmission at hierarchical rates from 155 Mbps to 2.5 Gbps and greater.

SDU—Service data unit.

SONET—Synchronous Optical Network. An ATM UNI specification and American National Standards Institute (ANSI) standard (T1.105-1988) for optical digital transmission at hierarchical rates from 51.840 Mbps (STS-N) to 2.5 Gbps and greater.

SONET OC3—Optical carrier-3 specification.

SSCOP—Service Specific Connection Oriented Protocol—Resides in the service specific convergence sublayer of the ATM adaptation layer. SSCOP is used to transfer variable-length service data units between users of SSCOP. SSCOP provides for the recovery of lost or corrupted SDUs.

SSCS—Service specific convergence sublayer.

SVC—Switched virtual circuit.

TAXI—Transparent Asynchronous Transmitter/Receiver Interface.

UNI—User-Network Interface. An ATM interface defined by the ATM Forum for public and private ATM network access.

VC—Virtual circuit. Point-to-point connections to remote hosts/routers. Each ATM VC has the following characteristics associated with the VC: peak rate, average rate, cell quota, quality of service (QOS), AAL mode (AAL3/4 or AAL5), encapsulation type (LLC/SNAP, NLPID, SMDS, MUX, QSAAL). The VC characteristics are defined when the VC is created.

VCD—Virtual circuit descriptor.

VPI/VCI—Virtual path identifier/virtual channel identifier. ATM virtual connection information. A virtual path is a generic term for a bundle of virtual channels that have the same end point.

Asynchronous Transfer Mode Overview

Asynchronous Transfer Mode (ATM) uses cell-switching and multiplexing technology that combines the benefits of circuit switching (constant transmission delay and guaranteed capacity) with those of packet switching (flexibility and efficiency for intermittent traffic).

ATM is a connection-oriented environment. All traffic to or from an ATM network is prefaced with a virtual path identifier (VPI) and virtual channel identifier (VCI). A VPI/VCI pair is considered a single virtual circuit (VC). Each VC is a private connection to another node on the ATM network. Each VC is treated as a point-to-point mechanism to another router or host and is capable of supporting bidirectional traffic.

Each ATM node is required to establish a separate connection to every other node in the ATM network that it must communicate with. All such connections are established using a PVC or an SVC with an ATM signaling mechanism. This signaling is based on the ATM Forum UNI Specification V3.0.

Each VC is considered a complete and separate link to a destination node. Users can encapsulate data as they see fit across the connection. The ATM network disregards the contents of the data. The only requirement is that data be sent to the AIP card in the specific ATM adaptation layer (AAL) format.

An AAL defines the conversion of user information into cells. The AAL segments upper-layer information into cells at the transmitter and reassembles them at the receiver. AAL3/4 and AAL5 support data communications. AAL3/4 is supported as of Cisco IOS Release 10.2 and later.

An ATM connection transfers raw bits of information to a destination router/host. The ATM router takes the common part convergence sublayer (CPCS) frame, carves it up into 53-byte cells, and sends these cells to the destination router or host for reassembly. Forty-eight bytes of each cell are used for the CPCS data; the remaining 5 bytes are used for cell routing. The 5-byte cell header contains the destination VPI/VCI, payload type, cell loss priority (CLP), and header error control.

Unlike a LAN, which is connectionless, ATM requires certain features to provide a LAN environment to the users. One such feature is broadcast capability. Protocols wishing to broadcast packets to all stations in a subnet must be allowed to do so with a single call to Layer 2. In order to support broadcasting, the router allows the user to specify a particular VC as a broadcast VC. When the protocol passes a packet with a broadcast address to the ATM driver, the packet is duplicated and sent to each VC marked as a broadcast VC. This method is known as pseudobroadcasting.

What Is the AIP?

The ATM interface processor (AIP) (see Figure 1) provides a single ATM network interface for Cisco 7000 series and Cisco 7500 series routers.

Figure 1   ATM Interface Processor (AIP)
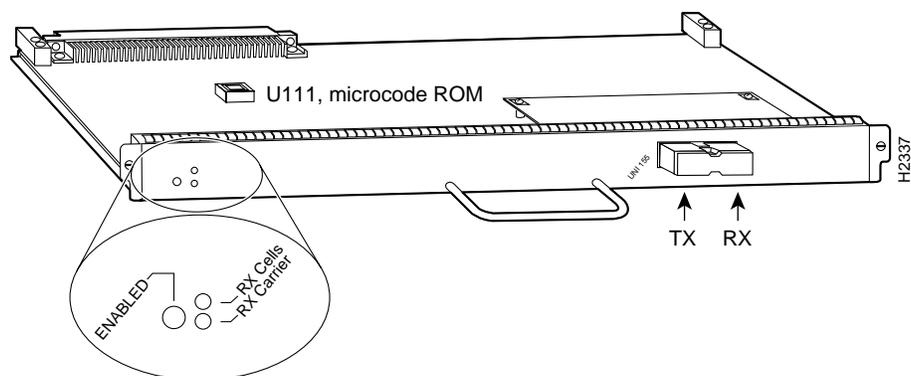
The AIP provides a direct connection between the high-speed Cisco Extended Bus (CxBus and CyBus) and external ATM networks. A physical layer interface module (PLIM) on the AIP determines the type of ATM connection. There are no restrictions on slot locations or sequence; you can install an AIP in any available interface processor slot.

Note   Traffic from multiple ATM network interfaces could theoretically exceed the bandwidth of the system bus; this would cause packets to be dropped. Two AIP modules per chassis is considered to be a practical limit.

The AIP provides the ATM connection between your router and an ATM switch. (To configure your ATM switch, refer to its user documentation.)

The AIP supports the following features:

- Multiple rate queues.
- Reassembly of up to 512 buffers simultaneously. Each buffer represents a packet.
- Up to 2,048 virtual circuits.

- Both AAL5 and AAL3/4.

Note AAL3/4 is supported as of Cisco IOS Release 10.2 and later.

- Exception queue, which is used for event reporting. Events such as CRC errors are reported to the exception queue.

- Raw queue, which is used for all raw traffic over the ATM network. Raw traffic includes Operation, Administration, and Maintenance (OAM) cells and Interim Local Management Interface (ILMI) cells. (ATM signaling cells are not considered raw.)

- MIB attributes, which are readable and writable across the ILMI using a Simple Network Management Protocol (SNMP). The ATM UNI specification defines the required MIB functionality for ATM interfaces. The ILMI uses SNMP, without UDP, and Internet Protocol (IP) addressing along with the ATM MIB.

- RFC 1213 interface MIBs as specified in the ATM MIB V2 specification. (Refer to the ATM UNI specification for additional details of the MIB.)

AIP Interface Types

All AIP ATM interfaces are full-duplex. You must use the appropriate ATM interface cable to connect the AIP with an external ATM network. Refer to the section "AIP Installation Prerequisites," on page 7, for descriptions of ATM connectors.

The AIP provides an interface to ATM switching fabrics for transmitting and receiving data at rates of up to 155 Mbps bidirectionally; the actual rate is determined by the PLIM.

The AIP supports PLIMs that connect to the following physical layers (with product numbers included):

- TAXI 4B/5B 100-Mbps multimode (CX-AIP-TM[=])

- SONET/SDH 155-Mbps multimode—STS-3 or STM-1 (CX-AIP-SM[=])

- SONET/SDH 155-Mbps single-mode—STS-3 or STM-1 (CX-AIP-SS[=])

- E3 34 Mbps (CX-AIP-E3[=])

- DS3 45 Mbps (CX-AIP-DS3[=])

  The E3 and DS3 PLIMs require cable CAB-ATM-DS3/E3. To ensure compliance with EMI standards, the E3 PLIM connection requires an EMI filter clip (CLIP-E3-EMI) on the receive port (RCVR).

For wide-area networking, ATM is currently being standardized for use in Broadband Integrated Services Digital Networks (BISDNs) by the International Telecommunications Union Telecommunication Standardization Sector (ITU-T) and the American National Standards Institute (ANSI). BISDN supports rates from E3 (34 Mbps) to multiple gigabits per second (Gbps).

The DS3 interface performs physical layer translation from the AIP to a DS3 line interface in accordance with ATM Forum UNI Specification Version 3.1, ACCUNET T45 service specifications, and ANSI T1.107.

AIP Installation Prerequisites

Before you begin this installation, review the safety and ESD-prevention guidelines in this section to avoid injuring yourself or damaging the equipment. This section also provides a list of parts and tools you will need to perform the installation.

Software Requirements

The AIP is compatible with any Cisco 7000 series router that is operating with the following system software: Cisco IOS Release 10.0 or later.

To ensure correct operation of the E3, DS3, and TAXI AIPs, Hardware Revision 1.3 (shipped from March 1995), the following minimum Cisco IOS release levels are required: 10.0(9), 10.2(5), 10.3(1), or later.

The **show version** command displays the current hardware configuration of the router, including the system software version that is currently loaded and running. The **show controller cbus** command lists all CxBus interfaces and includes the currently loaded and running microcode version for each. You can check the version of the default ROM image by either removing the board and checking the ROM labels, or by configuring the interface or system software to boot from ROM, restarting the system, and using these same commands to check the running version.

Use the **show version** command to display the current system software version, and use the **show controller cbus** command to display the microcode version of the system processor and each interface processor. In the following example of the **show version** command, the running system software is Release 10.0.

```
Router> show version
GS Software (GS7), Version 10.0
Copyright (c) 1986-1994 by cisco Systems, Inc.
Compiled Thu 05-Feb-93 14:16
(remainder of displayed text omitted from example)
```

In the following example of the **show controller cbus** display, the running AIP microcode is Version 170.30. Note the display of the PLIM type (4B/5B) and available bandwidth (100 Mbps).

```
router# show cont cbus
Switch Processor 5, hardware version 11.1, microcode version 170.46
 Microcode loaded from system
   512 Kbytes of main memory, 128 Kbytes cache memory
   60 1520 byte buffers, 91 4496 byte buffers
   Restarts: 0 line down, 0 hung output, 0 controller error
 AIP 4, hardware version 1.0, microcode version 170.30
   Microcode loaded from system
   Interface 32 - ATM4/0, PLIM is 4B5B(100Mbps)
     15 buffer RX queue threshold, 36 buffer TX queue limit, buffer size 4496
     ift 0007, rql 12, tq 0000 0620, tql 36
     Transmitter delay is 0 microseconds
```

If the displays indicate that the running system software is an earlier version than Release 10.0 or that the running system processor microcode is an earlier version than 1.2, check the contents of Flash memory to determine if the required images are available on your system. The **show flash** command displays a list of all files stored in Flash memory.

Hardware Requirements

To ensure correct operation of the E3, DS3, and TAXI AIPs, Hardware Revision 1.3 (shipped from March 1995), the following minimum Cisco IOS release levels are required: 10.0(9), 10.2(5), 10.3(1), or later.

⚠ **Caution** To ensure compliance with EMI standards, the E3 PLIM connection requires an EMI filter clip (CLIP-E3-EMI) on the receive port (RCVR).

SONET Distance Limitations

The SONET specification for fiber-optic transmission defines two types of fiber: single mode and multimode. Modes can be thought of as bundles of light rays entering the fiber at a particular angle. Single-mode fiber allows only one mode of light to propagate through the fiber, while multimode fiber allows multiple modes of light to propagate through the fiber. Because multiple modes of light propagating through the fiber travel different distances depending on the entry angles, causing them to arrive at the destination at different times (a phenomenon called modal dispersion), single-mode fiber is capable of higher bandwidth and greater cable run distances than multimode fiber.

The typical maximum distances for single-mode and multimode transmissions, as defined by SONET, are listed in Table 1. If the distance between two connected stations is greater than these maximum distances, significant signal loss can result, making transmission unreliable.

Table 1   SONET Maximum Fiber-Optic Transmission Distances

Transceiver Type	Maximum Distance between Stations[1]
Single-mode	Up to 9 miles (15 kilometers)
Multimode	Up to 1.5 miles (3 kilometers)

1. Table 1 gives typical results. You should use the power budget calculations to determine the actual distances.

Evaluating the Power Budget

To design an efficient optical data link, you need to evaluate the power budget. The power budget is the amount of light available to overcome attenuation in an optical link and to exceed the minimum power that the receiver requires to operate within its specifications. Proper operation of an optical data link depends on modulated light reaching the receiver with enough power to be correctly demodulated.

Attenuation, caused by the passive media components (cables, cable splices, and connectors), is common to both multimode and single-mode transmission.

The following variables reduce the power of the signal (light) transmitted to the receiver in multimode transmission:

- Chromatic dispersion (spreading of the signal in time because of the different speeds of light wavelengths)

- Modal dispersion (spreading of the signal in time because of the different propagation modes in the fiber)

Attenuation is significantly lower for optical fiber than for other media. For multimode transmission, chromatic and modal dispersion reduce the available power of the system by the combined dispersion penalty (dB). The power lost over the data link is the sum of the component, dispersion, and modal losses.

Table 2 lists the factors of attenuation and dispersion limit for typical fiber-optic cable.

Table 2   Typical Fiber-Optic Link Attenuation and Dispersion Limits

Limits	Single-Mode	Multimode
Attenuation	0.5 dB	1.0 dB/km
Dispersion	No limit	500 MHzkm[1]

1. The product of bandwidth and distance must be less than 500 megahertz per kilometer (MHzkm).

Approximating the AIP Power Margin

The LED used for a multimode transmission light source creates multiple propagation paths of light, each with a different path length and time requirement to cross the optical fiber, causing signal dispersion (smear). Higher order mode loss (HOL) results from light from the LED entering the fiber and being radiated into the fiber cladding. A worst case estimate of power margin (PM) for multimode transmissions assumes minimum transmitter power (PT), maximum link loss (LL), and minimum receiver sensitivity (PR). The worst case analysis provides a margin of error, although not all of the parts of an actual system will operate at the worst case levels.

For SONET versions of the AIP module, the signal must meet the worst case parameters listed in Table 3.

Table 3   AIP SONET Signal Requirements

	Single-Mode	Multimode
PT	−18.5 dB	−15 dB
PR	−30 dB	−28 dB
PM	11.5 dB	13 dB

The power budget (PB) is the maximum possible amount of power transmitted. The following equation shows the calculation of the power budget:

$$PB = PT - PR$$

$$PB = -18.5 - (-30)$$

$$PB = -18.5 + 30$$

$$PB = 11.5 \text{ dB}$$

The power margin (PM) calculation is derived from the power budget minus the link loss (LL), as follows:

$$PM = PB - LL$$

If the power margin is positive, as a rule, the link will work.

Table 4 lists the factors that contribute to link loss and the estimate of the link loss value attributable to those factors.

Table 4   Estimating Link Loss

Link Loss Factor	Estimate of Link Loss Value
Higher order mode losses	0.5 dB
Clock recovery module	1 dB
Modal and chromatic dispersion	Dependent on fiber and wavelength used
Connector	0.5 dB
Splice	0.5 dB
Fiber attenuation	1 dB/km

Note   After calculating the power budget minus the data link loss, the result should be greater than zero; this is the power margin. Results less than zero might have insufficient power to operate the receiver.

Multimode Power Margin Example with Sufficient Power for Transmission

The following is an example of a multimode power margin calculation based on the following variables:

- Length of multimode link = 3 kilometers (km), with a loss of 1.0 dB per km

- 4 connectors, each with a loss of 0.5 dB

- 3 splices, each with a loss of 0.5 dB

- Higher order loss (HOL) of 0.5 dB

- Clock recovery module (CRM), with a loss of 1.0 dB

Estimate the power margin as follows:

PM = 11.5 dB – 3 km (1.0 dB/km) – 4 (0.5 dB) – 3 (0.5 dB) – 0.5 dB (HOL) – 1 dB (CRM)

PM = 11.5 dB – 3 dB – 2 dB – 1.5 dB – 0.5 dB – 1 dB

PM = 2.5 dB

The value of 3.5 dB indicates that this link would have sufficient power for transmission.

Multimode Power Margin Example of Dispersion Limit

Following is an example with the same parameters as the previous example, but with a multimode link distance of 4 km:

PM = 11.5 dB – 4 km (1.0 dB/km) – 4 (0.5 dB) – 3 (0.5 dB) – 0.5 dB (HOL) – 1 dB (CRM)

PM = 11.5 dB – 4 dB – 2 dB – 1.5 dB – 0.5 dB – 1 dB

PM = 1.5 dB

The value of 1.5 dB indicates that this link would have sufficient power for transmission; however, because of the dispersion limit on the link (4 km x 155.52 MHz > 500 MHzkm), this link would not work with multimode fiber. In this case, single-mode fiber would be the better choice.

Single-Mode Transmission

The single-mode signal source is an injection laser diode. Single-mode transmission is useful for longer distances because there is a single transmission path within the fiber, and smear does not occur. In addition, chromatic dispersion is reduced because laser light is essentially monochromatic.

The maximum overload specification on the single-mode receiver is –14 dB. The single-mode receiver can be overloaded when using short lengths of fiber because the transmitter can transmit up to –8 dB, while the receiver could be overloaded at –14 dB, but no damage to the receiver will result. To prevent overloading the receiver connecting short fiber links, insert a 5- to 10-dB attenuator on the link between any single-mode SONET transmitter and the receiver.

SONET Single-Mode Power Budget Example

The following example of a single-mode power budget describes two buildings, 11 kilometers apart (with a loss of .05 dB/km), connected through a patch panel in an intervening building with a total of 12 connectors (each with a loss of 0.5 dB).

Estimate the power budget as follows:

PB = 11.5 dB – 11 km (0.5 dB/km) – 12 (0.5 dB)

PB = 11.5 dB – 5.5 dB – 6 dB

PB = 2.5 dB

The value of 2.5 dB indicates that this link would have sufficient power for transmission and is not in excess of the maximum receiver input power.

Using Statistics to Estimate the Power Budget

Statistical models more accurately determine the power budget than the worst case method. Determining the link loss with statistical methods requires accurate knowledge of variations in the data link components. Statistical power budget analysis is beyond the scope of this document. For further information, refer to UNI Forum specifications, ITU-T standards, and your equipment specifications.

Additional Power Budget and Attenuation References

The following publications contain information on determining attenuation and power budget:

- T1E1.2/92-020R2 ANSI, the Draft American National Standard for Telecommunications entitled "Broadband ISDN Customer Installation Interfaces: Physical Layer Specification"

- *Power Margin Analysis, AT&T Technical Note,* TN89-004LWP, May 1989

List of Parts and Tools

You need the following tools and parts to install or upgrade an AIP. If you need additional equipment, contact your service representative for ordering information.

- Number 2 Phillips screwdriver

- 3/16-inch flat-blade screwdriver

- ATM interface cable to connect the AIP with the ATM network

- ESD cord and wrist strap

Safety Guidelines

This section lists safety guidelines to follow when working with any equipment that connects to electrical power or telephone wiring.

Safety Warnings

Safety warnings appear throughout this publication in procedures that, if performed incorrectly, might harm you. A warning symbol precedes each warning statement.

Warning   Means *danger.* You are in a situation that could cause bodily injury. Before you work on any equipment, be aware of the hazards involved with electrical circuitry and be familiar with standard practices for preventing accidents. To see translations of the warnings that appear in this publication, refer to the *Regulatory Compliance and Safety Information* document that accompanied this device.

Waarschuwing   Dit waarschuwingssymbool betekent gevaar. U verkeert in een situatie die lichamelijk letsel kan veroorzaken. Voordat u aan enige apparatuur gaat werken, dient u zich bewust te zijn van de bij elektrische schakelingen betrokken risico's en dient u op de hoogte te zijn van standaard maatregelen om ongelukken te voorkomen. Voor vertalingen van de waarschuwingen die in deze publicatie verschijnen, kunt u het document *Regulatory Compliance and Safety Information* (Informatie over naleving van veiligheids- en andere voorschriften) raadplegen dat bij dit toestel is ingesloten.

Varoitus   Tämä varoitusmerkki merkitsee vaaraa. Olet tilanteessa, joka voi johtaa ruumiinvammaan. Ennen kuin työskentelet minkään laitteiston parissa, ota selvää sähkökytkentöihin liittyvistä vaaroista ja tavanomaisista onnettomuuksien ehkäisykeinoista. Tässä julkaisussa esiintyvien varoitusten käännökset löydät laitteen mukana olevasta *Regulatory Compliance and Safety Information* -kirjasesta (määräysten noudattaminen ja tietoa turvallisuudesta).

Attention   Ce symbole d'avertissement indique un danger. Vous vous trouvez dans une situation pouvant causer des blessures ou des dommages corporels. Avant de travailler sur un équipement, soyez conscient des dangers posés par les circuits électriques et familiarisez-vous avec les procédures couramment utilisées pour éviter les accidents. Pour prendre connaissance des traductions d'avertissements figurant dans cette publication, consultez le document *Regulatory Compliance and Safety Information* (Conformité aux règlements et consignes de sécurité) qui accompagne cet appareil.

Warnung   Dieses Warnsymbol bedeutet Gefahr. Sie befinden sich in einer Situation, die zu einer Körperverletzung führen könnte. Bevor Sie mit der Arbeit an irgendeinem Gerät beginnen, seien Sie sich der mit elektrischen Stromkreisen verbundenen Gefahren und der Standardpraktiken zur Vermeidung von Unfällen bewußt. Übersetzungen der in dieser Veröffentlichung enthaltenen Warnhinweise finden Sie im Dokument *Regulatory Compliance and Safety Information* (Informationen zu behördlichen Vorschriften und Sicherheit), das zusammen mit diesem Gerät geliefert wurde.

Avvertenza Questo simbolo di avvertenza indica un pericolo. La situazione potrebbe causare infortuni alle persone. Prima di lavorare su qualsiasi apparecchiatura, occorre conoscere i pericoli relativi ai circuiti elettrici ed essere al corrente delle pratiche standard per la prevenzione di incidenti. La traduzione delle avvertenze riportate in questa pubblicazione si trova nel documento *Regulatory Compliance and Safety Information* (Conformità alle norme e informazioni sulla sicurezza) che accompagna questo dispositivo.

Advarsel Dette varselsymbolet betyr fare. Du befinner deg i en situasjon som kan føre til personskade. Før du utfører arbeid på utstyr, må du vare oppmerksom på de faremomentene som elektriske kretser innebærer, samt gjøre deg kjent med vanlig praksis når det gjelder å unngå ulykker. Hvis du vil se oversettelser av de advarslene som finnes i denne publikasjonen, kan du se i dokumentet *Regulatory Compliance and Safety Information* (Overholdelse av forskrifter og sikkerhetsinformasjon) som ble levert med denne enheten.

Aviso Este símbolo de aviso indica perigo. Encontra-se numa situação que lhe poderá causar danos físicos. Antes de começar a trabalhar com qualquer equipamento, familiarize-se com os perigos relacionados com circuitos eléctricos, e com quaisquer práticas comuns que possam prevenir possíveis acidentes. Para ver as traduções dos avisos que constam desta publicação, consulte o documento *Regulatory Compliance and Safety Information* (Informação de Segurança e Disposições Reguladoras) que acompanha este dispositivo.

¡Advertencia! Este símbolo de aviso significa peligro. Existe riesgo para su integridad física. Antes de manipular cualquier equipo, considerar los riesgos que entraña la corriente eléctrica y familiarizarse con los procedimientos estándar de prevención de accidentes. Para ver una traducción de las advertencias que aparecen en esta publicación, consultar el documento titulado *Regulatory Compliance and Safety Information* (Información sobre seguridad y conformidad con las disposiciones reglamentarias) que se acompaña con este dispositivo.

Varning! Denna varningssymbol signalerar fara. Du befinner dig i en situation som kan leda till personskada. Innan du utför arbete på någon utrustning måste du vara medveten om farorna med elkretsar och känna till vanligt förfarande för att förebygga skador. Se förklaringar av de varningar som förkommer i denna publikation i dokumentet *Regulatory Compliance and Safety Information* (Efterrättelse av föreskrifter och säkerhetsinformation), vilket medföljer denna anordning.

Electrical Equipment

Follow these basic guidelines when working with any electrical equipment:

- Before beginning any procedures requiring access to the chassis interior, locate the emergency power-off switch for the room in which you are working.

- Disconnect all power and external cables before moving a chassis.

- Do not work alone if potentially hazardous conditions exist.

- Never assume that power is disconnected from a circuit; always check.

- Do not perform any action that creates a potential hazard to people or makes the equipment unsafe.

- Carefully examine your work area for possible hazards such as moist floors, ungrounded power extension cables, and missing safety grounds.

Telephone Wiring

Use the following guidelines when working with any equipment that is connected to telephone wiring or to other network cabling:

- Never install telephone wiring during a lightning storm.

- Never install telephone jacks in wet locations unless the jack is specifically designed for wet locations.

- Never touch uninsulated telephone wires or terminals unless the telephone line has been disconnected at the network interface.

- Use caution when installing or modifying telephone lines.

Preventing Electrostatic Discharge Damage

Electrostatic discharge (ESD) damage, which can occur when electronic cards or components are improperly handled, results in complete or intermittent failures. Electromagnetic interference (EMI) shielding, connectors, and a handle are integral components of the carrier. Although the metal carrier helps to protect the board from ESD, use a preventive antistatic strap whenever handling an interface processor. Handle the carriers by the handles and the carrier edges only; never touch the boards or connector pins.

Following are guidelines for preventing ESD damage:

- Always use an ESD-preventive wrist or ankle strap and ensure that it makes good skin contact; connect the equipment end of the strap to a captive installation screw on an installed power supply.

- When installing an interface processor, use the ejector levers to properly seat the bus connectors in the backplane, then tighten both captive installation screws. These screws prevent accidental removal, provide proper grounding for the system, and help ensure that the bus connectors are seated in the backplane.

- When removing an interface processor, use the handle to pull the interface processor out slowly while keeping your other hand underneath the carrier to guide it straight out of the slot.

- Handle carriers by the handles and carrier edges only; avoid touching the board or connectors.

- Place a removed interface processor board-side-up on an antistatic surface or in a static shielding bag. If you plan to return the component to the factory, immediately place it in a static shielding bag.

- Avoid contact between the interface processor and clothing. The wrist strap only protects the board from ESD voltages on the body; ESD voltages on clothing can still cause damage.

- Never attempt to remove an interface processor printed circuit board from the metal interface processor carrier.

 Caution For safety, periodically check the resistance value of the antistatic strap. The measurement should be between 1 and 10 megohms.

Interface Processor Slot Locations

The AIP is installed in the interface processor slots in the Cisco 7000 series and Cisco 7500 series routers. The interface processor slots in the Cisco 7000 series and Cisco 7500 series routers are as follows:

- Cisco 7000—slots 0 through 4 (See Figure 2.)

- Cisco 7010—slots 0 through 2 (See Figure 3.)

- Cisco 7505—slots 0 through 3 (See Figure 4.)

- Cisco 7507—slots 0 and 1, and slots 4 through 6 (See Figure 5.)

- Cisco 7513—slots 0 through 5, and slots 8 through 12 (See Figure 6.)

Note   The interface processor slots are oriented horizontally in the Cisco 7010 and Cisco 7505, and vertically in the Cisco 7000, Cisco 7507, and Cisco 7513.

Figure 2   Cisco 7000 Interface Processor Slots
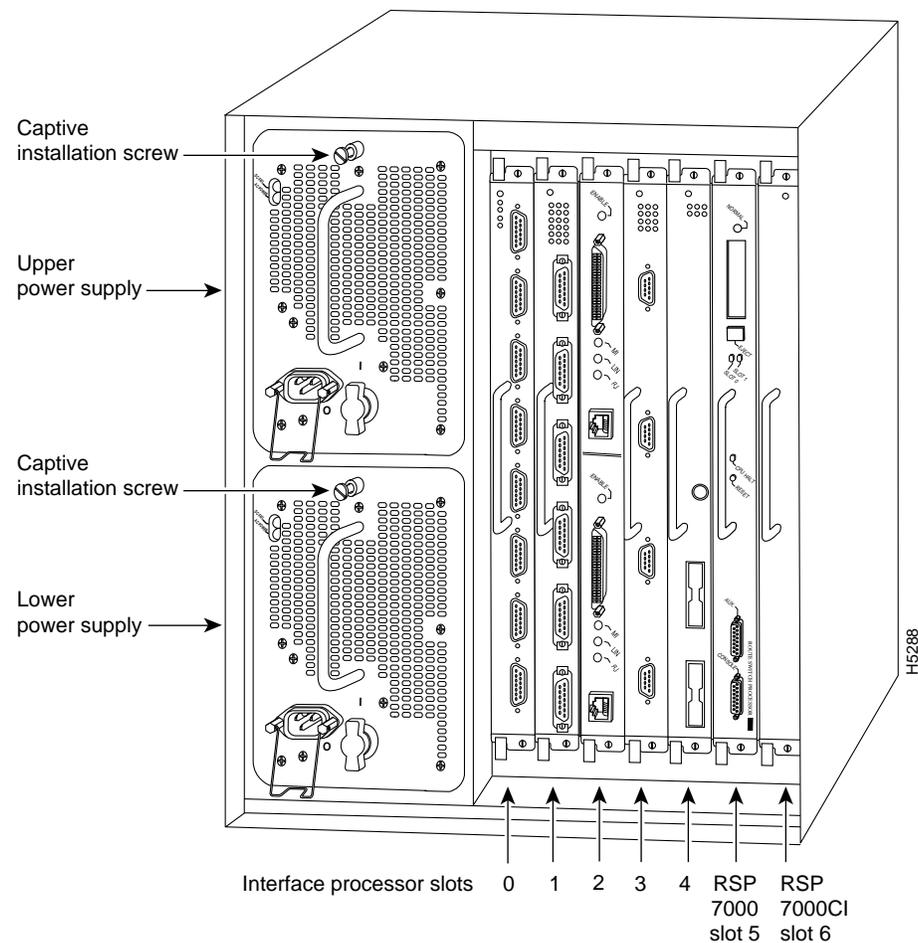
Figure 3   Cisco 7010 Interface Processor Slots

RSP7000CI slot 4
RSP7000 slot 3
Interface processor slot 2
Interface processor slot 1
Interface processor slot 0
DC OK LED

Power switch
Chassis ground screw

Power receptacle   AC-input power supply
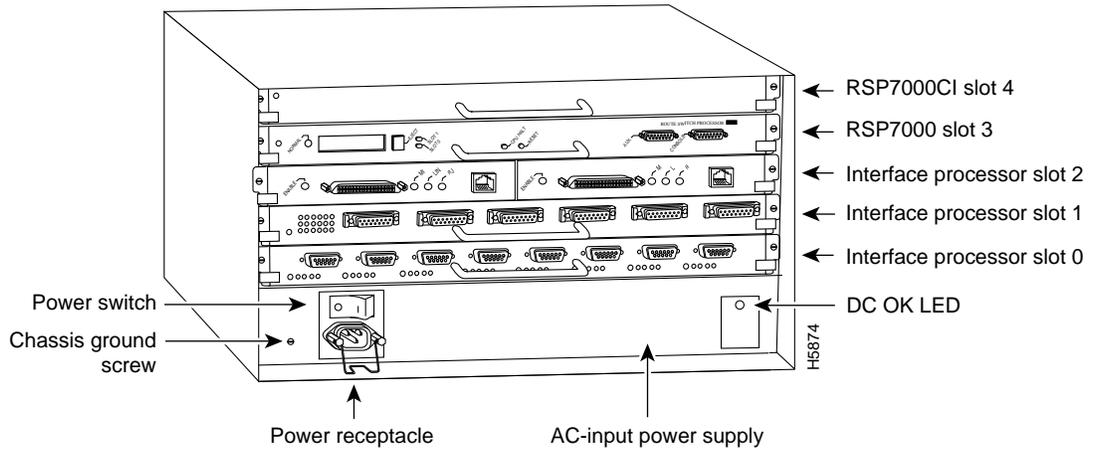
Figure 4   Cisco 7505 Interface Processor Slots

RSP slot
Interface processor slot 3
Interface processor slot 2
Interface processor slot 1
Interface processor slot 0
DC OK LED

ɔwer switch
Chassis grounding receptacles

Power receptacle   AC-input power supply
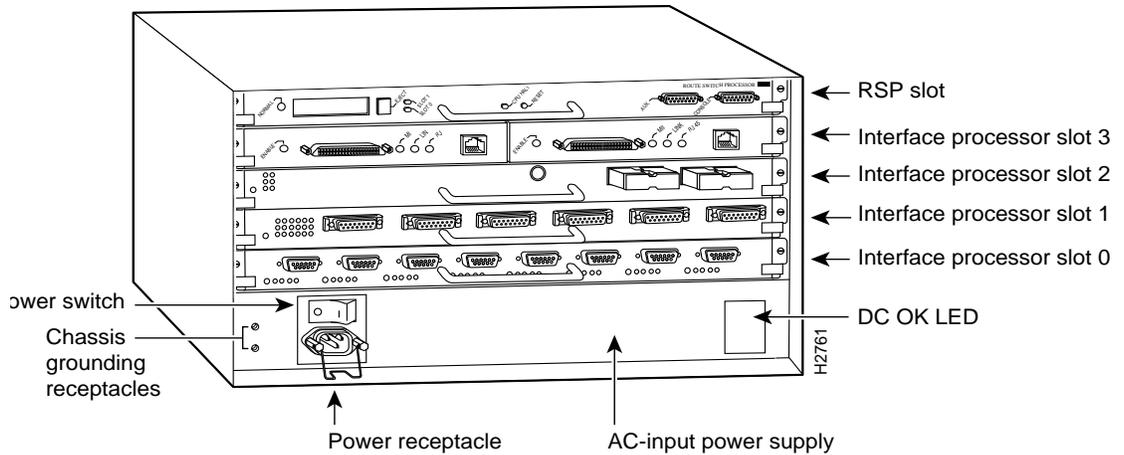
Figure 5   Cisco 7507 Interface Processor Slots

Captive installation screw

Upper power supply

Chassis grounding receptacles

Captive installation screw

Lower power supply

Slot 0   1   2   3   4   5   6

RSP slots

H3888
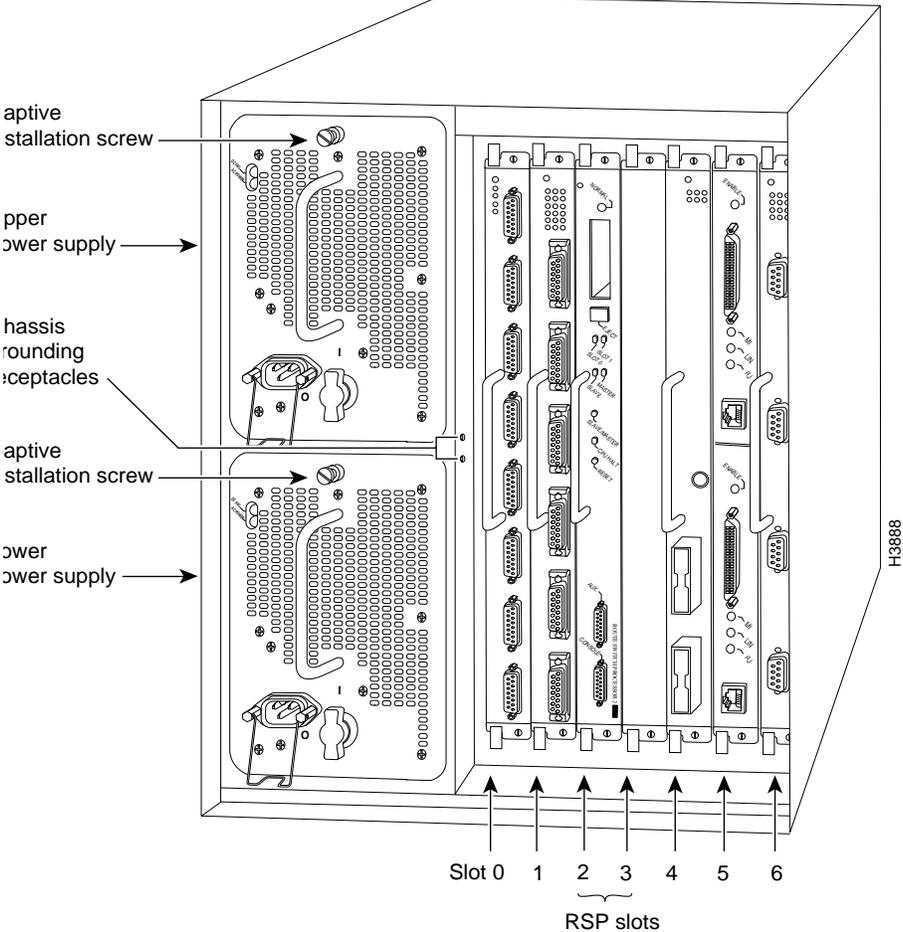
Figure 6   Cisco 7513 Interface Processor Slots
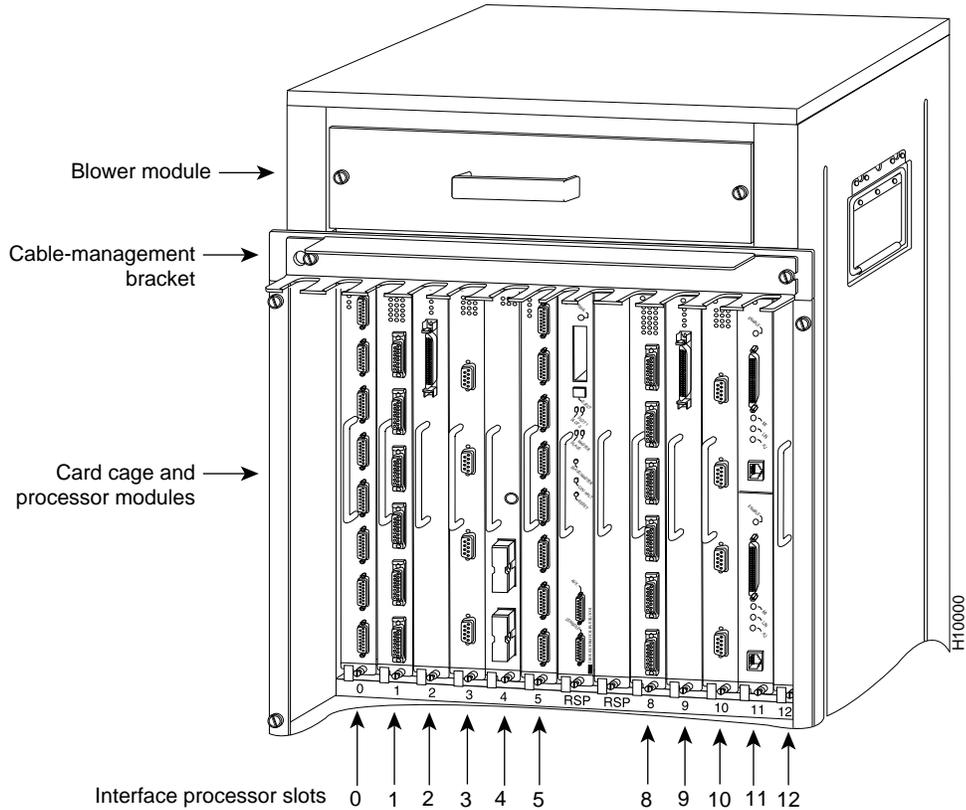
Guidelines for Interface Processor Removal and Installation

This section describes the mechanical functions of system components and emphasizes the importance of following correct procedures to avoid unnecessary board failures. Specific procedures follow these general background and safety guidelines in the section "Interface Processor Replacement Procedures" on page 19.

You can remove and replace interface processors while the system is operating; you do not need to notify the software or reset the system power. This functionality allows you to add, remove, or replace interface processors with the system online, which provides a method that is seamless to end users on the network, maintains all routing information, and ensures session preservation.

After an interface processor is reinstalled, the system brings on line only interfaces that match the current configuration and were previously configured as up; all others require that you configure them with the **configure** command. (For AIP configuration information, refer to the section "Configuring the AIP" on page 32.)

![caution] **Caution**   The system can indicate a hardware failure if you do not follow proper procedures. Remove or insert only one interface processor at a time. Allow at least 15 seconds for the system to complete the preceding tasks before removing or inserting another interface processor. Disrupting the sequence before the system completes its verification can cause the system to interpret hardware failures.

Note We recommend that you install interface processors starting with the slots closest to the RSPs and work out concentrically from there. This will help to ensure that rejection of electromagnetic interference (EMI) is maintained.

All interface processors have ejector levers that allow you to firmly seat an interface processor in the interface processor slot (see Figure 8). The function of the ejector levers is to align and seat the card connectors in the backplane. Failure to use the ejector levers and insert the interface processor properly can disrupt the order in which the pins make contact with the backplane.

Follow the installation and removal instructions carefully, and review the following examples of *incorrect* insertion practices and results:

- Using the handle to force the interface processor all the way into the slot can pop the ejector levers out of their springs. If you then try to use the ejector levers to seat the interface processor, the first layer of pins (which are already mated to the backplane) can disconnect and then remate with the backplane, which the system interprets as a board failure.

- Using the handle to force or slam the interface processor all the way into the slot can also damage the pins on the board connectors if they are not aligned properly with the backplane.

- When using the handle (rather than the ejector levers) to seat the interface processor in the backplane, you might need to pull the interface processor back out and push it in again to align it properly.

  Even if the connector pins are not damaged, the pins mating with and disconnecting from the backplane will cause the system to interpret a board failure. Using the ejector levers ensures that the board connector mates with the backplane in one continuous movement.

- Using the handle to insert or remove an interface processor, or failing to push the ejector levers to the full parallel position, can leave some (not all) of the connector pins mated to the backplane, a state that will hang the system. Using the ejector levers and making sure that they are pushed fully into position ensures that all three layers of pins are mated with (or free from) the backplane.

It is also important to use the ejector levers when removing an interface processor to ensure that the board connector pins disconnect from the backplane in the logical sequence expected by the system. Any processor module (interface processor or RSP) that is only partially connected to the backplane can hang the bus. (Detailed steps for correctly installing and removing an interface processor follow in the section "Interface Processor Replacement Procedures.")

Interface Processor Replacement Procedures

Typically, your interface processors arrive preinstalled in your Cisco 7000 series and Cisco 7500 series routers (with the exception of the Cisco 7513); however, occasionally you might have to remove and replace interface processors for maintenance.

The following sections describe the procedures for removing or installing an interface processor. (Refer the section "Guidelines for Interface Processor Removal and Installation" before removing an interface processor while power to the system is on.)

Caution To avoid erroneous failure messages, remove or insert only one interface processor at a time. Also, after inserting or removing an interface processor, allow at least 15 seconds before removing or inserting another interface processor so that the system can reinitialize and note the current configuration of all interfaces.

> **Note**   If you install or remove other interface processors in a Cisco 7000 series or Cisco 7500 series router with a CT3IP installed, you might have to reboot the system after the removal and replacement of that interface processor. (In general, and to prevent system problems, we recommend you follow the procedures described in this section and the guidelines described in the preceding section "Guidelines for Interface Processor Removal and Installation.")

Removing an Interface Processor

If you are replacing a failed interface processor, remove the existing board first, then install the new interface processor in the same slot. Figure 7 shows proper handling of an interface processor during installation.

Figure 7   Handling Interface Processors during Installation (Horizontal Orientation Shown)

Captive installation
screws
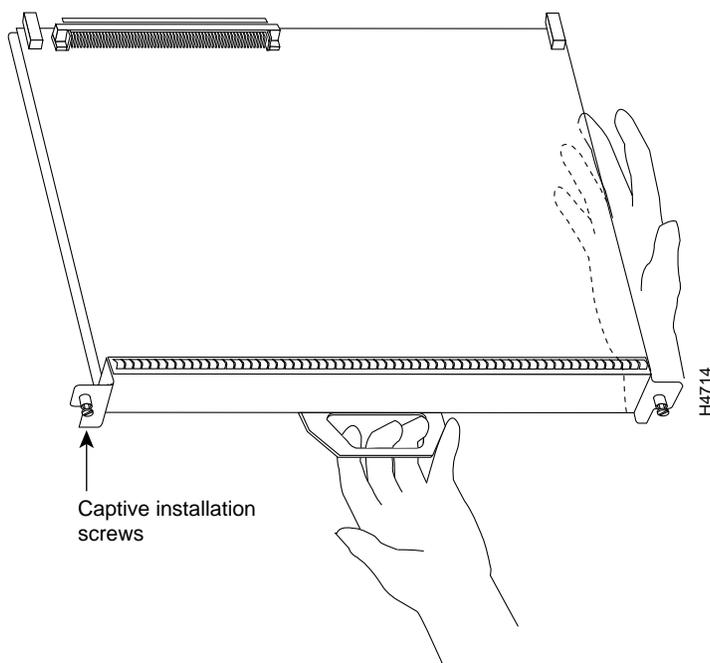
Before you remove an interface processor that you will not replace, or replace an interface processor component, we recommend you shut down (disable) the interfaces to prevent anomalies when you reinstall the new or reconfigured interface processor. When you shut down an interface, it is designated *administratively down* in the **show** command displays.

Use the following procedure to remove an interface processor:

Step 1   Disconnect the interface processor's cables from the interface ports.

Step 2   Loosen the captive installation screws at the ends of the interface processor faceplate. (See Figure 8a.)

> **Caution**   Always use the ejector levers to remove or install an interface processor. Failure to do so can cause erroneous system error messages, indicating a board failure.

Step 3   Place your thumbs on the upper and lower ejector levers and simultaneously push the top ejector lever up and the bottom ejector lever down (in the opposite direction from that shown in Figure 8c) to release an interface processor from the backplane connector.

Step 4   Grasp the interface processor handle with one hand and place your other hand under the carrier to guide the interface processor out of the slot. (See Figure 7.) Avoid touching the board or any connector pins.

Step 5   Carefully pull the interface processor straight out of the slot, keeping one hand under the carrier to guide it. (See Figure 7.) Keep the interface processor parallel to the backplane.

Step 6   Place the removed interface processor on an antistatic mat or foam pad, or place it in an antistatic bag if you will return it to the factory.

Step 7   If the interface processor slot is to remain empty, install an interface processor filler (MAS-7000BLANK=) to keep dust out of the chassis and to maintain proper airflow through the interface processor compartment.

Installing an Interface Processor

Interface processors slide into any available interface processor slot and connect directly to the backplane. The backplane slots are keyed so that interface processors can be installed only in an interface processor slots. Interface processor fillers, which are blank interface processor carriers, occupy empty slots to maintain consistent air flow through the interface processor compartment.

If you install a new interface processor, you have to first remove the interface processor filler from the available interface processor slot. Figure 8 shows functional details of inserting an interface processor and using ejector levers. (Figure 7 shows proper handling of an interface processor during installation.)

Note   There are no restrictions on slot locations or interface processor sequence, and you can install the interface processor in any available interface processor slot; however, in the Cisco 7507 and Cisco 7513, we recommend that you install interface processors starting with the slots closest to the RSPs and work out concentrically from there. This will help prevent electromagnetic interference (EMI).

⚠ **Caution**   Remove or insert only one interface processor at a time. Allow at least 15 seconds for the system to complete the preceding tasks before removing or inserting another interface processor. Disrupting the sequence before the system completes its verification can cause the system to interpret this as a hardware failure.

Use the following procedure to install an interface processor:

Step 1   Ensure that a console terminal is connected to the RP (or RSP) *Console* port and that the console is turned on.

Step 2   Choose an available interface processor slot for the interface processor, and ensure that the interface processor's cable is of a sufficient length to connect the interface processor with any external equipment. We recommend that you install interface processors starting with the slots closest to the RSPs and work out concentrically from there. This will help prevent EMI.

Step 3   Interface processors and interface processor fillers are secured with two captive installation screws. (See Figure 8a.) Use a flat-blade screwdriver to loosen the captive installation screws and remove the interface processor filler (or the existing interface processor) from the slot. If you remove an interface processor, immediately place it in an antistatic bag to prevent damage from electrostatic discharge.

Figure 8   Location of Ejector Levers and Captive Installation Screws
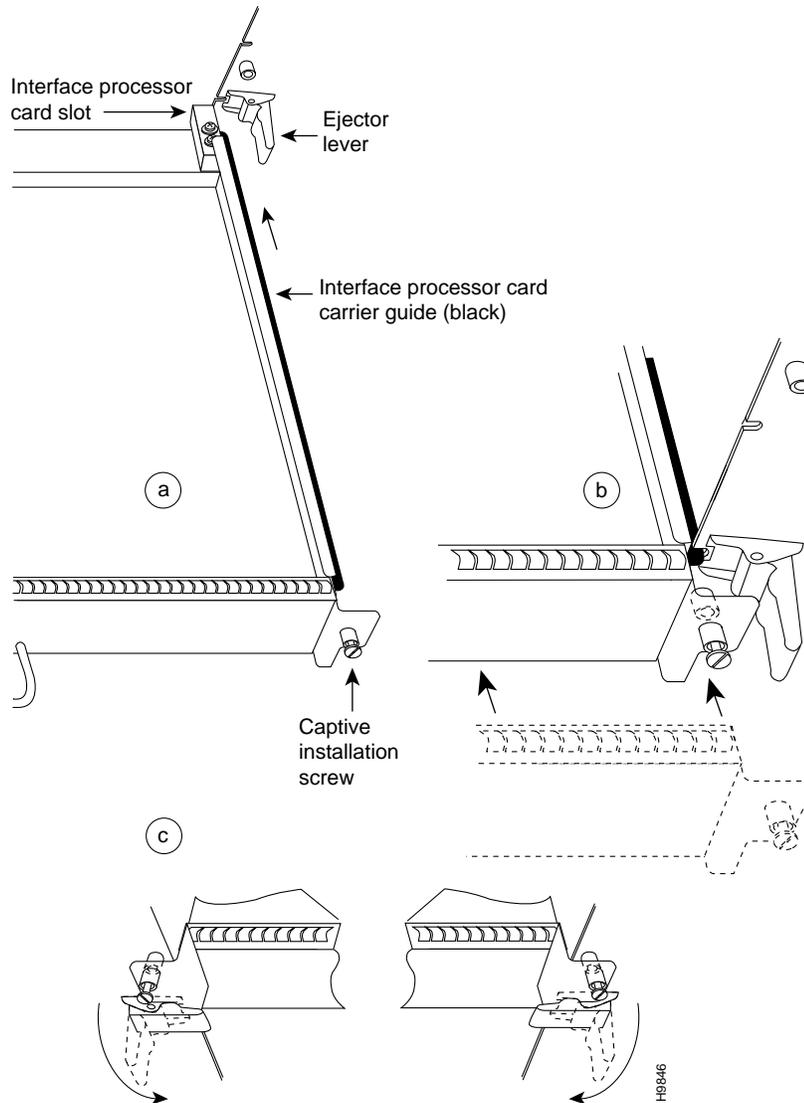
Step 4   Hold the interface processor handle with one hand, and place your other hand under the carrier to support the interface processor (see Figure 7); guide the carrier into the slot. Avoid touching the card or any connector pins.

⚠ **Caution**   To prevent ESD damage, handle interface processors by the handles and carrier edges only.

Step 5 Place the back of the interface processor in the slot and align the notch on the bottom of the carrier with the groove in the slot. (See Figure 8a.)

Step 6 While keeping the interface processor parallel to the backplane, carefully slide the interface processor into the slot until the back of the faceplate makes contact with the ejector levers, then *stop*. (See Figure 8b.)

Caution Always use the ejector levers when installing or removing processor modules. A module that is partially seated in the backplane will cause the system to hang and subsequently crash.

Step 7 Using the thumb and forefinger of each hand to pinch each ejector lever, simultaneously push the top ejector lever down and the bottom ejector lever up until both are parallel to the faceplate. (See Figure 8c.)

Step 8 Tighten the captive screws on the top and bottom of the interface processor faceplate to prevent the interface processor from becoming partially dislodged from the backplane and ensure proper EMI shielding. (These screws must be tightened to meet EMI specifications.)

Caution To ensure adequate space for additional interface processors, always tighten the captive installation screws on each newly installed interface processor *before* you insert any additional interface processors. These screws also prevent accidental removal, and provide proper grounding and EMI shielding for the system.

ATM Interface Cables

An ATM interface cable is used to connect your router to an ATM network or to connect two routers back-to-back.

The AIP can support interfaces that connect to the following physical layers:

- Transparent Asynchronous Transmitter/Receiver Interface (TAXI) 4B/5B 100-Mbps multimode fiber-optic

- SONET/SDH 155-Mbps multimode fiber-optic—STS-3C or STM-1

- SONET/SDH 155-Mbps single-mode fiber-optic—STS-3C or STM-1

- E3 34-Mbps coaxial cable

- DS3 44.736-Mbps (20 parts per million [ppm]) coaxial cable

Following are descriptions of the network interface cables used with the AIP.

- For TAXI 4B/5B traffic over multimode fiber, use the multimode MIC interface cable to connect the AIP with the external ATM switch. (See Figure 9.)

Figure 9   Multimode Network Interface Connector (MIC Type)
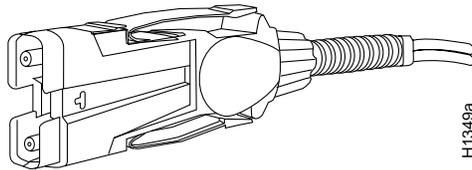
- For SONET/SDH multimode connections, use one multimode duplex SC connector (see Figure 10) or two single SC connectors (see Figure 11).

Figure 10   Duplex SC Connector
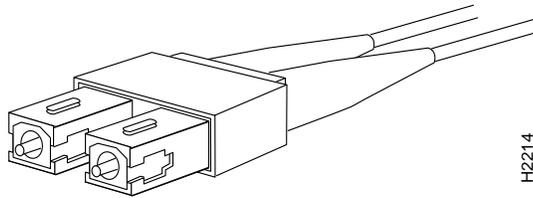
Figure 11   Simplex SC Connector
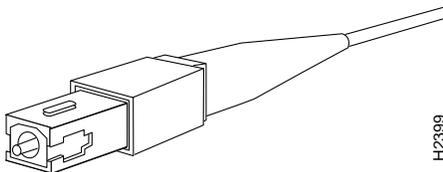
- For SONET/SDH single-mode connections, use the single-mode (ST2) connector (bayonet-style twist-lock). (See Figure 12.)

Figure 12   ST2 Connector
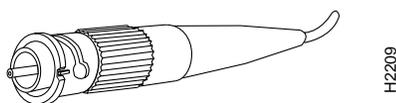
Warning   Invisible laser radiation can be emitted from the aperture ports of the single-mode ATM products when no fiber-optic cable is connected. *Avoid exposure and do not stare into open apertures*. This product meets the Class 1 Laser Emission Requirement from CDRH FDDI.

- For E3 and DS3 connections, use the 75-ohm, RG-59 coaxial cable CAB-ATM-DS3/E3, which has bayonet-style, twist-lock (BNC) connectors and ferrite beads. (See Figure 13.) The E3 and DS3 PLIMs both require cable CAB-ATM-DS3/E3.

Figure 13   CAB-ATM-DS3/E3 Cable (RG-59 Coaxial Cable with BNC Connectors)
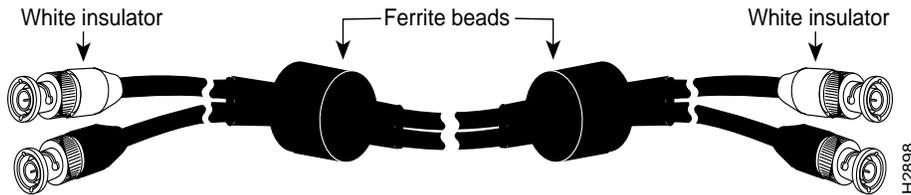
White insulator   Ferrite beads   White insulator

H2898

Caution   To ensure compliance with EMI standards, the E3 PLIM connection requires an EMI filter clip (CLIP-E3-EMI) on the receive port (RCVR); the DS3 PLIM connection does not require this clip.

- For multimode connections, connect the multimode interface cable to the MIC connector. (See Figure 14.)

Figure 14   MIC Connector on a TAXI 4B/5B PLIM

H2213
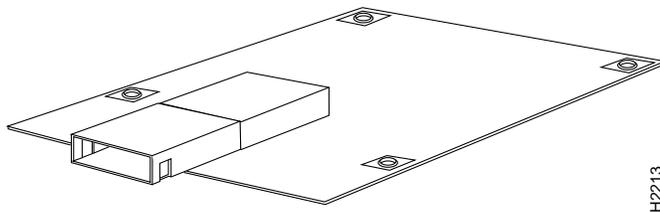
Note   To ensure correct operation of the TAXI, E3, and DS3 AIPs, Hardware Revision 1.3 (shipped from March 1995), the following minimum Cisco IOS release levels are required: Release 10.0(9), 10.2(5), 10.3(1) or later.

- For multimode SONET connections, connect the multimode cable to the SC connector on the PLIM. (See Figure 15.)

Figure 15   SONET Multimode SC Duplex PLIM
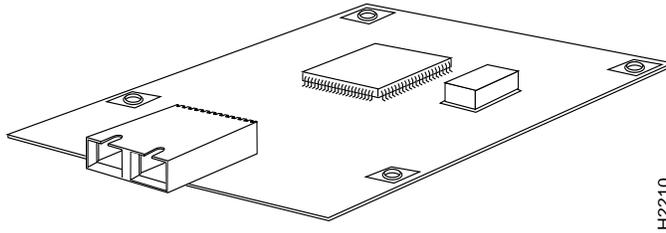
The SONET multimode SC-duplex connector is shipped with a dust plug. (See Figure 16.) Remove it by pulling on the plug as you squeeze its sides.

Figure 16   SONET ATM Multimode Fiber-Optic Transceiver and Dust Plug
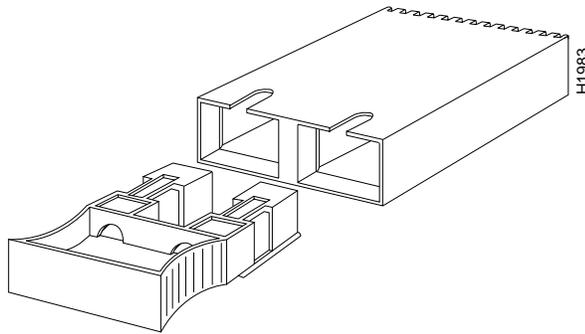
- For single-mode SONET connections, connect the single-mode cable to the ST connector on the SONET PLIM. (See Figure 17.)

Figure 17   SONET Single-Mode PLIM
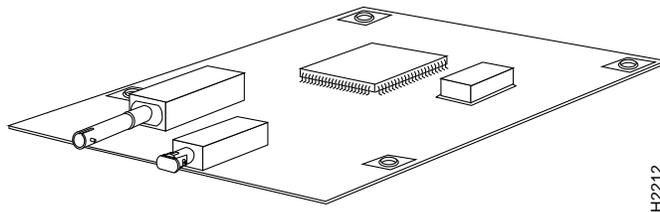
- For E3 and DS3 connections, connect the coaxial cable to the BNC connector on the E3 or DS3 PLIM. (See Figure 18.)

Note   The E3 and DS3 PLIMs require cable CAB-ATM-DS3/E3. Ensure that the transmit and receive portions of the cable are connected to the appropriate PLIM connectors, as shown in Figure 18. To ensure correct operation of the E3, DS3, and TAXI AIPs, Hardware Revision 1.3 (shipped from March 1995), the following minimum Cisco IOS release levels are required: 10.0(9), 10.2(5), 10.3(1), or later.

Figure 18   E3 and DS3 PLIM (Representative of Both PLIMs)
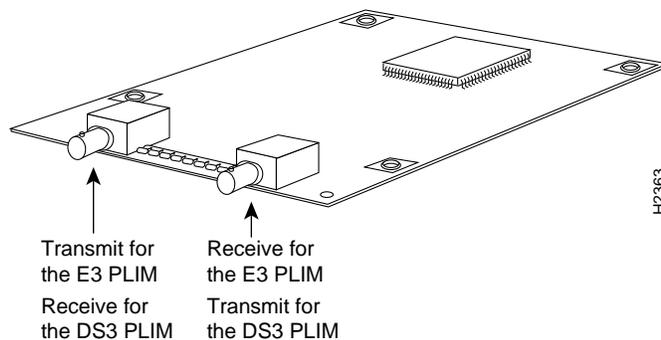
Transmit for
the E3 PLIM

Receive for
the DS3 PLIM

Receive for
the E3 PLIM

Transmit for
the DS3 PLIM

H2363

⚠ **Caution**   To ensure compliance with EMI standards, the E3 PLIM connection requires an EMI filter clip (CLIP-E3-EMI) on the receive port (RCVR); the DS3 PLIM connection does not require this clip. Figure 21, on page 30, shows the EMI filter clip assembly that is required for the E3 PLIM. *Do not* operate the E3 PLIM without this assembly.

Attaching Network Interface Cables to the AIP

All AIP interfaces are full duplex. You must use the appropriate ATM interface cable to connect the AIP to an external ATM network. The AIP provides an interface to an ATM switching fabric for transmitting and receiving data at up to 155 megabits per second (Mbps) bidirectionally. The actual data rate is determined by the physical layer interface module (PLIM).

Connect AIP cables as shown in Figure 19.

Figure 19   Connecting Cables to the AIP
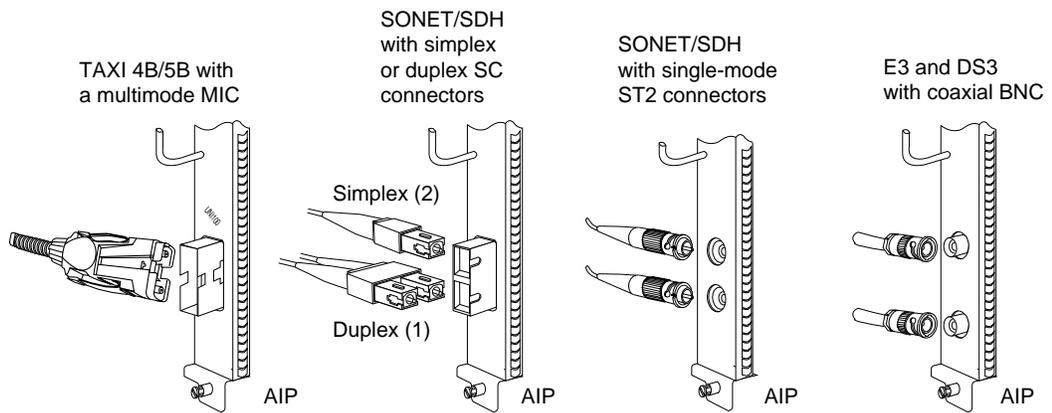
Warning   Invisible laser radiation may be emitted from the aperture ports of the single-mode products when no fiber cable is connected. *Avoid exposure and do not stare into open apertures*.

The aperture port contains a warning label, as shown in Figure 20.

Figure 20   Warning Label on the AIP

Caution   To ensure compliance with EMI standards, the E3 PLIM connection requires an EMI filter clip (CLIP-E3-EMI) on the receive port (RCVR); the DS3 PLIM connection does not require this clip. The following procedure and figure discuss the EMI filter clip assembly that is required for the E3 PLIM. *Do not* operate the E3 PLIM without this assembly.

Use the following procedure to install a CAB-ATM-DS3/E3 cable and EMI filter clip:

Step 1   Attach the CAB-ATM-DS3/E3 cable to the transmit (XMTR) and receive (RCVR) ports on the E3 PLIM, as shown in Figure 21A.

One portion of the cable has a white insulator on both ends to ensure that the receive-to-transmit and transmit-to-receive relationship is maintained between the E3 PLIM and your ATM switch. The white banded portion of the cable should attach between the receive and transmit *or* transmit and receive ports of the E3 PLIM and your ATM switch, respectively.

Step 2   Hold the EMI filter clip as shown in Figure 21B.

Step 3   Attach the EMI filter clip to the receive cable, as shown in Figure 21C.

Note   Make certain the EMI filter clip makes mechanical contact with the metal sleeve on the cable connector *and* the metal sleeve on the E3 PLIM connector.

Step 4   To ensure that the clip is not pulled off when adjacent interface processors are removed, position the clip parallel to the orientation of the AIP, as shown in Figure 21C and D.

Figure 21   Attaching CAB-ATM-DS3/E3 and EMI Filter Clip to E3 or DS3 PLIMs
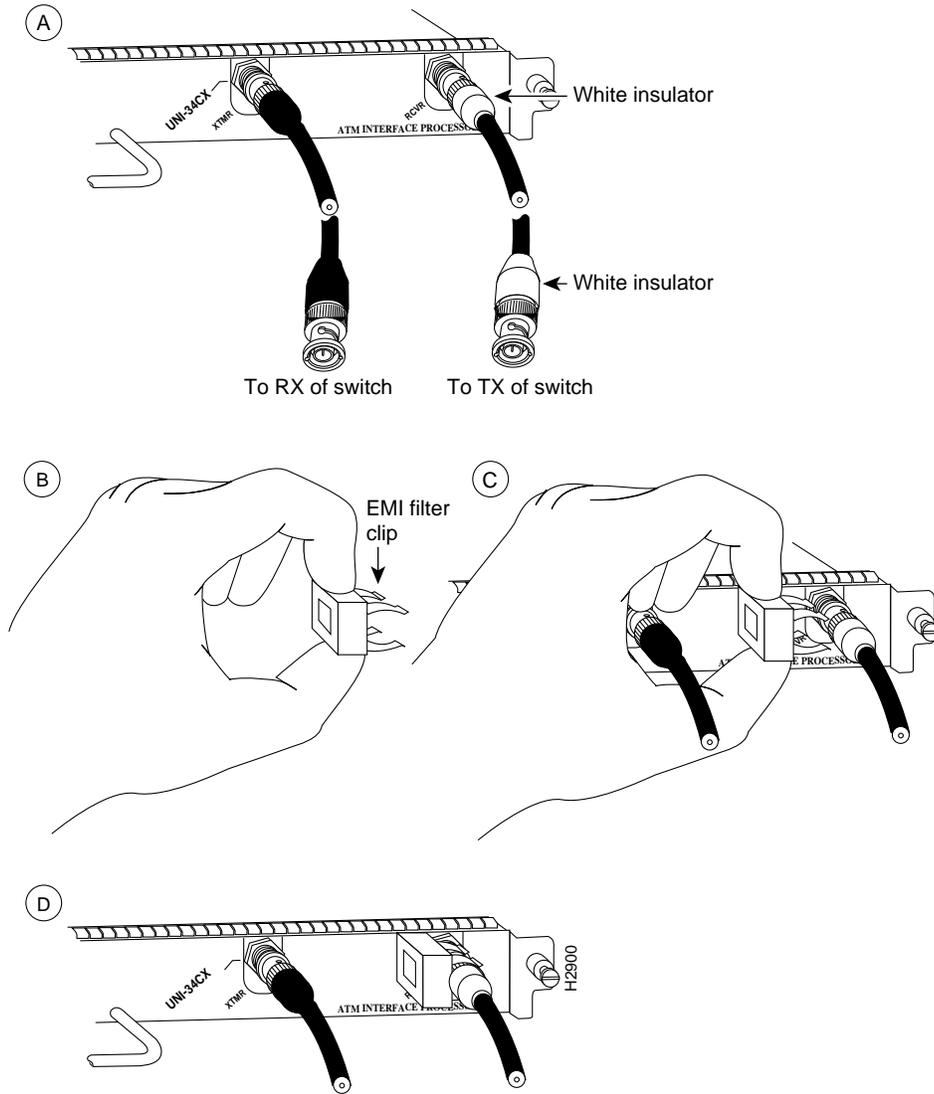
Using LEDs to Check AIP Status

Each AIP model has three status LEDs on its faceplate. (See Figure 22.)

Figure 22   AIP LEDs
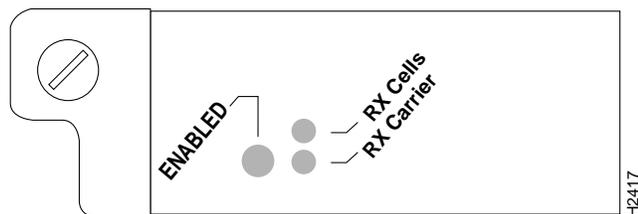
AIP LEDs function as follows:

- Enabled—When on, this LED indicates that the AIP is enabled for operation; however, the interface ports might not be functional or enabled.

- RX cells —When on, indicates that the AIP has received an ATM cell. This LED will flicker in normal operation, indicating traffic.

- RX carrier —When on, indicates that the AIP has detected carrier on the RX cable. For a fiber-optic interface, this means simply that light is detected.

After you connect cables to the AIP, observe the LED states and the console display as the router initializes. When the system has reinitialized all interfaces, the enabled LED on the AIP should go on. The console screen will also display a message as the system discovers each interface during its reinitialization. After system initialization, the enabled LED goes on to indicate that the AIP is enabled for operation.

The following conditions must be met before the AIP is enabled:

- The AIP is correctly connected to the backplane and receiving power.

- The system bus recognizes the AIP.

- A valid version of AIP microcode is loaded and running.

If any one of these conditions is not met, the enabled LED does not go on.

Verify that the AIP is connected correctly as follows:

Step 1 While the system reinitializes each interface, observe the console display messages and verify that the system discovers the AIP. The system should recognize the ATM interface but leave the interface configured as *down*.

Step 2 When the reinitialization is complete, verify that the enabled LED on the AIP is on and remains on. If the LED does stay on, proceed to Step 5. If the enabled LED does not stay on, proceed to the next step.

Step 3 If the enabled LED on the AIP fails to go on, suspect the that the AIP board connector is not fully seated in the backplane. Loosen the captive installation screws, then firmly push the top ejector down while pushing the bottom ejector up until both are parallel to the AIP faceplate. Tighten the captive installation screws. After the system reinitializes the interfaces, the enabled LED on the AIP should go on. If the enabled LED goes on, proceed to Step 5. If the enabled LED does not go on, proceed to the next step.

Step 4 If the enabled LED still fails to go on, remove the AIP and try installing the AIP in another available interface processor slot.

- If the enabled LED goes on when the AIP is installed in the new slot, suspect a failed backplane port in the original interface processor slot.

- If the enabled LED still fails to go on, but other LEDs on the AIP go on to indicate activity, proceed to Step 5 to resume the installation checkout and suspect that the enabled LED on the AIP has failed.

- If no LEDs on the AIP go on, suspect that the AIP is faulty.

- If the enabled LED still does not go on, do not proceed with the installation. Contact a service representative to report the faulty equipment and obtain further instructions.

Step 5   Use the **show interfaces** or **show controllers cbus** command to verify the status of the
ATM interface. (If the ATM interface is not configured, you must use the procedures in
the section "Configuring the AIP" to configure the interface.)

If an error message displays on the console terminal, refer to the appropriate reference publication
for error message definitions. If you experience other problems that you are unable to solve, contact
a service representative for assistance.

This completes the procedure for checking initial AIP status.

Configuring the AIP

Configuration of the AIP (and ATM) is a two-step process:

1 Configure the AIP. To do so, complete the following tasks:

— Enable the AIP

— Configure the rate queue

— Customize the AIP configuration (optional)

Configure PVCs

Configure SVCs

— Monitor and maintain the ATM interface (optional).

The first two tasks are required, and then you must configure at least one PVC or SVC. The VC
options you configure must match in three places: on the router, on the ATM switch, and at the
remote end of the PVC or SVC connection.

2 Configure the ATM switch to which your AIP will connect.

Note   To configure your ATM switch, refer to the user documentation for your ATM switch.

On power up, the interface on a new AIP is shut down. To enable the interface, you must enter the
no shutdown command in configuration mode. When the AIP is enabled (taken out of shutdown)
with no additional arguments, the default interface configuration file parameters are used.

These default parameters are listed in Table 5.

Table 5   AIP Configuration Default Values

Parameter	Configuration Command	Default Value
MTU	**mtu** *bytes*	4470 bytes
Exception queue buffers	**atm exception-queue**	32
ATM virtual path filter	**atm vp-filter hexvalue**	0x7B (hexadecimal)
Receive buffers	**atm rxbuff**	256
Transmit buffers	**atm txbuff**	256
Maximum number of VCs	**atm maxvc**	2048
AAL encapsulation	**atm aal aal5**	AAL5
ATM raw cell queue size	**atm rawq-size**	32
ATM VCs per VP	**atm vc-per-vp**	1024

After you verify that the new AIP is installed correctly (the enabled LED goes on and all cables are correctly connected), you can configure the new ATM interface. Be prepared with the information you will need, such as the interface IP address, MTU size, AAL mode, and desired rate queues.

Interface Port Numbering for the ATM Interface

The Cisco 7000 series and Cisco 7500 series routers identify an interface address by its interface processor slot number and port number in the format *slot/port*. Because each AIP contains a single ATM interface, the port number is always 0. For example, the slot/port address of an ATM interface on an AIP installed in interface processor slot 0 would be 0/0; if installed in interface processor slot 1, the slot/port address changes to 1/0.

Configuring the Interface

Use the following guidelines to perform a basic configuration: enabling an interface and specifying IP routing. You might also need to enter other configuration subcommands, depending on the requirements for your system configuration and the protocols you plan to route on the interface.

For additional descriptions of configuration subcommands and the configuration options available for ATM, refer to the appropriate router system software configuration publications listed in the section "If You Need More Information" on page 2.

Configuring the AIP first requires privileged-level access to the EXEC command interpreter. Also, privileged-level access usually requires a password. (Contact your system administrator, if necessary, to obtain privileged-level access.)

The following steps describe a basic configuration. The system will prompt you for a password if one is set. Press the **Return** key after each configuration step unless otherwise noted.

Step 1   At the privileged-mode prompt, enter configuration mode and specify that the console terminal will be the source of the configuration subcommands as follows:

```
Router# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#
```

Step 2   At the prompt, specify the new ATM interface to configure by entering the **interface** command, followed by the *type* (**atm**) and *slot/port* (interface processor slot number/port number). The example that follows is for an AIP in interface processor slot 1:

```
Router(config)# interface atm 1/0
```

Step 3   If IP routing is enabled on the system, you can assign an IP address and subnet mask to the interface with the **ip address** configuration subcommand, as in the following example:

```
Router(config)# ip address 1.1.1.3 255.255.255.0
```

Step 4   Change the shutdown state to up and enable the ATM interface as follows:

```
Router(config)# no shutdown
```

The **no shutdown** command passes an **enable** command to the AIP, which then begins segmentation and reassembly (SAR) operations. It also causes the AIP to configure itself based on the previous configuration commands sent.

Step 5   Add any additional configuration subcommands required to enable routing protocols and adjust the interface characteristics.

Step 6   When you have included all of the configuration subcommands to complete the configuration, enter **^Z** (hold down the **Control** key while you press **Z**) to exit configuration mode.

Step 7   Write the new configuration to memory as follows:

```
Router# copy running-config startup-config
[OK]
```

The system will display an OK message when the configuration has been stored.

After you have completed your configuration, you can check it using **show** commands. For an explanation of **show** commands, refer to the section "Using show Commands to Check the Configuration" on page 41.

Configuring the Rate Queue

A rate queue defines the maximum speed at which an individual virtual circuit (VC) transmits data to a remote ATM host. There are no default rate queues. Every VC *must* be associated with one rate queue.

The AIP supports up to eight different *peak* rates. The peak rate is the maximum rate, in kilobits per second, at which a VC can transmit data. After attachment to this rate queue, the VC is assumed to have its peak rate set to that of the rate queue.

You can configure each rate queue independently to a portion of the overall bandwidth available on the ATM link. The combined bandwidths of all rate queues should not exceed the total bandwidth available for the AIP physical layer interface. The total bandwidth depends on the PLIM. (For PLIM information, refer to the section "AIP Interface Types" on page 6.)

The rate queues are broken into a high (0 through 3) and low (4 through 7) bank. When the rate queues are configured, the AIP will service the high priority banks until they are empty and then service the low priority banks.

Virtual circuits get the entire bandwidth of the associated rate queue. If over subscription occurs, the other rate queues in bank A will miss the service opportunities. In the worst case, a 10-Mbps rate queue will take 100 Mbps if there are 10 VCs attached to it and all of them have packets to send at the same time.

Note   For E3, rate queues greater than 34 are disallowed. For DS3, rate queues greater than 45 are disallowed.

To configure rate queue 1 at 10 Mbps, use the **atm rate-queue** *queue-number rate* command in interface configuration mode as follows:

```
Router(config-if)# atm rate-queue 1 10
```

where the *queue-number* is in the range of 0 to 7 and the *rate* (in Mbps) is in the range of 1 to 155. The **no** form of the command removes the rate queue.

You must create a rate queue before you can create permanent virtual circuits (PVCs) or switched virtual circuits (SVCs). If all rate queues are unconfigured, a warning message will appear, as follows:

```
%WARNING:(ATM4/0): All rate queues are disabled
```

If the combined queue rates exceed the AIP physical layer interface bandwidth maximum, a warning message will appear, as follows:

```
%WARNING(ATM4/0): Total rate queue allocation nMbps exceeds maximum of nMbps
```

Customizing the AIP Configuration

You can change the AIP default configuration values to match your network environment. Perform the tasks in the following sections if you need to customize the AIP's configuration:

- Selecting an AIP Interface
- Setting the MTU Size
- Configuring SONET Framing, page 36
- Configuring an ATM Interface for Local Loopback, page 36
- Setting the Reassembly Buffers, page 36
- Setting the Transmit Buffers, page 36
- Setting the Source of the Transmit Clock, page 36

Selecting an AIP Interface

The AIP's interface is referred to as **atm** in the configuration commands. An interface is created for each AIP found in the system at reset time.

To select a specific AIP interface, use the **interface atm** *slot/port* command, as follows:

```
Router(config)# interface atm slot/port
```

Setting the MTU Size

To set the maximum transmission unit (MTU) size, use the following command:

```
Router(config-if)# mtu bytes
```

where *bytes* is in the range of 64 through 9188 bytes; the default is 4470 bytes. (4470 bytes exactly matches FDDI and HSSI interfaces for autonomous switching.)

The **no** form of the command restores the default:

```
Router(config-if)# no mtu
```

Configuring SONET Framing

In STM-1 mode, the AIP sends *idle* cells for cell-rate decoupling. In STS-3C mode, the AIP sends *unassigned* cells for cell-rate decoupling. The default SONET setting is STS-3C. To configure for STM-1, use the following command:

```
Router(config-if)# atm sonet stm-1
```

To return to STS-3C, use the **no atm sonet stm-1** command.

Configuring an ATM Interface for Local Loopback

To configure an ATM interface for local loopback (useful for checking that the AIP is working), use the following command:

```
Router(config-if)# loopback plim
```

The **no** form of the command turns off loopback:

```
Router(config-if)# no loopback plim
```

Setting the Reassembly Buffers

The **atm rxbuff** command sets the maximum number of reassemblies that the AIP can perform simultaneously. The AIP allows up 512 simultaneous reassemblies; the default is 256. The **no** form of the command restores the default.

Setting the Transmit Buffers

To set the number of transmit buffers for simultaneous fragmentation, use the following command:

```
Router(config-if)# atm txbuff n
```

where *n* is in the range 0 to 512. The default is 256.

The **no** form of the command restores the default:

```
Router(config-if)# no atm txbuff
```

Setting the Source of the Transmit Clock

By default, the AIP uses the recovered receive clock to provide transmit clocking. To specify that the AIP generates the transmit clock internally for SONET, E3, and DS3 PLIM operation, use the following command:

```
Router(config-if)# atm clock internal
```

Configuring Virtual Circuits

A VC is a point-to-point connection between remote hosts and routers. A VC is established for each ATM end node with which the router communicates. The characteristics of the VC are established when the VC is created and include the following:

- Quality of service (QOS)

- AAL mode (AAL3/4 or AAL5)

- Encapsulation type (LLC/SNAP, MUX, NLPID, and QSAAL)

- Peak and average transmission rates

Each VC supports the following router functions:

- Multiprotocol (AppleTalk, CLNS, DECnet, IP, IPX, VINES, XNS, and so forth)

- Fast switching of IP, IPX, VINES, CLNS, and AppleTalk packets

- Autonomous switching of IP packets

- Pseudobroadcast support for multicast packets

By default, fast switching is enabled on all AIP interfaces. These switching features can be turned off with interface configuration commands. Autonomous switching must be explicitly enabled per interface.

Configuring Permanent Virtual Circuits

All permanent virtual circuits (PVCs) configured into the router remain active until the circuit is removed from the configuration. The PVCs also require a permanent connection to the ATM switch. All virtual circuit characteristics apply to PVCs. When a PVC is configured, all the configuration options are passed on to the AIP. These PVCs are writable into the nonvolatile RAM (NVRAM) as part of the configuration and are used when the Cisco IOS image is reloaded.

Some ATM switches have point-to-multipoint PVCs that do the equivalent of broadcasting. If a point-to-multipoint PVC exists, then that PVC can be used as the sole broadcast PVC for all multicast requests.

To configure a PVC, you must perform the following tasks:

- Create a PVC

- Map a protocol address to a PVC

Using PVC Configuration Commands

When you create a PVC, you create a virtual circuit descriptor (VCD) and attach it to the VPI and VCI. A VCD is an AIP-specific mechanism that identifies to the AIP which VPI/VCI to use for a particular packet. The AIP requires this feature to manage the packets for transmission. The number chosen for the VCD is independent of the VPI/VCI used.

When you create a PVC, you also specify the AAL and encapsulation. A rate queue is used that matches the peak and average rate selections, which are specified in kilobits per second. Omitting a peak and average value causes the PVC to be connected to the highest bandwidth rate queue available. In that case, the peak and average values are equal.

To create a PVC on the AIP interface, you use the **atm pvc** command as follows:

```
Router(config-if)# atm pvc vcd vpi vci aal-encap protocol-type-for-mux [peak-rate]
[average-rate] [cell-quota]
```

where:

- *vcd* is a per-AIP unique index value describing this VC in the range of 1 to MAXVC.

- *vpi* is the ATM network VPI to use for this VC, in the range of 0 through 255.

- *vci* is the ATM network VCI to use for this VC, in the range of 0 through 65,535.

- *aal-encap* is the ATM adaptation layer encapsulation type to use on this VC from the following:

    — *aal5mux* specifies the MUX-type for this VC. A protocol type must be specified.

    — *aal5snap* specifies that LLC/SNAP precedes the protocol datagram.

    — *aal5nlpid* specifies that NLPID precedes the protocol datagram.

    — *aal34smds* specifies that SMDS framing precedes the protocol datagram.

    — *qsaal* is a signaling type VC.

- *protocol-type-for-mux* is a protocol type compatible with the MUX and is required from the following protocols: *ip*, *decnet*, *novell*, *vines*, *xns*.

- *peak-rate* is the (optional) maximum rate, in kbps, at which this VC can transmit data.

- *average-rate* is the (optional) average rate, in kbps, at which this VC will transmit data.

- *cell-quota* is an (optional) integer value, in the range 1 through 2047, describing the maximum number of credits that a VC can accumulate. The AIP makes use of this in multiples of 32 cells. Every cell transfer consumes one cell credit. One cell transfer credit is issued to a VC in the average rate speed.

To remove a PVC, use the **no** form of this command, as follows:

```
Router(config-if)# no atm pvc vcd
```

Following is an example of the **atm pvc** command:

```
Router(config)# interface atm 2/0
Router(config-if)# atm pvc 2048 255 128 aal5snap ip 10 10 2046
```

The **atm pvc** command creates *PVC n* and attaches the PVC to *VPI* and *VCI*. The AAL used is specified by *aal* and encapsulation by *encap*. A rate queue is used that matches the *peak* and average (*avg*) rate selection. The *peak* and *avg* rate selection values are specified in kbps. Not specifying a *peak* and *avg* value causes the PVC to default to the highest bandwidth rate queue available.

Note   For E3, rate queues greater than 34 are disallowed. For DS3, rate queues greater than 45 are disallowed.

Configuring the VP Filter

The **vp-filter** command configures the hexadecimal value used in the virtual path (vp) filter register in the reassembly operation. When a cell is received, the right half (most-significant byte) of the filter is exclusively NORed with the incoming virtual path identifier (VPI). The result is then ORed with the left half (least-significant byte) of the filter (the mask). If the result is all ones, then reassembly is done using the VCI/MID table. Otherwise, reassembly is done using the VPI/VCI table.

The vp filter mechanism allows a way of specifying which VPI (or range of VPIs) will be used for AAL3/4 processing, all other VPIs mapping to AAL5 processing. In the case where only AAL5 processing is desired, the vp filter should be set to the default VPI of 0x7B (hexadecimal). In that case, AAL5 processing will be performed on the first 127 VPIs. Currently you can only configure one VPI for all the AAL3/4 packets.

Examples follow:

```
Router(config)# atm vp-filter 1
```

All incoming cells with VPI = 1 will be reassembled via AAL3/4 processing, which is supported with Cisco IOS Release 10.2 and later.

```
Router(config)# atm vp-filter 0
```

All incoming cells with VPI = 0 will be reassembled via AAL3/4 processing. All other cells will be reassembled via AAL5 processing.

Mapping a Protocol Address to a PVC

The Cisco IOS software supports a mapping scheme that identifies the ATM address of remote hosts/routers. This address can be specified either as a virtual circuit descriptor (VCD) for a PVC or a network service access point (NSAP) address for SVC operation.

Enter mapping commands as groups; multiple map entries can exist in one map list. First create a map list, then associate the list with an interface.

Enter the **map-list** *name* command; then enter the protocol, protocol address, and other variables, as follows:

```
Router(config)# map-list name
protocol protocol address atm-vc vcd | atm-nsap nsap [broadcast]
```

The **broadcast** keyword specifies that this map entry receives the corresponding protocol broadcast requests to the interface (for example, any network routing protocol updates). If you do not specify **broadcast**, the ATM software is prevented from sending routing protocol updates to the remote hosts.

After you create the map list, specify the ATM interface to which it applies with the interface command, as follows:

```
Router(config)# interface atm slot/port
```

Associate the map list to an interface with the following command:

```
Router(config-if)# map-group name
```

You can create multiple map lists, but only one map list can be associated with an interface. Different map lists can be associated with different interfaces.

Following is an example of mapping a list to an interface:

```
interface atm4/0
ip address 131.108.168.110 255.255.255.0
map-group atm
atm rate-queue 1 100
atm pvc 1 0 8 aal5snap
atm pvc 2 0 9 aal5mux decnet
decnet cost 1
!
map-list atm
ip 131.108.168.112 atm-vc 1 broadcast
decnet 10.2 atm-vc 2 broadcast
```

AIP Statistics

The AIP will maintain a count of certain errors. In addition to keeping a count of these errors, the AIP will also take a snapshot of the last VCI/VPI that caused an error. Each AIP error counter is 16 bits.

Errors include the following:

- CRC errors

- Giants received

- No buffers available

- Framing errors

- Applique/physical layer errors

- Packet timeout errors on receive

ATM show Commands

You can use the following ATM **show** commands to display the current state of the ATM network and the connected VCs:

- To show current VCs and traffic information, use the **show atm vc** command, as follows:

  ```
  Router# show atm vc [vcd]
  ```

  Specifying a VCD displays specific information about that VCD.

- To show current ATM-specific information about the AIP interface, use the **show atm int interface** command, as follows:

  ```
  Router# show atm int interface
  ```

- To show current ATM traffic, use the **show atm traffic** command, as follows:

  ```
  Router# show atm traffic
  ```

  The **show atm traffic** command displays global traffic information to and from all ATM networks connected to the router.

- To show the current ATM mapping of the active list of ATM static maps to remote hosts on an ATM network, use the **show atm map** command, as follows:

  ```
  Router# show atm map
  ```

Using show Commands to Check the Configuration

Following are descriptions and examples of the **show** commands that display AIP configuration information:

- Use the **show controllers cbus** command to display the internal status of the system processor and each interface processor, including the interface processor slot location, the card hardware version, and the currently-running microcode version. The **show controllers cbus** command also lists each interface (port) on each interface processor, including the logical interface number, interface type, physical (slot/port) address, and hardware (station address) of each interface. The following examples show an AIP installed in interface processor slot 0, the running AIP microcode is Version 170.46, the PLIM type is 4B/5B, and the available bandwidth is 100 Mbps:

  ```
  Router# show cont cbus

  (additional displayed text omitted from this example)

   AIP 4, hardware version 1.0, microcode version 170.46
    Microcode loaded from system
    Interface 32 - ATM0/0, PLIM is 4B5B(100Mbps)
      15 buffer RX queue threshold, 36 buffer TX queue limit, buffer size 4496
      ift 0007, rql 12, tq 0000 0620, tql 36
      Transmitter delay is 0 microseconds
  ```

- Use the **show interfaces atm** *slot/port* command to display statistics for the ATM interface you specify by its interface address, as follows:

  ```
  Router# show int atm 0/0
  ATM interface ATM0/0:
  AAL enabled: AAL5, Maximum VCs: 1024, Current VCs: 6
  Tx buffers 256, Rx buffers 256, Exception Queue: 32, Raw Queue: 32
  VP Filter: 0x7B, VCIs per VPI: 1024
  PLIM Type:4B5B - 100Mbps, No Framing, TX clocking: LINE
  4897 input, 2900 output, 0 IN fast, 0 OUT fast
  Rate-Queue 1 set to 100Mbps, reg=0x4EA
  Config. is ACTIVE
  ```

- Use the **show atm vc** command to display statistics for all PVCs, as follows:

```
Router# show atm vc
Intfc.    VCD   VPI   VCI   Input   Output  AAL/Encaps    Peak  Avg.  Burst
ATM0/0.1 1     1     1     305     0       AAL3/4-SMDS   0     0     0
ATM0/0   2     2     2     951     0       AAL5-SNAP     0     0     0
ATM0/0   3     3     3     0       0       AAL5-SNAP     0     0     0
ATM0/0   4     4     4     162     0       AAL5-MUX      0     0     0
ATM0/0   6     6     6     2722    0       AAL5-SNAP     0     0     0
ATM0/0   7     7     7     733     0       AAL5-SNAP     0     0     0
```

To display statistics for a given PVC, use the **show atm vc** *n* command, where *n* is the VCD, as follows:

```
Router# show atm vc 4

ATM0/0: VCD: 4, VPI: 4, VCI: 4, etype:0xBAD, AAL5 - MUX, Flags: 0x34
PeakRate: 0, Average Rate: 0, Burst: 0 *32cells, Vcmode: 0xE200
InPkts: 164, OutPkts: 0, InFast: 0, OutFast: 0, Broadcasts: 0
```

The following sample shows the output from the **show atm vc** command when a *vcd* is specified, AAL3/4 is enabled, an ATM Switched Multimegabit Data Service (SMDS) subinterface has been defined, and a range of message identifier numbers (MIDs) has been assigned to the PVC:

```
Router# show atm vc 1

ATM0/0.1: VCD: 1, VPI: 0, VCI: 1, etype:0x1, AAL3/4 - SMDS, Flags: 0x35
PeakRate: 0, Average Rate: 0, Burst: 0 *32cells, VCmode: 0xE200
MID start: 1, MID end: 16
InPkts: 0, OutPkts: 0, InFast: 0, Broadcasts: 0
```

- Use the **show atm map** command to display the PVC map, as follows:

```
Router# show atm map
Map list atm:

vines 3004B310:0001 maps to VC 4, broadcast
ip 131.108.168.110 maps to VC 1, broadcast
clns 47.0004.0001.0000.0c00.6e26.00 maps to VC 6, broadcast
appletalk 10.1 maps to VC 7, broadcast
decnet 10.1 maps to VC 2, broadcast
```

- Use the **show version** command to display the configuration of the system hardware (the number of each interface processor type installed), the software version, the names and sources of configuration files, and the boot images.

  The following sample shows the output of the **show version** command from a Cisco 7513:

  ```
  Router> show version

  Cisco Internetwork Operating System Software
  IOS (tm) GS Software (RSP-JV-MZ), Released Version 11.1(10)CA [biff 135]
  Copyright (c) 1986-1997 by cisco Systems, Inc.
  Compiled Mon 10-Mar-97 10:06 by biff
  Image text-base: 0x600108A0, data-base: 0x60982000
  ROM: System Bootstrap, Version 11.1(2) [biff 2], RELEASE SOFTWARE (fc1)
  ROM: GS Bootstrap Software (RSP-BOOT-M), Version 10.3(8), RELEASE SOFTWARE (fc2)

  Router uptime is 23 minutes
  System restarted by reload
  System image file is "biff/rsp-jv-mz", booted via tftp from 1.1.1.254
  cisco RSP2 (R4600) processor with 32768K bytes of memory.
  R4700 processor, Implementation 33, Revision 1.0
  Last reset from power-on
  G.703/E1 software, Version 1.0.
  SuperLAT software copyright 1990 by Meridian Technology Corp).
  Bridging software.
  X.25 software, Version 2.0, NET2, BFE and GOSIP compliant.
  TN3270 Emulation software (copyright 1994 by TGV Inc).
  Chassis Interface.

  (additional displayed text omitted from this example)

  1 AIP controller (1 ATM)
  1 ATM network interface

  (additional displayed text omitted from this example)

  123K bytes of non-volatile configuration memory.

  8192K bytes of Flash PCMCIA card at slot 0 (Sector size 128K).
  8192K bytes of Flash internal SIMM (Sector size 256K).
  No slave installed in slot 7.
  Configuration register is 0x0
  ```

- Use the **show atm traffic** command to display the interface traffic, as follows:

  ```
  Router# show atm traffic
  4915 Input packets
  0 Output packets
  2913 Broadcast packets
  0 Packets for non-existent VC
  0 Packets with CRC errors
  0 OAM cells received
  0 Cells lost
  ```

- Use the **show sscop** command to display SSCOP details for the ATM interface.

- Use the **show protocols** command to display the global (system-wide) and interface-specific status of any configured Level 3 protocol.

- Use the **show running-config** command to display the currently running AIP configuration in RAM, as follows:

```
Router# show running-config
interface atm2/0
ip address 1.1.1.110 255.255.255.0
atm rate-queue 1 100
atm rate-queue 2 5
atm pvc 1 1 1 aal5mux ip
atm pvc 3 3 3 aal5snap
atm pvc 4 4 5 aal5snap 4000 3000
appletalk address 10.1
appletalk zone atm
```

ATM Configuration Examples

The following sections contain examples of ATM interface configurations:

- Example of PVCs with AAL5 and LLC/SNAP Encapsulation

- Example of PVCs in a Fully Meshed Network

- Example of SVCs in a Fully Meshed Network

- Example of Connecting Two AIPs Back to Back

For additional configuration examples, refer to the appropriate Cisco IOS software configuration publications listed in the section "If You Need More Information" on page 2.

Example of PVCs with AAL5 and LLC/SNAP Encapsulation

The following example creates PVC 5 on ATM interface 3/0 using LLC/SNAP encapsulation over AAL5. ATM interface 3/0 (IP address 1.1.1.1) connects with the ATM interface (IP address 1.1.1.5) at the other end of the connection. The static map list named *atm* declares that the next node is a broadcast point for multicast packets from IP.

```
interface atm 3/0
ip address 1.1.1.1 255.255.255.0
atm rate-queue 1 100
atm pvc 5 0 10 aal5snap
ip route-cache cbus
map-group atm

map-list atm
ip 1.1.1.5 atm-vc 5 broadcast
```

The following example is of a typical ATM configuration for a PVC:

```
interface atm4/0
ip address 1.1.1.112 255.255.255.0
map-group atm
atm rate-queue 1 100
atm maxvc 512
atm pvc 1 1 1 aal5snap
atm pvc 2 2 2 aal5snap
atm pvc 6 6 6 aal5snap
atm pvc 7 7 7 aal5snap
decnet cost 1
clns router iso-igrp comet
!
router iso-igrp comet
net 47.0004.0001.0000.0c00.6666.00
!
router igrp 109
network 1.1.0.0
!
ip domain-name CISCO.COM
!
map-list atm
ip 131.108.168.110 atm-vc 1 broadcast
clns 47.0004.0001.0000.0c00.6e26.00 atm-vc 6 broadcast
decnet 10.1 atm-vc 2 broadcast
```

Example of PVCs in a Fully Meshed Network

Figure 23 illustrates an example of a fully meshed network.

Figure 23   Fully Meshed ATM Configuration Example
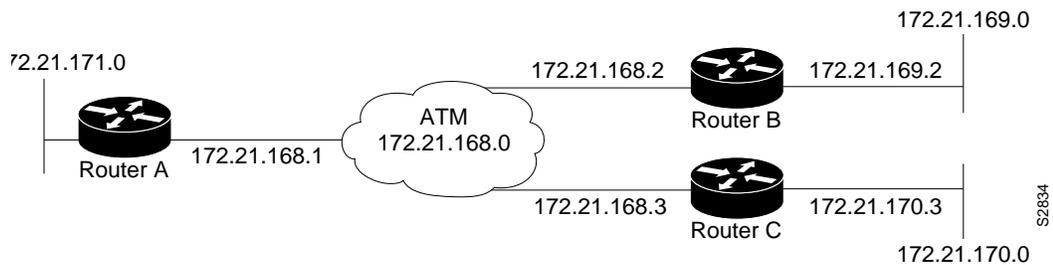
The term *fully meshed* indicates that any workstation can communicate with any other workstation.

In this example, the routers are configured to use PVCs; note the following:

- The two map list statements configured in Router A identify the ATM addresses of Routers B and C.

- The two map list statements in Router B identify the ATM addresses of Routers A and C.

- The two map list statements in Router C identify the ATM addresses of Routers A and B.

The configurations for Routers A, B, and C follow:

Router A

```
ip routing
!
interface atm 4/0
ip address 131.108.168.1 255.255.255.0
atm rate-queue 1 100
atm pvc 1 0 10 aal5snap
atm pvc 2 0 20 aal5snap
map-group test-a
!
map-list test-a
ip 131.108.168.2 atm-vc 1 broadcast
ip 131.108.168.3 atm-vc 2 broadcast
```

Router B

```
ip routing
!
interface atm 2/0
ip address 131.108.168.2 255.255.255.0
atm rate-queue 1 100
atm pvc 1 0 20 aal5snap
atm pvc 2 0 21 aal5snap
map-group test-b
!
map-list test-b
ip 131.108.168.1 atm-vc 1 broadcast
ip 131.108.168.3 atm-vc 2 broadcast
```

Router C

```
ip routing
!
interface atm 4/0
ip address 131.108.168.3 255.255.255.0
atm rate-queue 1 100
atm pvc 2 0 21 aal5snap
atm pvc 4 0 22 aal5snap
map-group test-c
!
map-list test-c
ip 131.108.168.1 atm-vc 2 broadcast
ip 131.108.168.2 atm-vc 4 broadcast
```

Example of SVCs in a Fully Meshed Network

The following example is also a configuration for the fully meshed network shown in Figure 23, but using SVCs. SVC 1 is the signaling SVC.

Router A

```
interface atm 4/0
ip address 131.108.168.1 255.255.255.0
map-group atm
atm nsap-address AB.CDEF.01.234567.890A.BCDE.F012.3456.7890.1234.12
atm rate-queue 1 100
atm maxvc 1024
atm pvc 1 0 5 qsaal
!
map-list atm
ip 131.108.168.2 atm-nsap BC.CDEF.01.234567.890A.BCDE.F012.3456.7890.1334.13
ip 131.108.168.3 atm-nsap BC.CDEF.01.234567.890A.BCDE.F012.3456.7890.1224.12
```

Router B

```
interface atm 2/0
ip address 131.108.168.2 255.255.255.0
map-group atm
atm nsap-address BC.CDEF.01.234567.890A.BCDE.F012.3456.7890.1334.13
atm rate-queue 1 100
atm maxvc 1024
atm pvc 1 0 5 qsaal
!
map-list atm
ip 131.108.168.1 atm-nsap AB.CDEF.01.234567.890A.BCDE.F012.3456.7890.1234.12
ip 131.108.168.3 atm-nsap BC.CDEF.01.234567.890A.BCDE.F012.3456.7890.1224.12
```

Router C

```
interface atm 4/0
ip address 131.108.168.3 255.255.255.0
map-group atm
atm nsap-address BC.CDEF.01.234567.890A.BCDE.F012.3456.7890.1224.12
atm rate-queue 1 100
atm maxvc 1024
atm pvc 1 0 5 qsaal
!
map-list atm
ip 131.108.168.1 atm-nsap AB.CDEF.01.234567.890A.BCDE.F012.3456.7890.1234.12
ip 131.108.168.2 atm-nsap BC.CDEF.01.234567.890A.BCDE.F012.3456.7890.1334.13
```

Example of Connecting Two AIPs Back to Back

Two routers, each containing an AIP, can be connected directly back to back with a standard cable, which allows you to verify the operation of the ATM port or to directly link the routers in order to build a larger node. To connect two routers, attach the cable between the ATM port on each one.

By default, the AIP expects a connected ATM switch to provide transmit clocking. To specify that the AIP generates the transmit clock internally for SONET, E3, or DS3 PLIM operation, add the **atm clock internal** command to your configuration.

Note For SONET, E3, or DS3 interfaces, at least one of the AIPs must be configured to supply its internal clock to the line.

Following is an example of configuration file commands for two routers connected through their SONET, E3, or DS3 interfaces:

First router:

```
interface ATM3/0
ip address 1.0.0.1 255.0.0.0
no keepalive
map-group atm-in
atm clock internal
atm rate-queue 2 34
atm pvc 1 1 5 aal5snap
!
map-list atm-in
ip 1.0.0.2 atm-vc 1 broadcast
```

Second router:

```
interface ATM3/0
ip address 1.0.0.2 255.0.0.0
no keepalive
map-group atm-in
atm clock internal
atm rate-queue 2 34
atm pvc 1 1 5 aal5snap
!
map-list atm-in
ip 1.0.0.1 atm-vc 1 broadcast
```

Using the Debug ATM Commands

You can use the following **debug** commands to aid in solving ATM network problems:

- Use the **debug atm packet** command to display the contents of the SNAP/NLPID/SMDS header followed by the first 40 bytes of a packet in hexadecimal format.

- Use the **debug atm errors** command to display information from all detected ATM errors. This includes such errors as encapsulation failures and errors during ATM configuration.

- Use the **debug atm events** command to display event changes to the AIP. Reset, VC configurations, AIP configurations, and PLIM failures are displayed here.

Note For a list of ATM error messages associated with the **debug atm events** command, refer to the section "Interpreting ATM Error Messages," which follows.

- Use the **debug atm oam** command to display the contents of OAM cells as they arrive from the network.

After you use a **debug** command, turn off debugging with the **no debug** command.

Interpreting ATM Error Messages

The following are the possible error messages displayed when you enter the **debug atm events** command:

Error Message
```
RESET(ATM2/0): PLIM type is 0, Rate is 0Mbps
```

Explanation Displays the PLIM TYPE value returned from the AIP and the expected associated rate.

Error Message
```
aip_disable(ATM2/0): state=1
```

Explanation The AIP DISABLE code to shut the AIP down has been entered.

Error Message
```
config(ATM2/0)
```

Explanation The current configuration to the AIP was sent including TXBUFF, RXBUFF, exception queue length, raw queue length, and rate queue information.

Error Message
```
aip_enable(ATM2/0)
```

Explanation The AIP is taken out of shutdown.

Error Message
```
aip_love_note(ATM2/0): asr=0xaaaa
```

Explanation System processor received a *love note* from the AIP. Love notes are messages that the AIP passes to the system processor to indicate an action or event has taken place. For example, the AIP signals the system processor with a love note when the AIP completes a VC setup/teardown request. Another love note signals to the system processor that CD sense has changed. The *ASR* is a bit mask that defines the actions that might have taken place. The ASR values are different for all the interfaces.

Of the following bit mask values, only 0x4000, which singles CD state changes, is consistent between the different interfaces:

- 0x8000—IP panic

- 0x4000—CD state change

- 0x200—Command to AIP has completed

- 0x00n0—Completion status of a command (0–9) 0 is OK; a value of greater than 0 indicates failure

All other values of the ASR are meaningless and discarded. The love note messages only appear if **debug atm events** is turned on.

Error Message
```
aip_cstate(ATM2/0): state=1
```
Explanation The state of the device is changed to either UP (1) or DOWN (0).

Error Message
```
aip_setup_vc(ATM2/0): vc:1 vpi:0 vci:7
```
Explanation   A VC SETUP request is being sent to the AIP to establish a VC.

Error Message
```
aip_setup_vc(ATM2/0): vc1 creation delayed, AIP config. in progress
```
Explanation The SETUP VC request is being delayed to allow the AIP to come up and configure itself.

Error Message
```
aip_teardown_vc(ATM2/0): vc:1 vpi:0 vci:
```
Explanation A VC teardown is requested. The VC is being deconfigured.

Error Message
```
aip_enable(ATM2/0): restarting VCs: 5
```
Explanation All previously configured PVCs are being reconnected on the AIP.

The following are the possible error messages displayed when you enter the **debug atm errors** command:

Error Message
```
aip_love_note(ATM2/0): UNKNOWN asr=0x0000
```
Explanation A bad love note message was passed back by the AIP.

Error Message
```
aip_setup_vc(ATM2/0): TIQ err. VC 1 peak 1000 avg. 1 rateq rate 2
```
Explanation Indicates that a VC SETUP failed because the average rate requested could not be configured on the AIP. The average rate is far too low from the peak rate.

Error Message
```
aip_setup_vc(ATM2/): CQ err. VC 1 CQ=2048 MTU=256000
```
Explanation Indicates that the cell quota selected is out of the range allowed by the AIP. In the case of PVCs, the parser catches these. The error message indicates SVC violations of out of range cell quota selection.

Error Message

aip_setup_vc(ATM2/0): Return value 0

Explanation   This is the return value from the AIP after a setup request.

Error Message

aip_teardown_vc(ATM2/0): Return value 0

Explanation   The PVC teardown return code from the AIP. Return value 0 indicates successful operation.

Error Message

ATM(ATM2/0): Config. scaler error. RateQ 1, rate 1

Explanation   Indicates that the rate specified for the peak rate is not allowable. The parser should catch most of these.

Error Message

aip_raw_input(ATM2/0): bad OAM type 0xaaaa

Explanation   The system processor received an OAM cell with an invalid OAM type value.

Error Message

aip_raw_input(ATM2/0): bad OAM function 0xaaaa

Explanation   The function value in the OAM cell is invalid in one of the following:

- F4 SEGMENT

- F4 END-to-END

- F5 SEGMENT

- F5 END-to-END

Error Message

atm_pakalign(ATM2/0): Invalid VC(65535) received, type=0xaaaa

Explanation   A packet was received by the AIP with a VC that is out of the valid range of VCs.

Error Message

atm_pakalign(ATM2/0): VC(1) NOT configured, type=0xaaaa

Explanation   A packet was received by the AIP for which a VC is not configured.

Error Message

ATM(ATM2/0): Encapsulation error, link=0xaaaa, host=0xaaaa

Explanation   The ATM software failed to encapsulate a protocol because the protocol address is not in a STATIC map table.

Error Message

```
ATM(ATM2/0: Encapsulation error, VC=1 not connected
```

Explanation   A static map exists for the protocol address, but the VC has not been configured.

Error Message

```
ATM(ATM2/0): VC(1) Bad SAP received
```

Explanation   A packet with a bad SNAP encapsulation was received.

Error Message

```
ATM(ATM2/0): Bad VC(1) encapsulation configured
```

Explanation   An internal error has occurred. Check the VC encapsulation.

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- Telnet: cco.cisco.com

- Modem: From North America, 408 526-8070; from Europe, 33 1 64 46 40 82. Use the following terminal settings: VT100 emulation; databits: 8; parity: none; stop bits: 1; and connection rates up to 28.8 kbps.

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