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 publication contains instructions for installing the Asynchronous Transfer Mode (ATM) Interface Processor (AIP). This publication also contains basic configuration steps and examples.

Sections in this publication include the following:

For complete descriptions of interface subcommands and the configuration options available for ATM interfaces, refer to the *Router Products Configuration Guide* and *Router Products Command Summary* publications.

Caution To ensure compliance with EMI standards, the E3 PLIM connection requires an EMI filter clip (CLIP-E3-EMI) on the receive port (RCVR). Refer to the important EMI compliance information in steps 10 through 12, on page 29.

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 Kbps, at which a given virtual circuit (VC) will transmit.

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 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 and Maintenance (cells).

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

Peak-rate—The maximum rate, in Kbps, at which VC can transmit.

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 AIP Interface Types, page 13 .)

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 >34 are disallowed. For DS3, rate queues >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-to-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 which 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 Internetwork Operating System (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.

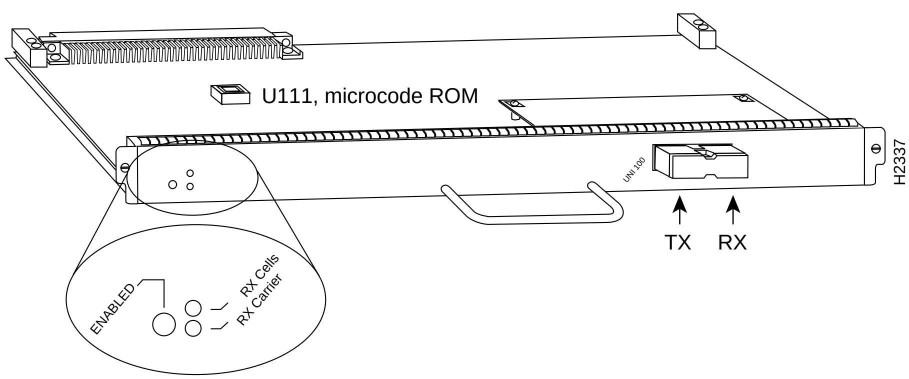
Unlike a LAN, which is connectionless, ATM requires certain features to provide a LAN environment to the users. One such feature is broadcast capability. Protocols wishing to broadcast packets to all stations in a subnet must be allowed to do so with a single call to Layer 2. In order to support broadcasting, 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.

AIP Description

This section provides a brief description of Cisco 7000 series routers and the ATM interface processor (AIP).

The AIP (see Figure 1) provides a single ATM network interface for Cisco 7000 series routers. An overview of the Cisco 7000 series and a description of the AIP follow.

Figure 1 ATM Interface Processor (AIP) with 100 Mbps UNI PLIM



The ATM network interface for a Cisco 7000 series router resides on a modular interface processor, the AIP, which provides a direct connection between the high-speed Cisco Extended Bus (CxBus) and the external networks. The 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 CxBus. This would cause packets to be dropped. Although up to five AIPs can be used in a Cisco 7000 chassis and up to three AIPs can be used in the Cisco 7010, two AIP modules per chassis is considered to be a practical limit.

AIP Features

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 and maintenance (OAM) cells and Interim Local Management Interface (ILMI) cells. (ATM signaling cells are not considered raw.)

AIP Hardware Prerequisites

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.

ATM Management Information Base (MIB)

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

The AIP supports RFC 1213 interface MIBs as specified in the ATM MIB V2 specification. Refer to the ATM UNI specification for additional details of the MIB. DS3 MIB variables are outlined in RFC 1407.

What is the Cisco 7000 Family?

The Cisco 7000 family of routers consists of the Cisco 7000 series routers: Cisco 7000 and Cisco 7010; and the Cisco 7500 series: Cisco 7505, Cisco 7507, and Cisco 7513. The following sections describe the Cisco 7000 series nd Cisco 7500 series.

What is the Cisco 7000 Series?

The Cisco 7000 series comprises the seven-slot Cisco 7000 (see Figure 2) and the five-slot Cisco 7010 (see Figure 3). Both models use the same Route Processor (RP), Switch Processor (SP) or Silicon Switch Processor (SSP), CxBus interface processors, and arbiter (MAS-7KARB). The Cisco 7000 provides five interface slots and offers a second modular power supply for redundant power. The Cisco 7010 provides three interface slots, which each offer the same performance as the Cisco 7000.

Figure 2 shows the interface processor end of the Cisco 7000 model, which provides access to the seven processor slots and the removable power supplies. When facing the interface processor end of the chassis, the RP and SP slot are on the far right. The five interface processor slots are numbered 0 to 4 from left to right.

In both models, interface processor slots support any combination of network interface types: ATM, Ethernet, Token Ring, fiber distributed data interface (FDDI), serial, and high-speed serial interface (HSSI). The RP, SP, and interface processors are keyed with guides on the backplane to prevent them from being fully inserted in the wrong slot.

Figure 2 Cisco 7000, Interface Processor End

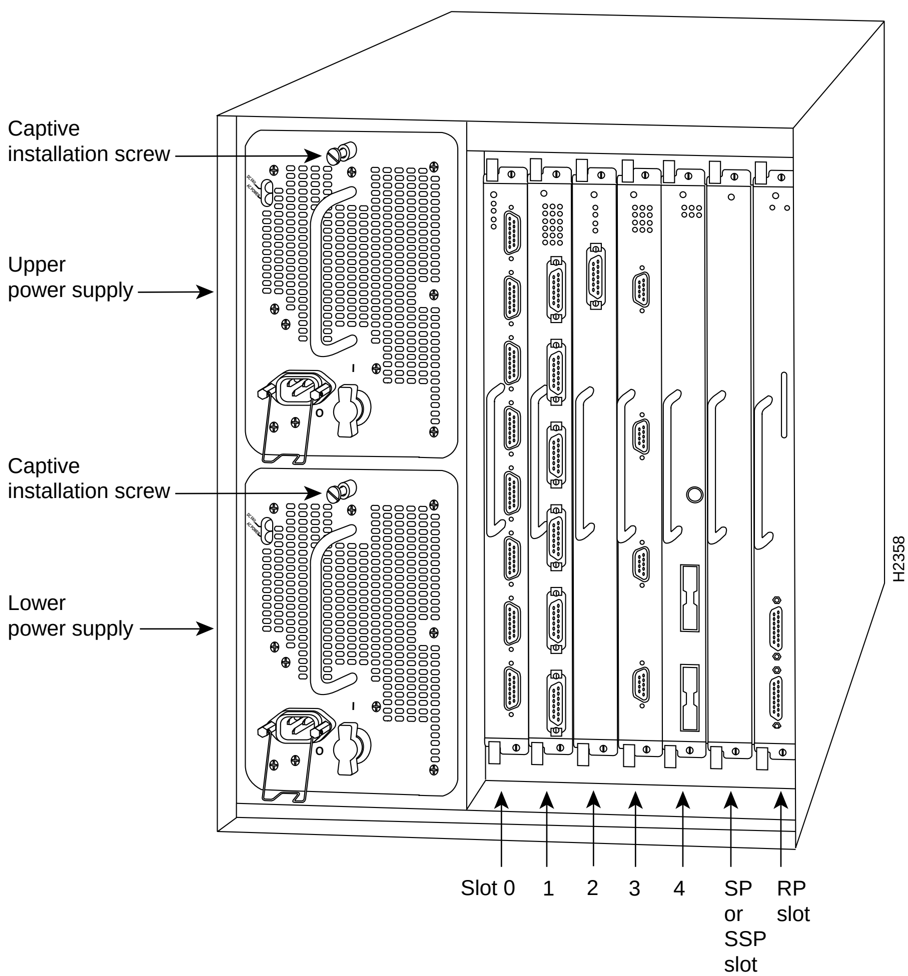
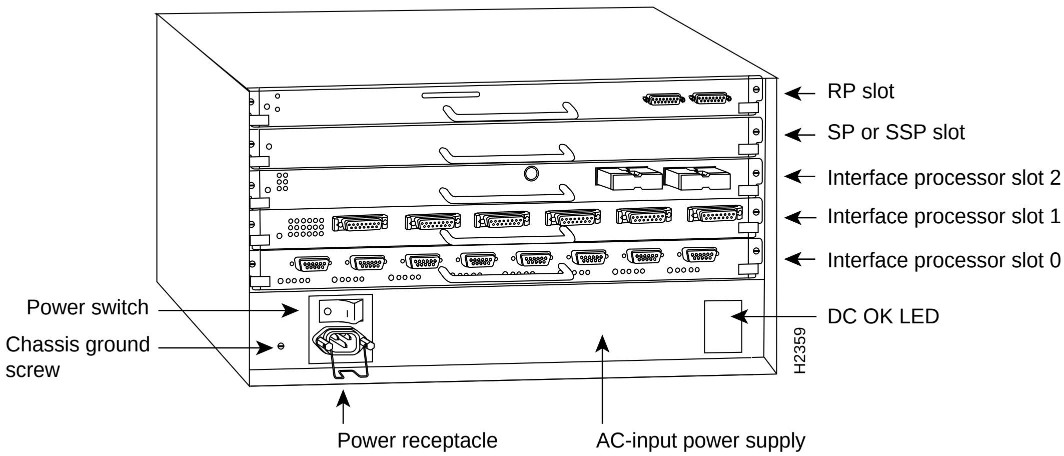


Figure 3 shows the interface processor end of the Cisco 7010 model, which provides access to the five processor slots, the AC power input receptacle, the power switch, and a power status indicator. When facing the interface processor end of the chassis, the RP and SP slots are at the top. The three interface processor slots are numbered from the bottom up beginning with slot 0 (the bottom slot) through 2 (the center slot).

Figure 3 Cisco 7010, Interface Processor End



What is the Cisco 7500 Series?

The Cisco 7500 series consists of three router models: the Cisco 7505, the Cisco 7507, and the Cisco 7513. All three models provide high reliability, availability, serviceability, and performance. The three systems support multiprotocol, multimedia routing, and bridging with a wide variety of protocols and any combination of Ethernet, Fast Ethernet, Token Ring, Fiber Distributed Data Interface (FDDI), serial, multichannel, channel attachment, and High-Speed Serial Interface (HSSI) media. Network interfaces reside on modular interface processors, which provide a direct connection between the high-speed, 1.067-gigabits-per-second (Gbps) Cisco Extended Bus (CyBus) and the external networks.

Note The Cisco 7507 and Cisco 7513 have dual CyBuses, for an aggregate bandwidth of 2.134 Gpbs.

Figure 4 shows the rear of the five-slot Cisco 7505 router. In the Cisco 7505, one slot (4) is reserved for the Route Switch Processor (RSP1), which contains the system processor and performs packet switching functions. Slots 0 through 3 are for interface processors.

Figure 4 Cisco 7505, Interface Processor End

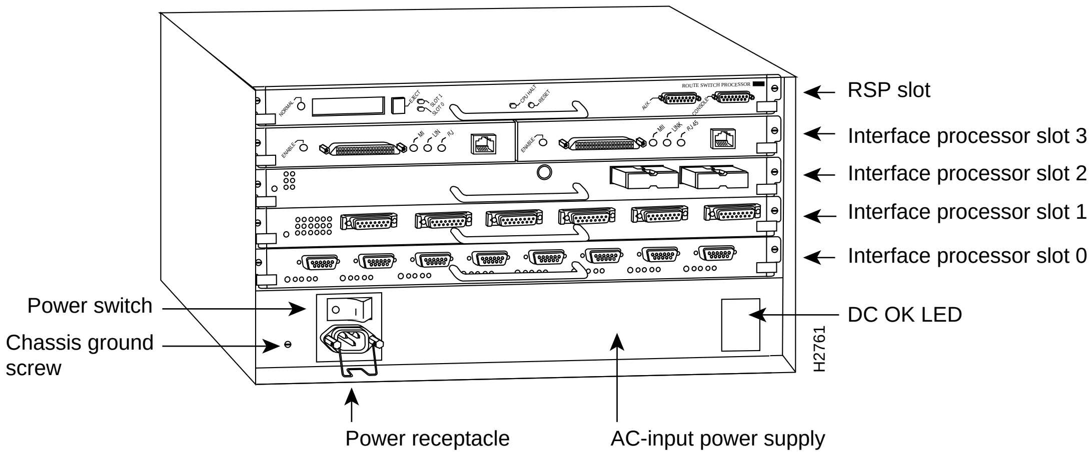


Figure 5 shows the rear of the seven-slot Cisco 7507 router. In the Cisco 7507, up to two slots (2 and 3) are reserved for the Route Switch Processor (RSP2), which contains the system processor and performs packet switching functions. Slots 0 and 1 and 4 through 6 are for interface processors.

Figure 5 Cisco 7507, Interface Processor End

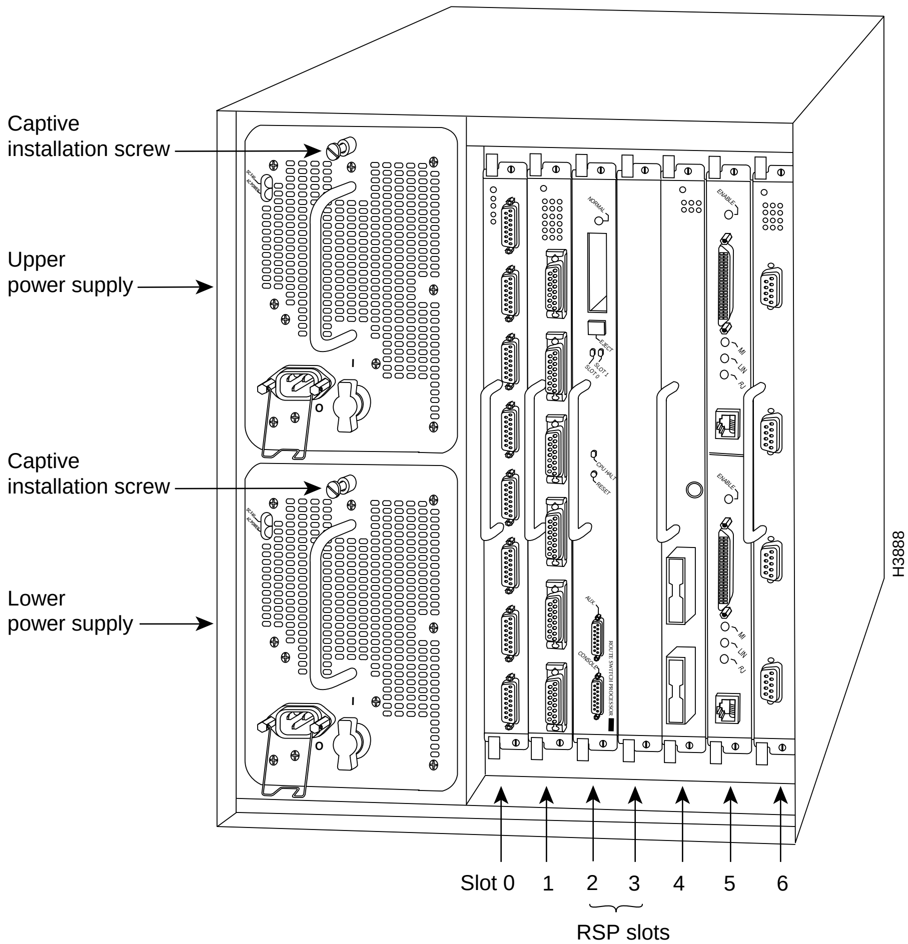
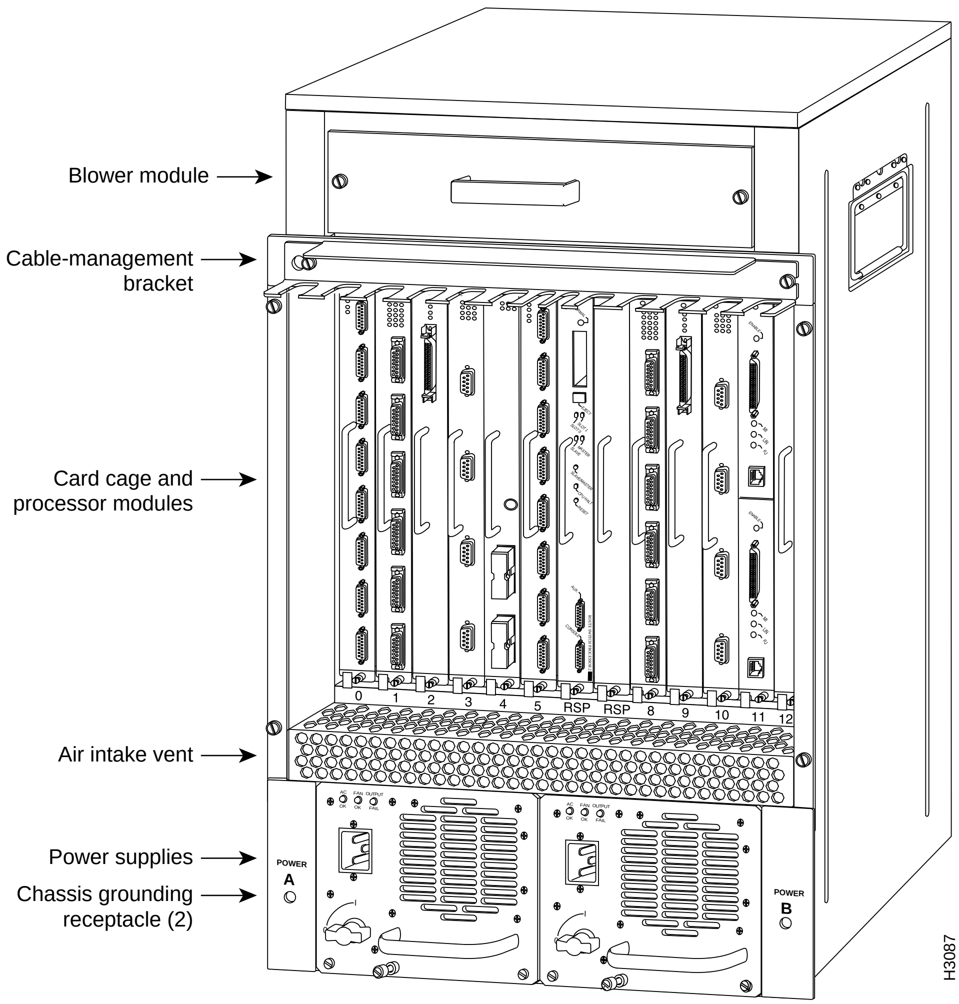


Figure 6 shows the rear of the Cisco 7513, with two AC-input power supplies installed. Two slots (6 and 7) are reserved for the second generation Route Switch Processor (RSP2), which contains the system processor and performs packet switching functions. Slots 0 through 5 and 8 through 12 are for interface processors.

Figure 6 Cisco 7513, Interface Processor End



Installing and Removing Processor Modules

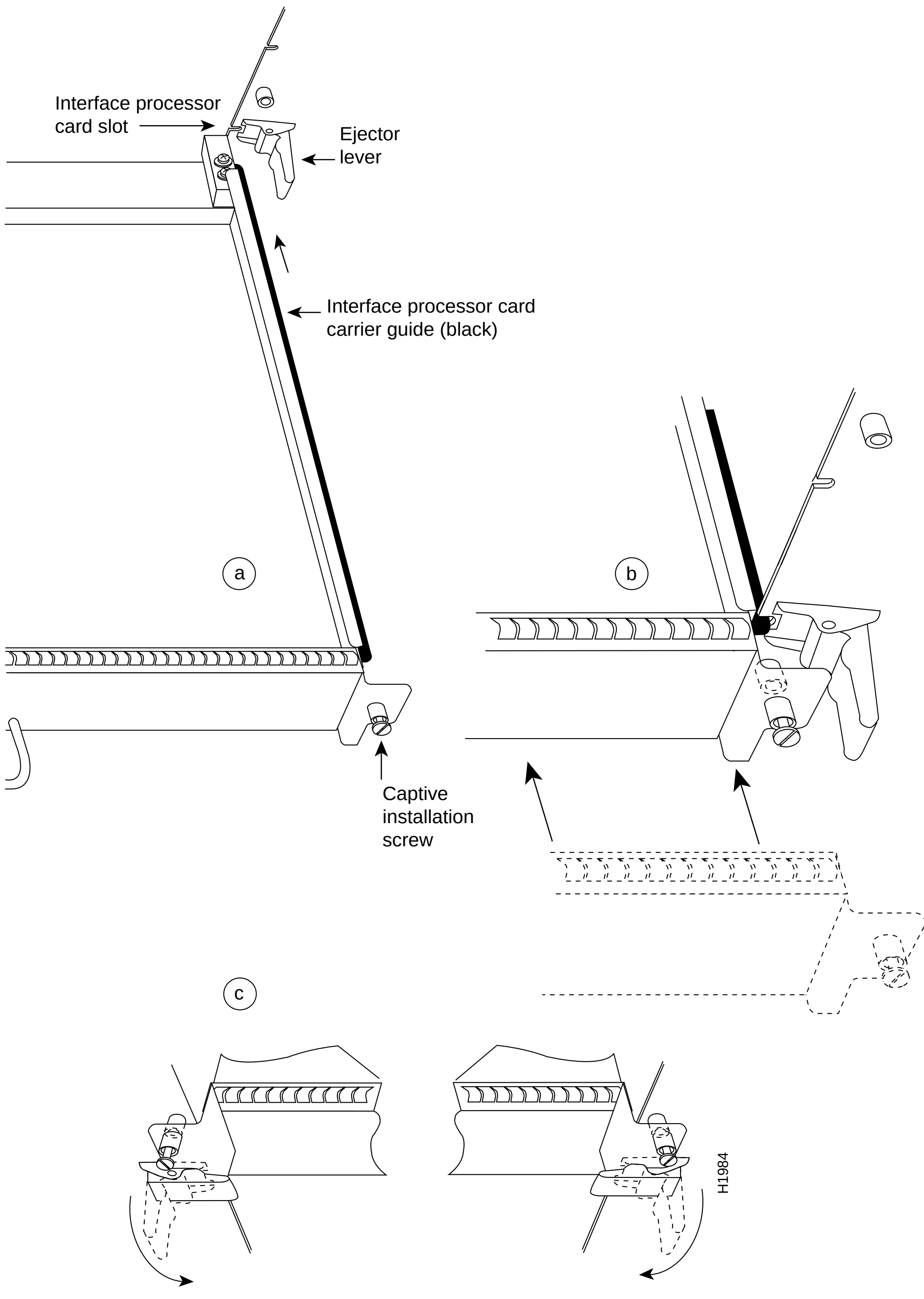
The processor modules slide into slots in the rear of the chassis and connect directly to the backplane. The backplane slots are keyed so that the processor modules can be installed only in the slots designated for them.

Figure 7 shows the ejector levers and captive installation screws on a typical interface processor. To remove an interface processor, loosen the captive screws and pull the ejector levers to the sides; then pull the module out using the handle. To insert an interface processor, reverse the process, making sure to firmly seat the interface processor in its connectors on the backplane. For detailed directions, follow the procedures in “Removing the AIP” and “Installing the AIP.”

Caution Always use the ejector levers to remove or install the AIP. The ejectors help ensure that backplane connectors on the card are fully seated in, or fully ejected from, the backplane. Failure to use the ejector levers could result in a partial backplane connection, which can hang the system.

The captive installation screws on the ends (see Figure 7) of each faceplate, when tightened, provide EMI shielding and also help ensure proper seating in the backplane. After using the ejector levers to install an AIP, tighten the captive installation screws to prevent the AIP from becoming partially dislodged from the backplane. These screws must be tightened to meet EMI specifications.

Figure 7 Ejector Levers and Captive Installation Screws



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 "ATM Interface Cables" on page 17 for descriptions of ATM connectors. The AIP, shown in Figure 1, 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 can support PLIMs that connect to the following physical layers:

- TAXI 4B/5B 100 Mbps multimode fiber optic
- SONET/SDH 155 Mbps multimode fiber optic—STS-3 or STM-1
- SONET/SDH 155 Mbps single-mode fiber optic—STS-3 or STM-1
- E3 34 Mbps coaxial cable
- DS3 45 Mbps coaxial cable

Note The E3 and DS3 PLIMs require cable CAB-ATM-DS3/E3.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).

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) (formerly the Consultative Committee for International Telegraph and Telephone (CCITT)) 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.

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 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.

Power Budget

To design an efficient optical data link, evaluate the power budget. The power budget is the amount of light available to overcome attenuation in the 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 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.

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

PB = PT – PR

PB = –18.5 dBm – (–30 dBm)

PB = 11.5 dB

The power margin calculation is derived from the power budget and subtracts the link loss, as follows:

PM = PB – LL

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

Table 3 lists the factors that contribute to link loss and the estimate of the link loss value attributable to those factors.

Table 3 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

After calculating the power budget minus the data link loss, the result should be greater than zero. Results less than zero may have insufficient power to operate the receiver.

For SONET versions of the AIP module, the signal must meet the worst case parameters listed in Table 4.

Table 4 AIP SONET Signal Requirements

	Single-Mode	Multimode
PT	–18.5	–15
PR	–30	–28
PB	–11.5	–13

Multimode Power Budget Example with Sufficient Power for Transmission

The following is an example multimode power budget calculated based on the following variables:

Length of multimode link = 3 kilometers (km)

4 connectors

3 splices

Higher order loss (HOL)

Clock recovery module (CRM)

Estimate the power budget as follows:

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

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

PB = 2.5 dB

The value of 2.5 dB indicates that this link would have sufficient power for transmission.

Multimode Power Budget 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:

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

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

PB = 1.5 dB

The value of 1.5 dB indicates that this link would have sufficient power for transmission. But, due to 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 also reduced because laser light is essentially monochromatic.

The maximum overload specification on the single-mode receiver is –14 dBm. 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 is of a two buildings, 11 kilometers apart, connected through a patch panel in an intervening building with a total of 12 connectors.

Length of single-mode link = 11 km

12 connectors

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.

For Further Reference

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

ATM Interface Cables

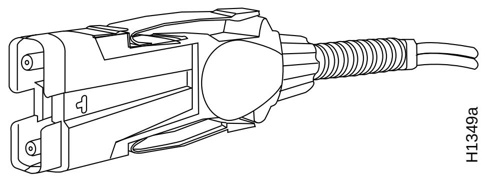
The ATM interface cable is used to connect your router to an ATM network or to connect two routers back-to-back.

Cables can be obtained from the following cable vendors:

- AT&T
- Siemens
- Red-Hawk
- Anixter
- AMP

For 4B/5B traffic over multimode fiber, use the multimode MIC interface cable to connect the AIP with the external ATM switch. (See Figure 8.)

Figure 8 Multimode Network Interface Connector (MIC Type)



For SONET/SDH multimode connections, use one multimode duplex SC connector (see Figure 9) or two single SC connectors. (See Figure 10.)

Figure 9 Duplex SC Connector

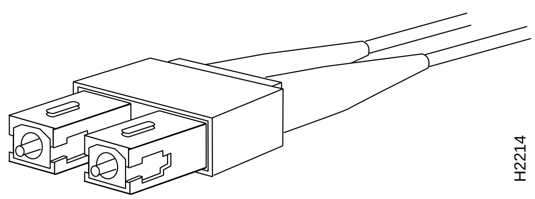
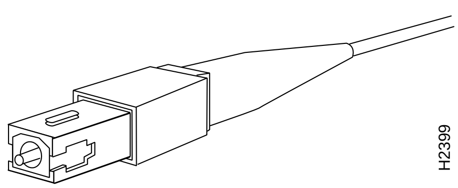
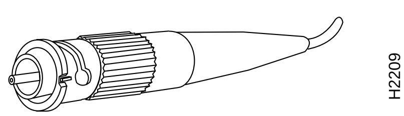


Figure 10 Simplex SC Connector



For SONET/SDH single-mode connections, use the single-mode (ST2) connector (bayonet-style twist-lock). (See Figure 11.)

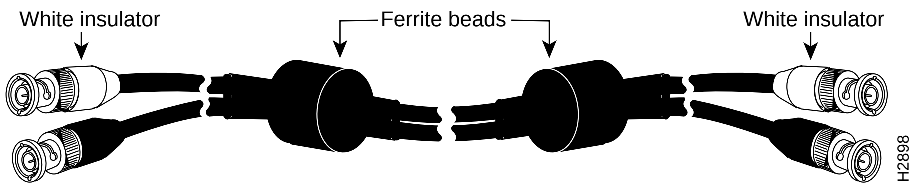
Figure 11 ST2 Connector



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 12.) The E3 and DS3 PLIMs both require cable CAB-ATM-DS3/E3.

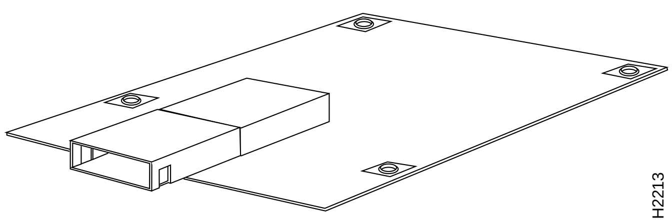
Figure 12 CAB-ATM-DS3/E3 Cable—RG-59 Coaxial Cable with BNC Connectors



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 13.)

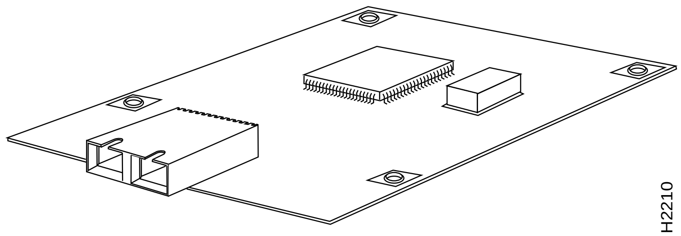
Figure 13 MIC Connector on a TAXI 4B/5B PLIM



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: 10.0(9), 10.2(5), 10.3(1), or later.

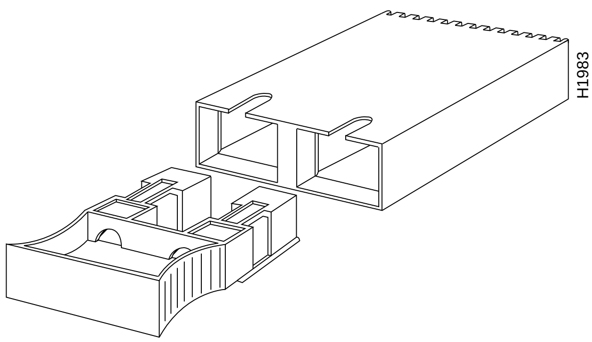
For multimode SONET connections, connect the multimode cable to the SC connector on the PLIM. (See Figure 14.)

Figure 14 SONET Multimode SC Duplex PLIM



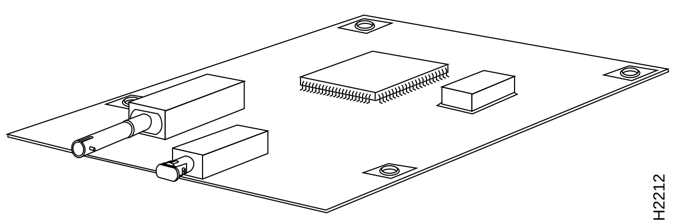
The SONET multimode SC-duplex connector is shipped with a dust plug. (See Figure 15.) Remove the plug by pulling on the plug as you squeeze the sides.

Figure 15 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 16.)

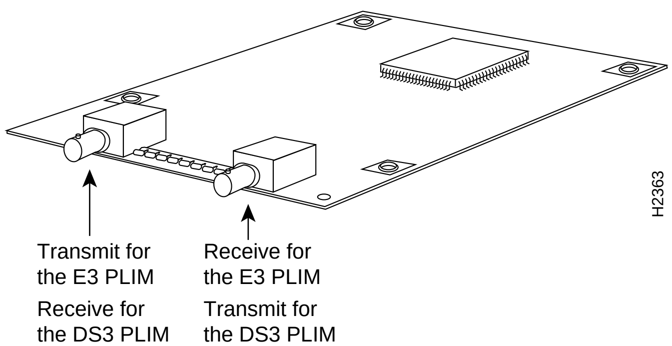
Figure 16 SONET Single-Mode PLIM



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

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 17. 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 17 E3 and DS3 PLIM—Representative of Both PLIMs



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 15 shows the EMI filter clip assembly that is required for the E3 PLIM. *Do not* operate the E3 PLIM without this assembly.

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

The following example shows that AIP Microcode Version 1.1 and SP Microcode Version 1.2 are stored in Flash memory.

```
Router# show flash
4096K bytes of flash memory on embedded flash (in RP1).
file     offset     length        name
  0     0x80        53364       aip1-1
  1     0xD134      55410       sp1-2
  [4085336/4194304 bytes free]
```

If the preceding displays indicate that the required system software and microcode are not available, contact a customer service representative for upgrade information.

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

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

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. The AIP comprises a printed circuit board that is fixed in a metal carrier. 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, always use a preventive antistatic strap when handling the AIP. Handle the carriers by the handles and the carrier edges only; never touch the boards or connector pins.

Caution Always tighten the captive installation screws on the AIP. (See Figure 1.) These screws prevent accidental removal, provide proper grounding for the system, and help ensure that the bus connectors are properly seated in the backplane.

Following are guidelines for preventing ESD damage:

- Always use an ESD wrist or ankle strap and ensure that the strap makes good skin contact.
- Connect the equipment end of the strap to a captive installation screw on an installed power supply.
- When installing an AIP, use the ejector levers to properly seat the bus connectors in the backplane, then tighten both (top and bottom) captive installation screws. (See Figure 1.) These screws prevent accidental removal, provide proper grounding for the system, and help to ensure that the bus connectors are seated in the backplane.
- When removing an AIP, use the ejectors to release the bus connectors from the backplane. Hold the handle on the front of the AIP with one hand and support the bottom edge of the metal carrier with the other hand. Pull the carrier out slowly, using your hand along the bottom of the carrier to guide the AIP straight out of the slot.
- Handle carriers by the handles and carrier edges only; avoid touching the board or any connector pins.
- Place a removed AIP board-side-up on an antistatic surface or in a static shielding bag. If the component will be returned to the factory, immediately place the AIP in a static shielding bag.
- Avoid contact between the AIP and clothing. The wrist strap only protects the board from ESD voltages on the body; ESD voltages on clothing can still cause damage.

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

Installation

The following sections describe the procedures for removing or installing an AIP in a Cisco 7000 series router. The online insertion and removal (OIR) feature allows you to install and remove an AIP without turning off system power; however, you must follow the insertion instructions carefully.

For example, failure to use the ejector levers or insert the AIP properly can cause system error messages indicating a board failure. Refer to “Online Insertion and Removal—An Overview” for a complete description of OIR.

Online Insertion and Removal—An Overview

Online insertion and removal (OIR) allows you to remove and replace CxBus interface processors while the system is operating; you do not need to notify the software or shut down the system power. This section describes the mechanical functions of the system components and stresses the importance of following the correct procedures to avoid unnecessary restarts or card failures. This section is for background information only. Subsequent sections provide specific procedures for removing and installing an AIP. All CxBus and CyBus interface processors support OIR

Each processor module contains a bus connector with which it connects to the system backplane. The bus connector is a set of tiered pins, in three lengths. The pins send specific signals to the system as they make contact with the backplane. The system assesses the signals it receives and the order in which it receives them to determine what event is occurring and what task it needs to perform, such as reinitializing new interfaces or shutting down removed ones. For example, when you insert an interface processor, the longest pins make contact with the backplane first, and the shortest pins make contact last. The system recognizes the signals and the sequence in which it receives them. The system expects to receive signals from the individual pins in this logical sequence, and the ejector levers help to ensure that the pins mate in this sequence.

When you remove or insert an interface processor, the backplane pins send signals to notify the system, which then performs as follows:

1. Rapidly scans the backplane for configuration changes and does not reset any interfaces.
2. Initializes all newly inserted interface processors, noting any removed interfaces and placing them in the administratively shutdown state.
3. Brings all previously configured interfaces on the interface processor back to the state they were in when they were removed. Any newly inserted interfaces are put in the administratively shut down state, as if they were present (but unconfigured) at boot time. If a similar interface processor type has been reinserted into a slot, then its ports are configured and brought online up to the port count of the original interface processor.

OIR functionality enables 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.

When you insert a new interface processor, the system runs a diagnostic test on the new interfaces and compares them to the existing configuration.

If this initial diagnostic test fails, the system remains off line for another 15 seconds while it performs a second set of diagnostic tests to determine whether or not the interface processor is faulty and if normal system operation is possible.

If the second diagnostic test passes, which indicates that the system is operating normally and the new interface processor is faulty, the system resumes normal operation but leaves the new interfaces disabled. If the second diagnostic test fails, the system crashes, which usually indicates that the new interface processor has created a problem on the bus and should be removed.

The system brings online only interfaces that match the current configuration and were previously configured as up; all other interfaces require that you configure them with the **configure** command. On interface processors with multiple interfaces, only the interfaces that have already been configured are brought online. The new interface remains in the administratively shutdown state until you configure it and bring it online.

The function of the ejector levers (see Figure 7) is to align and seat the card connectors in the backplane. Failure to use the ejectors and insert the interface processor properly can disrupt the order in which the pins make contact with the backplane. Follow the AIP 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 ejectors out of their springs. If you then try to use the ejectors 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 ejectors) to seat the AIP in the backplane, you might need to pull the AIP back out and push the AIP in again to align the pins 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 ejectors ensures that the board connector mates with the backplane in one continuous movement.
- Using the handle to insert or remove an AIP, or failing to push the ejectors to the full 90-degree position, can leave some (not all) of the connector pins mated to the backplane, a state which will hang the system. Using the ejectors 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.

Use the ejector levers when removing an AIP to ensure that the board connector pins disconnect from the backplane in the logical sequence expected by the system. Any RP, SP, or interface processor that is only partially connected to the backplane can hang the bus. Detailed steps for correctly performing OIR are included with the following procedures for installing and removing an AIP.

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.

Removing the AIP

The AIP supports OIR; therefore, you need not shut down the interface or the system power when removing an AIP. If you are replacing a failed AIP, remove the existing board first, then replace the new AIP in the same slot. Figure 18 shows proper handling of an AIP during installation. To remove an AIP, follow these steps:

Step 1 Disconnect the ATM interface cable from the AIP port.

Step 2 Slip on a grounding wrist strap and attach the strap to one of the captive installation screws on the rear of the chassis.

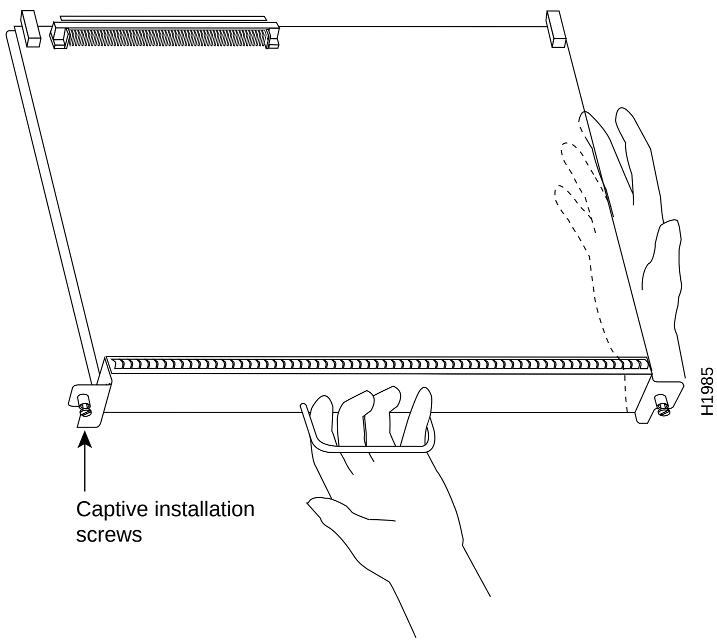
Step 3 Use a 3/8-inch flat-blade screwdriver to loosen the captive installation screws on the ends of the AIP. (See Figure 18.)

Caution Always use the ejector levers to remove or install the AIP. Failure to do so can cause erroneous system error messages indicating a board failure.

Step 4 Place your thumbs on the upper and lower ejectors and simultaneously push the top ejector up and the bottom ejector down (in the opposite direction from that shown in Figure 7c) to release the AIP from the backplane connector.

Step 5 Grasp the AIP handle with one hand and place your other hand under the carrier to guide the AIP out of the slot. (See Figure 18.) Avoid touching the board or any connector pins.

Figure 18 Handling an AIP During Installation



Step 6 Carefully pull the AIP straight out of the slot, keeping your other hand under the carrier to guide the AIP. (See Figure 18.) Keep the AIP at a 90-degree orientation to the backplane.

Step 7 Place the removed AIP on an antistatic mat or foam pad, or place the AIP in an antistatic bag if returning the AIP to the factory.

Step 8 If the interface processor slot is to remain empty, install an interface processor filler (MAS7K-BLANK) to keep dust out of the chassis and to maintain proper airflow through the interface processor compartment.

Installing the AIP

The AIP slides into any available interface processor slot and connects directly to the backplane. The backplane slots are keyed so that the AIP can be installed only in an interface processor slot. (See Figure 2 and Figure 3). Interface processor fillers, which are blank interface processor carriers, occupy empty slots to maintain consistent airflow through the interface processor compartment. If you are installing a new AIP, you will have to first remove the interface processor filler from the available interface processor slot. Figure 7 shows the functional details of inserting an interface processor and using the ejectors. Figure 18 shows proper handling of an interface processor during installation.

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.

Follow these steps to install an AIP:

Step 1 Ensure that the console terminal is connected to the RP *Console* port and that the console terminal is turned on.

Step 2 Choose an available interface processor slot (see Figure 2 or Figure 3) for the AIP, and ensure that the ATM interface cable is of a sufficient length to connect the AIP with the ATM switch.

Step 3 Interface processors and interface processor fillers are secured with two captive installation screws. (See Figure 7.) Use a 3/8-inch screwdriver to loosen the captive installation screws and remove the interface processor filler (or the existing AIP) from the slot. If you remove an AIP, immediately place the AIP into an antistatic bag to prevent damage from electrostatic discharge.

Step 4 Hold the AIP handle with one hand, and place your other hand under the carrier to support the AIP and guide the carrier into the slot. (See Figure 18.) 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 AIP in the chassis slot and align the notch on the carrier with the groove in the slot. (See Figure 7a.)

Step 6 While keeping the AIP at a 90-degree orientation to the backplane, carefully slide the AIP into the slot until the back of the faceplate makes contact with the ejector levers, then *stop*. (See Figure 7b.)

Step 7 Using the thumb and forefinger of each hand to pinch each ejector, simultaneously push the levers inward (toward the handle) until they are at a full 90-degree orientation to the faceplate. (See Figure 7c.)

Caution To prevent system problems, 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 8 Use a 3/8-inch flat-blade screwdriver to tighten the captive installation screws on the ends of the AIP. (See Figure 7.) (These screws must be tightened for maximum EMI protection.)

Caution Always tighten the captive installation screws on interface processors. These screws prevent accidental removal and provide proper grounding for the system.

Step 9 Attach an interface cable between the AIP interface ports and the ATM network.

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 19 shows the EMI filter clip assembly that is required for the E3 PLIM. *Do not* operate the E3 PLIM without the EMI filter clip assembly.

Note If you have an E3 PLIM, you must follow steps 10 through 12 to install the CAB-ATM-DS3/E3 cable and EMI filter assembly. If you do not have an E3 PLIM, proceed to the section “Checking the Installation,” which begins on page 30.

Step 10 Attach the CAB-ATM-DS3/E3 cable to the transmit (XMTR) and receive (RCVR) ports on the E3 PLIM. (See Figure 19a.)

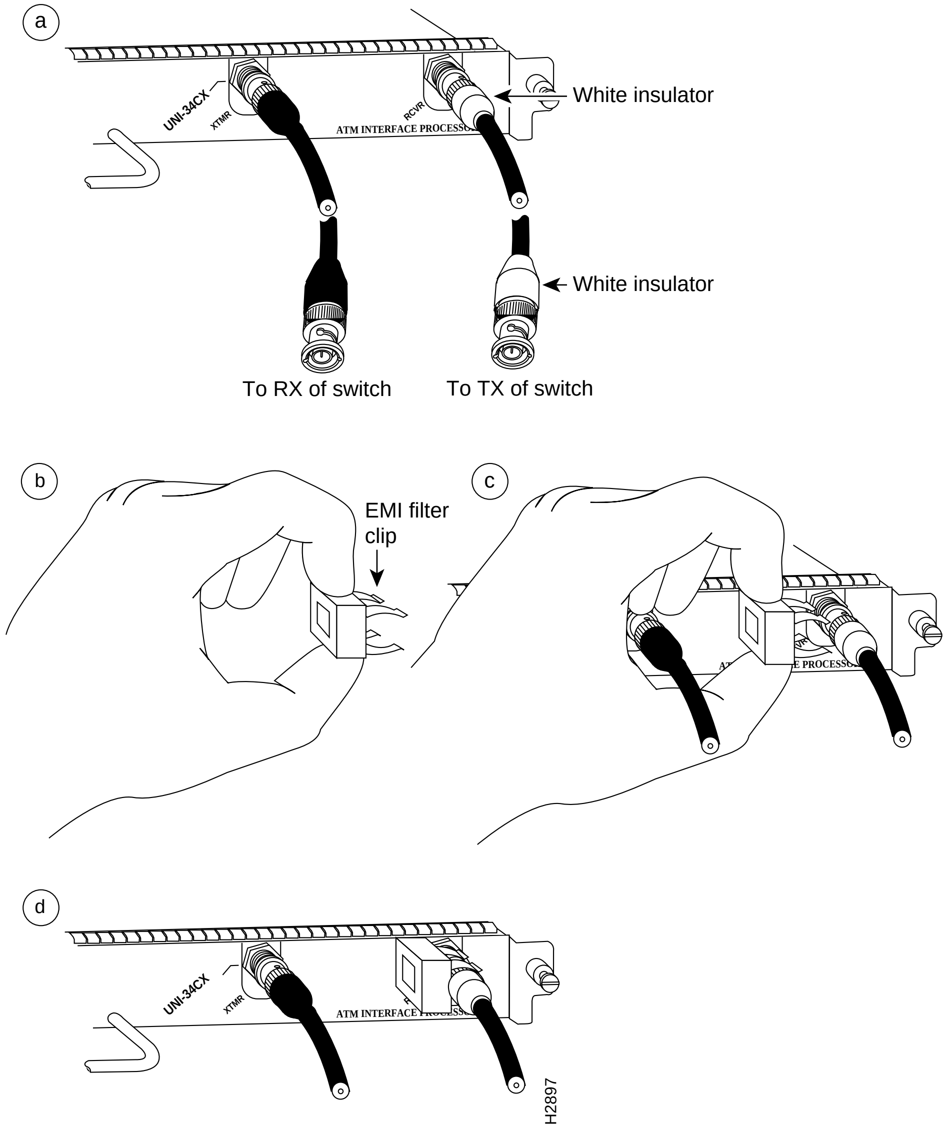
One portion of the cable has a white insulator on both ends to ensure that the receive-to-transmit and transmit-to-receive relationship is maintained between the E3 PLIM and your ATM switch. The portion of the cable with the white insulators should attach between receive and transmit *or* transmit and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

Step 11 Hold the EMI filter clip as shown in Figure 19b and attach it to the receive cable as shown in Figure 19c.

Step 12 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. (See Figure 19d.)

This completes the AIP installation. Proceed to the section “Checking the Installation,” on page 30.

Figure 19 Installing the CAB-ATM-DS3/E3 Cable and EMI Filter Clip Assembly



Checking the Installation

After you install the AIP, verify the installation by observing the LED states and the console display. When the system has reinitialized all interfaces, the enabled LED on the AIP and on all interface processors 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, which is present on all interface processors, 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 CxBus recognizes the AIP card.
- A valid version of AIP microcode is loaded and running.

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

AIP LEDs

The three LEDs above the ATM port (see Figure 1) indicate the following:

- Enabled—When on, 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.

System Status Messages

When you remove and replace CxBus interface processors, the system provides status messages on the console screen. The messages are for information only. The following sample display shows the events logged by the system as an AIP was removed from slot 1; the system then reinitialized the remaining interface processors and marked as *down* the AIP that was removed from slot 1. When the AIP was reinserted, the system marked the interface as *up* again because the ATM interface was not shut down before the AIP was removed.

```
Router#

%OIR-6-REMCARD: Card removed from slot 1, interfaces disabled
%LINK-5-CHANGED: Interface ATM1/0, changed state to administratively down

Router#
%OIR-6-INSCARD: Card inserted in slot 1, interfaces administratively shut down
%LINK-5-CHANGED: Interface ATM1/0, changed state to up
```

When a new AIP is inserted or when an AIP is moved to a new slot, the system recognizes the new ATM interface, but leaves the interface in a *down* state until you configure the interface. Change the state to *up* with the **configure** command. The following example display shows the events logged by the system as a new AIP is inserted in slot 3:

```
Router#
%OIR-6-INSCARD: Card inserted in slot 3, interfaces administratively shut down
```

Verify that the AIP is installed correctly as follows:

Step 1 While the system reinitializes each interface, observe the console display messages and verify that the system discovers the AIP as follows:

- If you installed a new AIP, the system should recognize the new ATM interface but leave the interface configured as *down*.
- If you replaced an AIP, the system should recognize the interface and put the interface into the same state (*up* or *down*) the interface had when removed.

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 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 at a 90-degree orientation 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 customer service representative to report the faulty equipment and obtain further instructions.

Step 5 If the ATM interface is new, proceed to "Configuring the AIP" to configure the new interface. (The interface is not available until you configure it.)

Step 6 If this installation was a replacement AIP, use the **show interfaces** or **show controllers cbus** command to verify the status of the ATM interface. (Refer to the section "Checking the Installation" for command descriptions and examples.)

Step 7 When the ATM interface is up, check the activity of the interface with the AIP LEDs. (See Figure 1.) The LED states are described in the section "SONET Distance Limitations."

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

This completes the AIP installation. If you installed a new AIP, you must now configure the new ATM interface, as described in the following section.

Configuring the AIP

Configuration of the AIP is a two step process: you will configure the AIP, then you will configure the ATM switch.

To configure ATM, complete the following tasks. 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.

- Enable the AIP.
- Configure the Rate Queue.
- Customize the AIP (optional).
- Configure PVCs.
- Configure SVCs.
- Monitor and Maintain the ATM Interface (optional).

Note To configure your ATM switch, refer to the appropriate user document.

Initial AIP Configuration

On power up, a new AIP is shut down. To enable the AIP, you must enter the **no shutdown** command in the configuration mode. (See the section "Using the Configure Command," which follows.

If you installed a new AIP or want to change the configuration of an existing interface, you must enter the configuration mode. When the AIP is enabled (taken out of shutdown) with no additional arguments, the default interface configuration file parameters are as 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), you can use the **configure** command to 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.

Using the Configure Command

Following are instructions for 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 complete descriptions of configuration subcommands and the configuration options available for ATM, refer to the *appropriate router system software* publications.

The Cisco 7000 series routers identify an interface address by its interface processor slot number (slots 0 to 4) and port number (port numbers 0 to 7, depending on the interface processor type) 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 1 would be *1/0*.

The following steps describe a basic configuration. Before using the **configure** command, you must enter the privileged level of the EXEC command interpreter with the **enable** command. 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 the configuration mode and specify that the console terminal will be the source of the configuration subcommands as follows:

```
Router# configure terminal <CR>
```

Step 2 At the prompt, specify the new ATM interface to configure by entering the **interface atm** 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 10.1.2.3 255.255.255.0
```

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 the configuration mode.

Step 7 Write the new configuration to memory as follows:

```
Router# write memory
```

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

Step 8 For an explanation of **show** commands which allow you to check the interface configuration, see “Checking the Configuration.”

Configuring the Rate Queue

A rate queue defines the maximum speed at which an individual 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. 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 (see the section entitled "AIP Interface Types" on page 13 of this publication).

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.

VCs 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 >34 are disallowed. For DS3, rate queues >45 are disallowed.

To configure rate queue 1 at 10 Mbps, use the **atm rate-queue** *queuenumber 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) 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 PVCs or 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 ex ceeds maximum of nMbps
```

AIP Configuration

The AIP default values may be changed to match your network environment. Perform the tasks in the following sections if you need to customize the AIP:

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

Selecting an AIP Interface

The AIP interface is referred to as **atm** in the RP 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** command, as follows:

```
interface atm n / i
```

where **n** is the slot number and **i** is the interface number.

Setting the MTU Size

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

```
mtu bytes
no mtu
```

where *bytes* is in the range of 64 through 9188 bytes and 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.

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:

```
atm sonet stm-1
```

To change back 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:

```
loopback plim
no loopback plim
```

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

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:

```
atm txbuff n
no atm txbuff
```

where *n* is in the range 0 to 512. The default is 256. The **no** form of the command restores the default.

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:

```
atm clock internal
```

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)
- 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.

Permanent Virtual Circuit (PVC) Configuration

All 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 RP configuration and are used when the RP 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.

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, use the **atm pvc** command. To remove a PVC, use the **no** form of this command.

```
atm pvc vcd vpi vci aal-encap [peak] [average] [cell-quota]
no atm pvc vcd
```

For example:

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

vcd—A per-AIP unique index value describing this VC in the range of 1 to MAXVC.

vpi—The ATM network VPI to use for this VC in the range of 0 through 255.

vci—The ATM network VCI to use for this VC in the range of 0 through 65,535.

encapsulation—The 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—LLC/SNAP precedes the protocol datagram.
aal5nlpid—NLPID precedes the protocol datagram.
aal34smds—SMDS framing precedes the protocol datagram.
qsaal—A signaling type VC.

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

peak-rate—(Optional) The maximum rate, in Kbps, at which this VC can transmit.

average-rat*e*—(Optional) The average rate, in Kbps, at which this VC will transmit.

cell quota—(Optional) The **cell-quota** is an 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.

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 >34 are disallowed. For DS3, rate queues >45 are disallowed.

The defaults for *peak-rate* and *average-rate* is that peak = average, and the PVC is automatically connected to the highest bandwidth rate queue available. 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.

VP Filter

The vp filter (vp_filter) configures the hex value used in the 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 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). AAL5 processing will be performed on the first 127 VPIs in that case. Currently you can only configure one VPI for all the AAL3/4 packets.

Examples follow:

```
atm vp-filter 1
```

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

```
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 initial release of IOS Release 10.0 will support 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 an 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:

map-list *name*
protocol protocol address atm-v**c 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:

interface atm *slot/port*

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

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. The following is an example of the 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 snapshot the last VCI/VPI that caused the 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

Checking the Configuration

After configuring the new interface, use the **show** commands to display the status of the new interface or all interfaces.

ATM Show Commands

ATM **show** commands are available to display the current state of the ATM network and the connected VCs.

To show current VCs and traffic information, use the following command:

```
show atm vc [vcd]
```

Specifying a VCD will display specific information about that VCD.

To show current information about an ATM interface, use the following command:

```
show atm int interface
```

The **show atm int interface** command will display ATM specific information about an interface.

To show current ATM traffic, use the following command:

```
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, use the following command:

```
show atm map
```

The **show atm map** command displays the active list of ATM static maps to remote hosts on an ATM network.

Other Commands That Display AIP Information

Following are descriptions and examples of the show commands that display AIP information.

- The **show controllers cbus** command displays the internal status of the SP and each cBus 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 example shows an AIP installed in interface processor slot 4, 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
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
```

- The **show atm vc** command displays the following types of statistics for all PVCs:

```
router# show atm vc
Intfc.   VCD   VPI   VCI   Input   Output  AAL/Encaps    Peak  Avg.  Burst
ATM4/0.1 1     1     1     305     0       AAL3/4-SMDS   0     0     0
ATM4/0   2     2     2     951     0       AAL5-SNAP     0     0     0
ATM4/0   3     3     3     0       0       AAL5-SNAP     0     0     0
ATM4/0   4     4     4     162     0       AAL5-MUX      0     0     0
ATM4/0   6     6     6     2722    0       AAL5-SNAP     0     0     0
ATM4/0   7     7     7     733     0       AAL5-SNAP     0     0     0
```

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

```
router# show atm vc 4
ATM4/0: 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 is sample output from the **show atm vc** command when a *vcd* is specified, AAL3/4 is enabled, an ATM SMDS subinterface has been defined, and a range of message identifier numbers (MIDs) has been assigned to the PVC:

```
Router# show atm vc 1

ATM4/0.1: 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 interfaces** command without arguments to display statistics for all interfaces in the system. **Use the show interfaces atm** *slot/port* command to display statistics for the ATM interface you specify by its slot/port address as follows:

```
router# show atm int atm 4/0
ATM interface ATM4/0:
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 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 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.
- **The show version** command displays 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.

```
Router> show version

GS Software (GS7), Version 10.0
Copyright (c) 1986-1993 by cisco Systems, Inc.
Compiled Mon 11-Jan-93 14:44

System Bootstrap, Version 4.6(1)

Current date and time is Fri 2-26-1994 2:18:52
Boot date and time is Fri 1-29-1994 11:42:38
Router uptime is 6 weeks, 6 days, 14 hours, 36 minutes
System restarted by power-on
Running default software
Network configuration file is "Router", booted via tftp from 131.109.2.333

RP1 (68040) processor with 16384K bytes of memory.
X.25 software.
Bridging software.
1 Switch Processor.
1 TRIP controller (4 Token Ring).
4 Token Ring/IEEE 802.5 interface.
1 AIP controller (1(ATM)
1 ATM network interface
4096K bytes of flash memory on embedded flash (in RP1).
Configuration register is 0x0
   (display text omitted)
```

- **The show protocols** command displays the global (system-wide) and interface-specific status of any configured Level 3 protocol.
- **The write terminal** command displays the currently running AIP configuration in RAM, as follows:

```
Router# write term
interface atm2/0
ip address 131.110.162.110 255.255.255.0
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
```

Using the Debug ATM Commands

The following **debug** commands are available to aid in solving ATM network problems:

To create a dump of all protocol packets, use the following command:

```
debug atm packet
```

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

To display errors, use the following command:

```
debug atm errors
```

The **debug atm errors** command displays information from all detected ATM errors. This includes such errors as encapsulation failures and errors during ATM configuration.

To display ATM events, use the following command:

```
debug atm events
```

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

To display information about OAM cells, use the following command:

```
debug atm oam
```

The **debug atm oam** command displays the contents of OAM cells as they arrive from the network.

After a **debug** command is used, turn off debugging with the **no debug** command.

ATM Error Messages

The following lists the possible ATM error messages displayed when you enter the **debug atm event** 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 Received a *love note* from the AIP. Love notes are messages that the AIP passes to the RP to indicate an action or event has taken place. For example, the AIP signals the RP with a love note when the AIP completes a VC setup/teardown request. Another love note signals to the RP 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 >0 indicates failure

All other values of the ASR are meaningless and discarded. The love note messages only show up if **debug atm event** 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 This error message 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 our of range cell quota selection.

Error Message
aip_setup_vc(ATM2/0): Return value 0

Explanation 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. 0 = Success.

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 RP 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 are 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.

ATM Configuration Examples

For detailed configuration examples, refer to the router software publications. 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 connected back to back

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
```

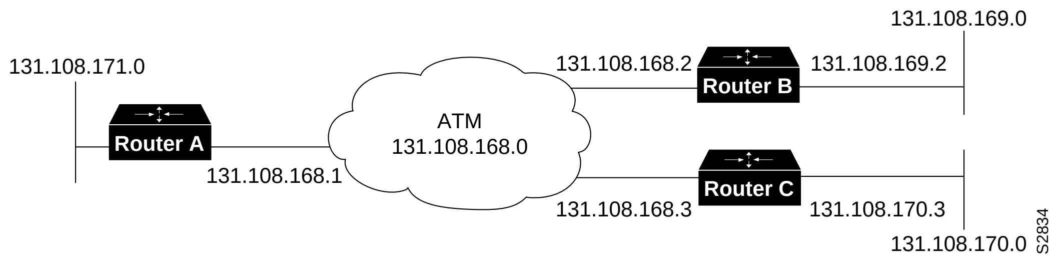
The following example is of a typical ATM configuration for a PVC:

```
interface atm4/0
ip address 131.108.168.112 255.255.255.0
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 131.108.0.0
!
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 20 illustrates a fully meshed network. The configurations for Routers A, B, and C follow. In this example, the routers are configured to use PVCs. *Fully meshed* indicates that any workstation can communicate with any other workstation. Note that 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.

Figure 20 Fully Meshed ATM Configuration Example



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 20, but using SVCs. PVC 1 is the signaling PVC.

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.

Define Cisco 7000 interfaces by interface type and physical slot/port location. The output of the **show interfaces** command displays the logical unit number in the router and the physical slot/port location in the Cisco 7000. For complete configuration descriptions and examples, refer to the router software publications appropriate for your IOS release.

To connect two routers, attach the cable between the ATM port on each.

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
```

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