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ForeRunner™ HPA-200 ATM EISA Bus Adapter

User's Manual

MANU0071 - Rev.A -March, 1996

Software Version 4.0

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Preface

The intent of this manual is to supply users of the *ForeRunner*™ HPA-200 ATM EISA Bus adapter with all the necessary information to install the HPA-200 adapter card (hereafter referred to as the HPA-200) and their accompanying software successfully. This document also provides general product information, network configuration information and information on software administration capabilities. This document was created for users with various levels of experience. If you have any questions or problems with the installation, please contact FORE Systems' Technical Support.

Chapter Summaries

Chapter 1 - Introduction - Provides an overview of ATM, an HPA-200 hardware and software overview, and general information to prepare for the installation of the HPA-200.

Chapter 2 - HPA-200 Hardware Installation - Guides you through the installation of an HPA-200. Included are hardware installation instructions, an installation test verifying the proper installation of the adapter card, and product registration information.

Chapter 3 - Software Installation and Kernel Configuration - Contains the requirements and instructions for the installation of the HPA-200 software. Also contains kernel configuration and verification information.

Chapter 4 - Network Interface Administration - Provides network configuration information such as assigning an IP address, configuring your workstation as a multi-homed or ATM-only workstation, and the dynamic and static IP routing of information for an ATM-only network.

Chapter 5 - Configuring a Classical IP ATM Network - Discusses how to integrate ATM into legacy LANs.

Chapter 6 - Configuring an Emulated LAN - Provides information on the methods for configuring emulated LANs.

Chapter 7 - ATM Network Configurations - Contains examples of various physical configurations for the HPA-200.

Chapter 8 - Additional Administration Information - Provides information about administration commands, on-line manual pages and available administrative programs.

Chapter 9 - Software Interfaces - Provides information about software interfaces supported by the HPA-200 device driver.

Chapter 10 - Troubleshooting - Provides information about tests to perform that can isolate and locate possible problems.

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Appendix A - PMD LED Indicators - describes the physical and functional capabilities of the PMD module LED indicators.

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   support@fore.com

2. You may FAX your questions to "support" at:

   412-933-3614

3. You may send questions, via U. S. Mail, to the following address:

   FORE Systems, Inc.

   174 Thorn Hill Road

   Warrendale, PA 15086-7535

4. You may telephone your questions to "support" at:

   412-933-6260

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When contacting Technical Support, please be prepared to provide the serial number(s) of the product(s) and as much information as possible describing your problem or question.

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Typographical Styles

Throughout this manual, specific commands to be entered by the user appear on a separate line in bold typeface. In addition, use of Enter or Return keys is represented as <ENTER>. The following example demonstrates this convention:

cd /usr <ENTER>

Commands, menu items, or file names that appear within the text of this manual are represented in the following style: "...the atmarp command shows a user the current connections to the adapter as well as the ATM address."

As in the following example, any messages appearing on your screen during software installation and network interface administration will appear in Courier font to distinguish them from the rest of the text.

```
.... Are all three conditions true?
```


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Important Information Indicators

To call your attention to safety and otherwise important information that must be reviewed to insure correct and complete installation, as well as to avoid damage to the adapter or your system, FORE Systems utilizes the following *WARNING/CAUTION/NOTE* indicators.

WARNING statements contain information that is critical to the safety of the operator and/or the system. Do not proceed beyond a ***WARNING*** statement until the indicated conditions are fully understood or met. This information could prevent serious injury to the operator and/or damage to the adapter, the system, or currently loaded software, and will be indicated as:

WARNING! Hazardous voltages are present. To lessen the risk of electrical shock and danger to personal health, follow the instructions carefully.



Information contained in **CAUTION** statements is important for proper installation/operation. Compliance with **CAUTION** statements can prevent possible equipment damage and/or loss of data and will be indicated as:

CAUTION You risk damaging your equipment and/or software if you do not follow these instructions.



Information contained in **NOTE** statements has been found important enough to be called to the special attention of the operator and will be set off from the text as follows:

NOTE: Steps 1, 3, and 5 are similar to the installation for the computer type above. Review the previous installation procedure before installation in your particular model.

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This preface provides safety precautions to follow when installing a FORE Systems, Inc., product.

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- Ensure that the voltage and frequency of your power source matches the voltage and frequency inscribed on the equipment's electrical rating label.
- Never push objects of any kind through openings in the equipment. Dangerous voltages may be present. Conductive foreign objects could produce a short circuit that could cause fire, electric shock, or damage to your equipment.

Symbols

The following symbols appear in this book.

WARNING! Hazardous voltages are present. If the instructions are not heeded, there is a risk of electrical shock and danger to personal health.



CAUTION If instructions are not followed, there is a risk of damage to the equipment.



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CHAPTER 1 Introduction

This chapter provides an overview of the ATM Standard and FORE Systems' HPA-200. It details the hardware and software requirements necessary to use the HPA-200 and also provides information on the contents of the HPA-200 package.

1.1 Overview of the ATM Standard

Asynchronous Transfer Mode, or ATM, is a communication architecture based on the switching of small fixed length packets of data called *cells*. In ATM, all data is transferred in 53-byte cells. Each cell has a 5-byte header that identifies the cell's route through the network and 48-bytes containing user data. This user data in turn carries any headers or trailers required by higher level protocols.

Perhaps the single most important advantage offered by ATM, in addition to data transfer speed, is its open-ended growth path. ATM is not locked into a single physical medium or speed. The fixed-size ATM cell allows traffic from multiple sources (simultaneous video, audio, and data communication) to be switched to multiple destinations by fast ATM switches. For example, a *ForeRunner* ASX-1000 ATM Switch can connect up to 96 users (with TAXI 100 network modules) and has an aggregate capacity of 10 gigabits per second. Larger LANs can be built by interconnecting multiple *ForeRunner* ATM switches.

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1.2 Overview of LAN Emulation

FORE Systems' *ForeThought* 4.0 LAN Emulation software is compliant with the ATM Forum's *LAN Emulation Over ATM Version 1.0* specification. LAN Emulation (LANE) allows higher level protocols and LAN applications to interoperate, without modifications, with an ATM network. The components of the emulated LAN (ELAN), running on the ATM network, work together to emulate an Ethernet LAN. The ELAN components resolve MAC addresses to ATM addresses, replace the connectionless operation of legacy LANs with point-to-point connections, and provide broadcast and multicast services. The ELAN consists of a LAN Emulation Client (LEC) running on each host in the ELAN, and the following LANE Services:

- the LAN Emulation Server (LES)
- the Broadcast and Unknown Server (BUS)
- the LAN Emulation Configuration Server (LECS)

In *ForeThought* 4.0, the LANE services operate on a FORE Systems switch or SunOS workstation.

In order to understand *ForeThought* 4.0, it is important to understand how these components work together to provide LAN Emulation.

1.2.1 The ELAN Components

The emulated LAN (ELAN) includes a number of components:

LAN Emulation Client (LEC) — Runs on each end station in the ELAN. Communicates with other ELAN components (the LES and BUS) to resolve MAC addresses into ATM addresses.

LAN Emulation Configuration Server (LECS) — Runs on a Sun OS workstation or in a FORE Systems switch. Maintains information about all ELANs within the administrative domain. When the LEC successfully communicates with the LECS, the LECS provides a list of ELANs which the LEC can join.

LAN Emulation Server (LES) — Runs on a Sun OS workstation or in a FORE Systems switch. Maintains information about the LECs within a single ELAN and performs address resolution.

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Broadcast and Unknown Server (BUS) — Runs on a Sun OS workstation or in a FORE Systems switch. Provides services within a single ELAN allowing broadcasts, multicast, and unknown unicasts within a single ELAN.

1.2.2 An Example Configuration

The diagram in Figure 1.1 shows an example configuration of a single emulated LAN in a FORE network. The ELAN includes:

- Workstations (PCs, Macintoshes, and UNIX boxes) running a LEC. Each has a *ForeRunner* ATM adapter, the *ForeRunner* driver for the adapter, and one or more *ForeRunner* ELAN drivers installed.
- Two ASX-200 switches, on which the LANE services are running. One switch is running the LECS, the LES, and the BUS. Both switches are also running LECs.
- An LAX-20 providing access to non-ATM networks.

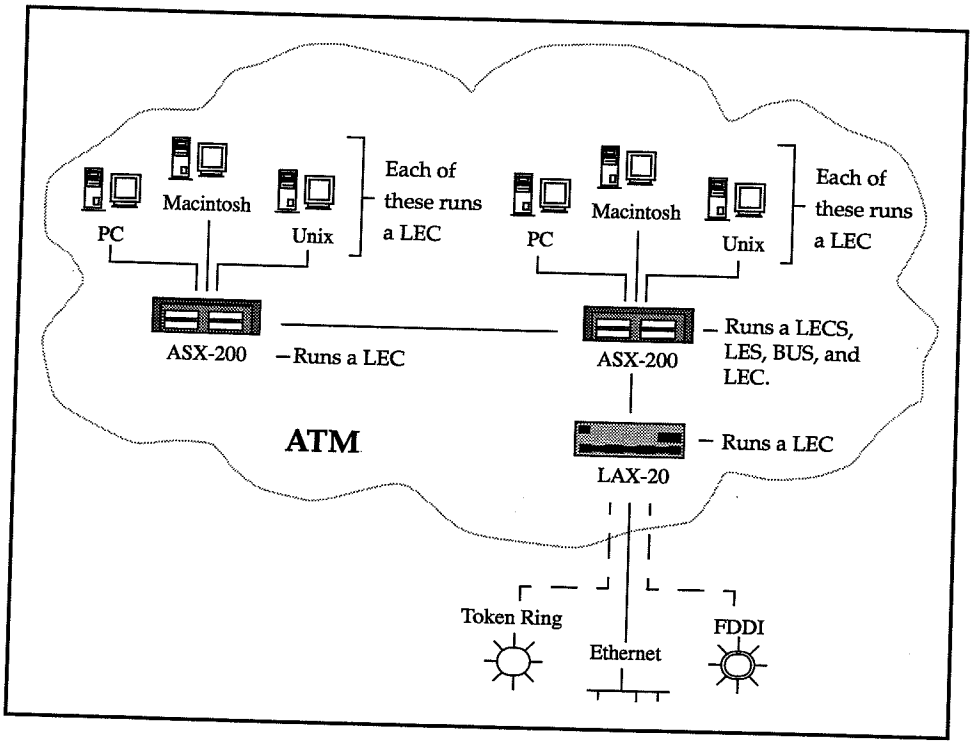


Figure 1.1 An Example of an ELAN

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1.2.3 The Initialization Process

The LAN Emulation Client (LEC) running on the workstation goes through the following process when it initializes:

1. The LEC obtains its own ATM address via address registration. (You can also manually specify the ATM address when you install the ForeRunner ELAN ATM driver.)
2. The LEC establishes a connection to the LECS. It gets the address through the well-known address or the permanent virtual circuit (0,17). (You can also manually specify the address of the LECS when you install the ForeRunner ELAN ATM driver.)
3. The LECS provides the LEC with the information necessary to join whatever ELANs it is allowed to join. The LECS has information about available ELANs and also information about what ELANs each LEC can join, and which ELAN the LEC wants to attempt to join first.
4. The LEC contacts the LES for the ELAN it wants to join and registers its MAC-ATM address. It also contacts the BUS for the ELAN. At this point the LEC and the LES have the information required to allow this host to communicate with other hosts on the ELAN as if it were an Ethernet network, and vice versa.

1.2.4 The Connection Process

To send Ethernet packets to another host on the emulated LAN:

1. The LEC calls the LES to map the MAC destination address into an ATM address. (The LES maintains a mapping table of the address of all LECs on the ELAN.)
2. If the LES finds an entry in its table for the destination MAC address, it returns the destination ATM address to the LES.
3. The LEC then opens up a point-to-point ATM connection to the destination host to send the packet.

For outgoing multicast and broadcast packets, the LEC sends them to the BUS which uses a point-to-multipoint connection to send the packet to every ATM address in the emulated LAN.

Note that the diagram in Figure 1.1 shows dotted lines from the LAX-20 to the Token Ring and FDDI networks. This is because the LAX-20 does not use LANE bridging to reach these networks but must route to them. Although the ATM Forum has defined Token Ring and FDDI LAN Emulation,

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ForeThought 4.0 only supports Ethernet LAN Emulation; so the LAX-20 must route to Token Ring and FDDI networks.

1.2.5 Multiple ELANs

It is possible to set up more than one emulated LAN in a FORE network. For each new emulated LAN, you must configure another LES and BUS instance for that LAN. On the access devices, bridge groups are used to associate physical Ethernet ports with emulated LANs on the ATM side.

An end station in the ELAN with a ForeRunner adapter can connect to up to 16 ELANs simultaneously.

1.2.6 Intelligent BUS

This feature reduces broadcast traffic by using the MAC address information in the LES. When an intelligent BUS receives a unicast frame with an unknown MAC destination address, the BUS first checks the LES's cache of addresses to see if the MAC address is registered there. If it is, the BUS routes the frame directly to the destination, instead of broadcasting.

1.2.7 Failover ELANs

To ensure that a single service failure does not cripple the entire ELAN, *ForeThought* 4.0 supports a simple failover mechanism. Rather than associating a single LES and BUS pair with a single ELAN, the LEC maintains an ordered list of LES and BUS pairs for each ELAN. While the LEC is only interacting with one LES at a time, it is ready to move to the next LES and BUS in the list if the current LES fails. If it is using a backup LES and BUS pair, the LEC will periodically check if the primary LES and BUS pair in the failover sequence are again available. If they are, the LEC resumes the connection to the original pair.

1.2.8 The Default ELAN

To simplify configuration of the ELAN, ForeThought 4.0 supports a default ELAN named default. This is the first ELAN in the list of ELANs provided by the LECS to the LEC. Unless you specify otherwise, the LEC initially attempts to join default and succeeds if the LECS is available, the proper LES address for default has been specified in the LECS, and the LES and BUS are available.

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1.3 The *ForeRunner* HPA-200 Adapter

The HPA-200 is a high performance adapter designed for use in an Apollo 9000, Series 700 workstation or server. The HPA-200 adapter provides ATM connectivity for the host systems, and is able to support evolving signalling and AAL standards. The adapter features FORE Systems' Advanced Cell Processing architecture, providing maximum network performance to all running applications. In addition, the HPA-200 provides transparent support for TCP/IP, Switched Virtual Circuits (SVCs) through the SPANS and UNI 3.0 signalling protocols, Permanent Virtual Circuits (PVCs), Classical IP, LAN emulation, an ATM Applications Programmer Interface (API), and an SNMP agent for network management.

The HPA-200 supports high-quality image, full-motion video, CD-quality audio, and high speed data communications over a single ATM network connection. Each physical connection in an ATM LAN is a point-to-point link between switches and/or hosts.

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1.4 Hardware Overview

The HPA-200 features FORE's Advanced Cell Processing Architecture which utilizes a dedicated embedded Intel i960 RISC processor along with special-purpose AAL5 and 3/4 Segmentation and Reassembly (SAR) hardware and scatter-gather DMA. The HPA-200 is an EISA Bus master device and supports 32-bit wide EISA Bus data transfers and EISA Bus DVMA (Direct Virtual Memory Access) bursts up to 64 bytes. With the HPA-200, users can add ATM networking capabilities to their applications, leaving the low-level ATM cell processing, segmentation and reassembly, and signalling to the HPA-200 hardware and device driver.

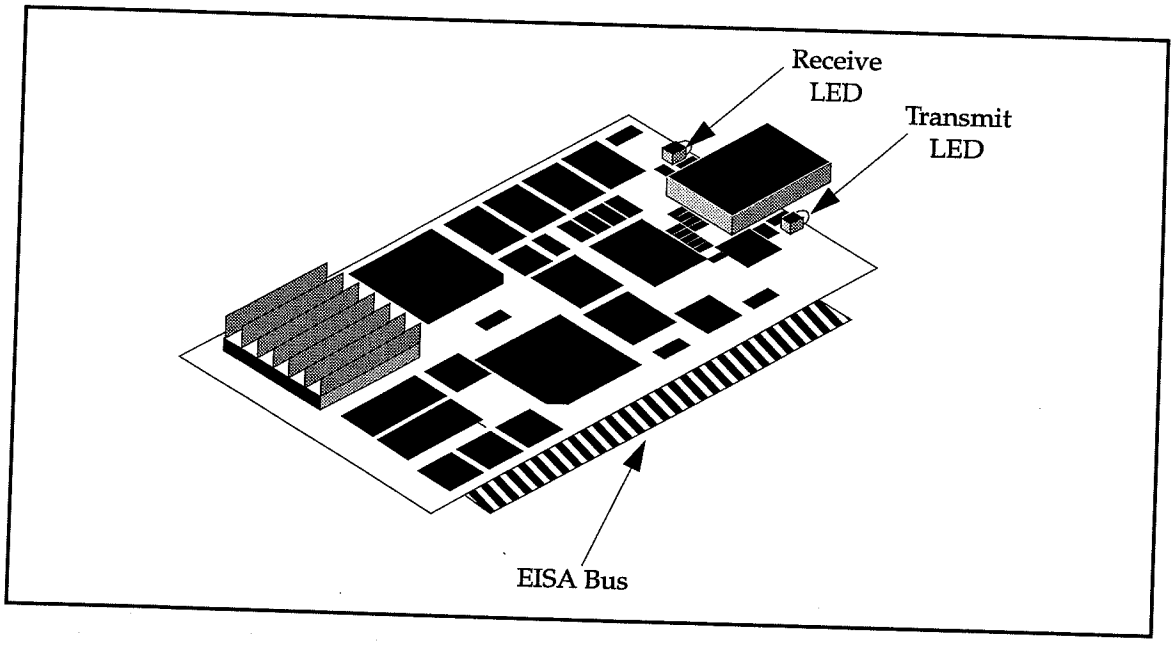


Figure 1.2 HPA-200 Adapter Card

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1.5 Software Overview

The HPA-200 adapter uses *ForeThought's* market-proven support for TCP/IP protocols (see Figure 1.3), allowing existing applications to operate with no modifications. Major advantages include high-performance network throughput delivered to applications, and the flexibility for future upgrades.

The HPA-200 software driver implements the SPANS Switched Virtual Circuits (SVC) signalling protocol to give applications end-to-end ATM connectivity including on-demand access to *ForeRunner* ATM switch multicast functions. An ATM Forum-compliant SNMP Management Information Base (MIB) is accessible by any SNMP network management system. The software supports the UNI 3.0 signalling standards. The current revision of software, *ForeThought 4.0*, is also compliant with the ATM Forum's *LAN Emulation over ATM, Version 1.0* standard.

The *ForeRunner* API library supplied with the HPA-200 offers applications access to the unique features of ATM such as guaranteed bandwidth reservation, per-connection selection of AAL5 or 3/4, and multicasting with dynamic addition and deletion of recipients.

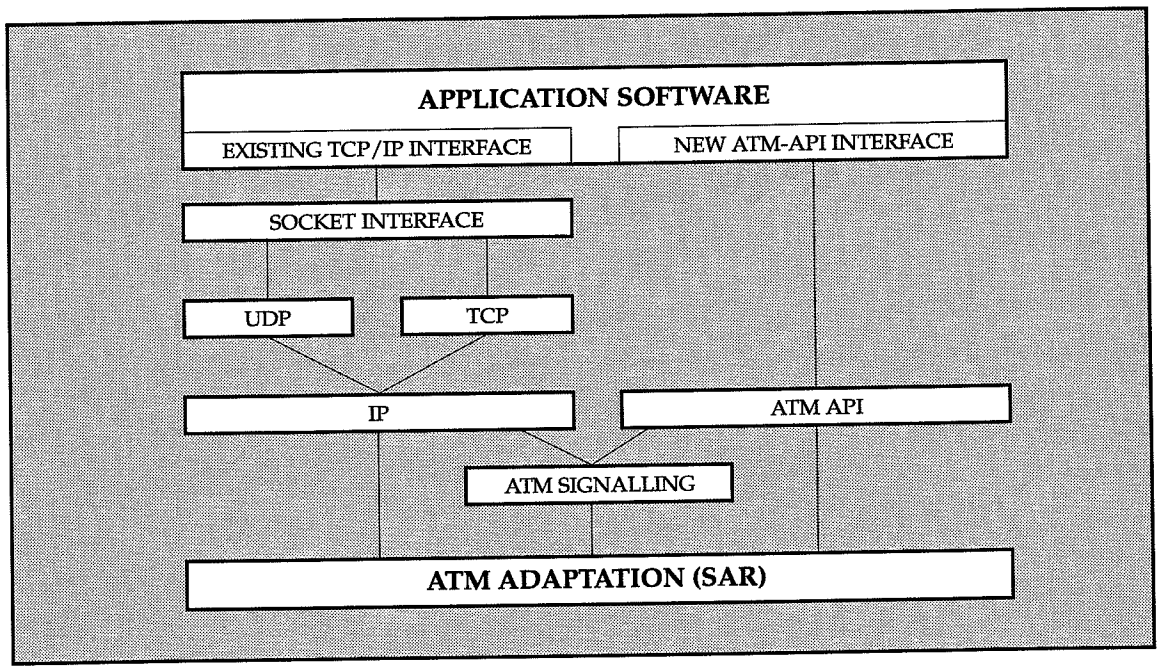


Figure 1.3 HPA Software Architecture

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1.5.1 HPA-200 Advanced Cell Processor Architecture

The HPA-200's Advanced Cell Processor Architecture provides optimized on-board cell processing functions including segmentation and reassembly. The software device driver provides a high-performance packet-level interface to the cell-processing engine. The driver identifies the data packets to be communicated over ATM; the cell-processing engine does the rest.

1.5.2 New Features

The 4.0 release of *ForeThought* software provides major new functionality, features, and enhancements. This software release supports the ATM Forum *LAN Emulation Over ATM, Version 1.0* standard. The particular features supported include:

- LAN Emulation Clients
- LEC failover
- Multiple Virtual LANs
- Ethernet emulation

Each of these features is detailed in the appropriate chapters throughout the manual.

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1.6 Hardware Requirements

The HPA-200 can be installed in an available EISA Adapter Card Assembly in any of the supported platforms.

1.6.1 HPA-200 Supported Platforms

The following are the supported platforms for the HPA-200 adapter cards:

- Hewlett-Packard Co., HP Apollo 9000, Series 700, Model 715 workstation or server
- Hewlett-Packard Co., HP Apollo 9000, Series 700, Model 720 workstation or server
- Hewlett-Packard Co., HP Apollo 9000, Series 700, Model 725 workstation or server
- Hewlett-Packard Co., HP Apollo 9000, Series 700, Model 730 workstation or server
- Hewlett-Packard Co., HP Apollo 9000, Series 700, Model 735 workstation or server
- Hewlett-Packard Co., HP Apollo 9000, Series 700, Model 747 workstation or server
- Hewlett-Packard Co., HP Apollo 9000, Series 700, Model 750 workstation or server
- Hewlett-Packard Co., HP Apollo 9000, Series 700, Model 755 workstation or server

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1.7 Software Requirements

The supplied *ForeRunner* HPA-200 device driver supports HP-UX version 9.xx.

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1.8 Unpacking Information

Before unpacking your HPA-200, inspect the package for any damage that may have occurred during shipping. If the package shows any signs of external damage or rough handling, notify your carrier's representative.

When unpacking the HPA-200, be sure to keep all original packing materials. They may be needed for storing, transporting, or returning the product.

CAUTION



All products returned to FORE Systems, under warranty, must be packed in their original packing materials.

CAUTION



The HPA-200 contains static-sensitive devices. Keep the adapter in its protective bag until installation.

The *ForeRunner* HPA-200 adapter package contains the following:

- HPA-200 Adapter
- HPA-200 Software on tape with license
- *ForeRunner* HPA-200 ATM Adapter User's Manual (this manual)
- Anti-static Grounding Strap
- Warranty Registration Card

If any of the above items are missing or damaged, please contact FORE Systems' Technical Support immediately.

CAUTION



Keep the HPA-200 in its anti-static protective bag until installation. Electronic components are subject to damage from even small amounts of static discharge. Therefore, be sure to have your equipment properly grounded.

A complete software manifest is contained on the software media in the file fore/MANIFEST.

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1.9 HPA-200 Technical Specifications

The capabilities and physical parameters of the HPA-200 are detailed in the table below.

Table 1.1 HPA-200 Technical Specifications

Hardware	
Architecture	On-board 25 mHz i960 cell processor with EISA bus master burst transfer capability
AAL Support	Special purpose, on-board hardware for HEC, CRC, and AAL5 and 3/4 calculations
UNI (Physical Layer)	100 and 140 Mbits/sec TAXI (4B/5B encoding); 155 Mbits/sec SONET STS-3c/SDH STM-1
Form Factor	Single-slot EISA bus
Compliance	ATM cell processing per ANSI T1S1.5/92-002R3, ITU I.361, and ATM Forum v3.0 UNI specification
Cabling	Duplex 62.5/125 micron multi-mode fiber (2,000 meters maximum, 10 dB loss); 2-pair 100 ohm Category 5, or Category 5 screened, UTP copper (100 meters maximum)
Connectors	ST and SC Types for multi-mode fiber; RJ-45 for Category 5 UTP copper
Memory	256 kbytes on-board RAM
DMA Support	32-bit burst mode, bus master; "Fly-by," scatter-gather DMA support; Supports block transfers up to 16 words; Full 32-bit datapath

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Table 1.1 HPA-200 Technical Specifications (Continued)

Software	
Transparent TCP/IP protocol interface.	
Enhanced-performance ATM Application Programming Interface (API) Library.	
SPANS Switched Virtual Circuit (SVC) signalling protocol	
Permanent Virtual Circuits (PVC)	
Application-controlled multicasting and broadcasting with recipient add and delete capabilities.	
Supports up to 1024 Virtual Circuit Identifiers (VCIs)	
Support for UNI 3.0 signalling	
Support for ILMI (Interim Local Management Interface)	
Support for Classical IP Interfaces	
SNMP MIB access to adapter status, ATM cell statistics, cell errors, and VPI/VCI information.	
Support for LAN Emulation Clients	
General	
Dimensions	0.6" H x 5.5" W x 9.4" D (1.5 cm x 12.7 cm x 23.8 cm)
Weight	8.3 oz. (235 g)
Power Requirements	2 A (maximum) @ +5V
Operating Temperature	32° F to 104° F (0° C to 40° C)
Operating Humidity	20% to 80%, non-condensing @ 40° C
Compliance	FCC Part15, Class A Verification (UTP); FCC Class B Certification (fiber-optic connectors)

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1.10 Cable Specifications

The following tables list the recommended cable specifications to ensure optimal adapter and switch performance:

Table 1.2 Multi-Mode Fiber-Optic Cable Specifications

Description	Specification
Core Diameter	62.5 µm
Fiber Diameter	125 µm
Wavelength	1310 nm
Loss characteristic	~0.5 dB/km
Connector Style	SC or ST
Power Budget	11 dB(1)
Maximum run	approximately 2 km
Transmit Power	-19 dBm (minimum)
Receive Power	-30 dBm (minimum)

(1) If a 50 µm core fiber is used, the power budget should be derated by 4dB.

The HPA-200 is available with UTP connectors. The requirements and pinouts for this cabling are given below.

Table 1.3 CAT 5 UTP Cable Specifications

Description	Specification
AWG	24
Impedance (Ω)	100 +/- 15%
Attenuation (dB/1000 ft. Max)	25 dB @ 16 mHz 52 dB @ 62.5 mHz 67 dB @ 100 mHz
Maximum Run	100 m(1)
Connector Type	RJ-45

(1) Within a 100 meter run, a maximum of two connections are permissible.

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The pinouts for the RJ-45 connector on an HPA are:

Table 1.4 CAT 5 UTP Pinouts

Pin	Signal
1	Transmit (+)
2	Transmit (-)
3	Not Used
4	Not Used
5	Not Used
6	Not Used
7	Receive (+)
8	Receive (-)

1.11 Product Registration Information

Please fill out the enclosed product registration card for your HPA-200 ATM adapter, and return it to FORE Systems.

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CHAPTER 2 Hardware Installation

This section is designed to guide you through the installation of the HPA-200 in an HP Apollo 9000, Series 700, workstation or server. The procedures contain step-by-step instructions for the successful installation of the HPA-200 into the EISA Adapter Card Assembly in your system. This section also contains important unpacking, handling, and registration information. It is strongly suggested that you read all information carefully before attempting the installation.

2.1 General Installation Procedures

Installation of the HPA-200 into an HP Apollo 9000, Series 700 workstation/server is a simple procedure. The HPA-200 installs into the EISA Adapter Card Assembly. Details for installation are documented in the following sections.

NOTE: The instructions for operations to be performed on your workstation/server are provided using both HP-UX Command Line Shell operation and for HP VUE (Hewlett-Packard Visual User Environment) operation.

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2.2 Halting the System

Before installing the HPA-200, your workstation should be halted and powered down. The following are procedures for halting your system using both HP-UX Command Line Operation and also the HP VUE Visual User Environment.

CAUTION



Do not turn off the power to your workstation without first performing this shutdown procedure. The workstation should be halted in an orderly manner. Always quit all open files and user processes. Improperly aborting an application may damage files.

2.2.1 HP-UX Command Line Operation

To halt your system using the HP-UX Command Line Operation perform the following routine:

1. Save all work and quit any applications.
2. Log in as root
3. Set your working directory to the root (/) directory by entering the following on the command line:

   cd / <ENTER>

4. Execute the following shutdown command:

   /etc/shutdown -h 0

5. The shutdown process takes about one minute. When it is complete, the following message appears in the lower left-hand corner of your screen:

```
Halted, you may now cycle power.
```


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6. When the system is halted, power down the devices in this order:
   a. any external devices, including disk drives, etc.
   b. workstation system
   c. the monitor
7. Unplug the power cord attached to the workstation.

NOTE: For additional information about halting your workstation, please refer to the Hewlett Packard *HP Apollo 9000, Series 700 Owners Guide.*

2.2.2 HP VUE Operation

To halt your system using HP VUE (Visual User Environment), perform the following routine:

1. Save all work and quit any applications.
2. Log in as root
3. Move the mouse pointer to the up arrow above the personal toolbox control icon, and click the left mouse button once.
4. The Toolboxes subpanel opens. Place the mouse cursor on the General toolbox icon and single-click the left mouse button.
5. A file manager window appears with a number of icons in it. Double-click the left mouse button on the System_Admin toolbox icon.
6. The System_Admin window appears. Move the mouse cursor onto the scroll bar slider at the side of the window. Press and hold the left mouse button while moving the mouse toward you. When the HaltSystem icon shown below appears, release the left mouse button.
7. Double-click on the HaltSystem icon.
8. The Halt System window appears. You are prompted if you are sure you want to halt the system. If you wish to halt the system, select the OK, Halt System command. If you do not wish to halt the system, select the No, Cancel command from the window.

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9. The shutdown process takes about one minute. When it is complete, the following message appears in the lower left-hand corner of your screen:

```
Halted, you may now cycle power.
```

10. When the system is halted, power down the devices in this order:
    a. any external devices, including disk drives, etc.
    b. the workstation system
    c. the monitor

CAUTION



Electronic components are extremely sensitive to static electricity. You must wear the wrist strap while installing the adapter card. Using the wrist strap in a properly static safeguarded environment can prevent damage to the HPA-200 and other computer components.

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2.3 HP 9000, Series 700, Model 715 Installation

This section provides the information necessary to install an HPA-200 into an HP 9000, Series 700, Model 715 workstation/server.

2.3.1 Installing the HPA-200 Adapter Card

1. Shut down your system as indicated in Section 2.2, Halting the System.

NOTE: The Model 715 system either has a handle that pushes in to open the system or a handle with a latch that slides to open the system.

2. Open the system unit, as shown in Figure 2.1.

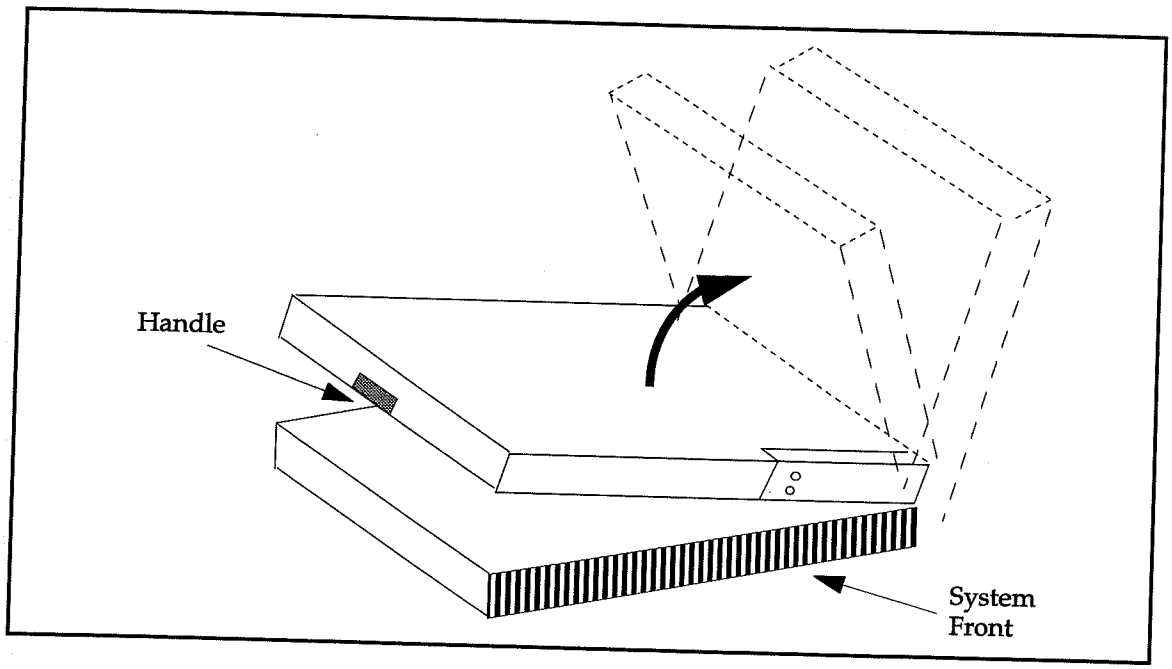


Figure 2.1 Opening the System Unit

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NOTE: If you have an optional CRX graphics board installed in your workstation, you may not install an HPA-200.

3. Remove the EISA adapter board and connector bucket from the system unit. Also remove the EISA filler panel assembly located behind the connector bucket (see Figure 2.2).

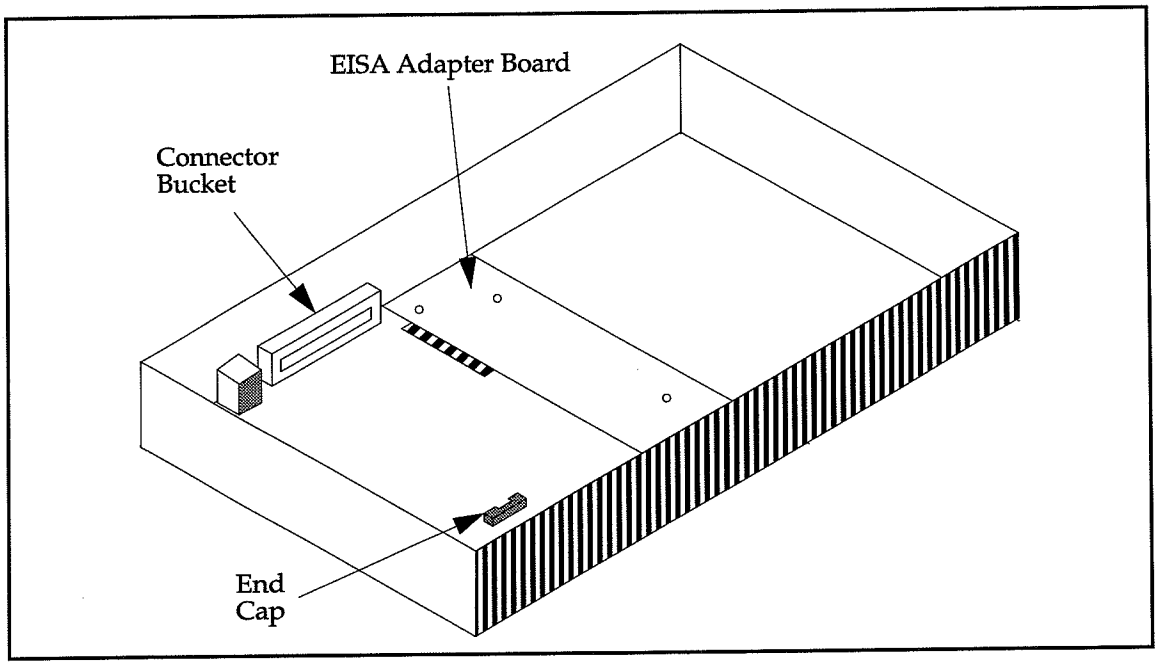


Figure 2.2 HPA-200 Card Installation

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4. Slide the connector bucket onto the HPA-200's connector bracket. Insert the board's connector bracket under the tabs on the face of the bucket. Then slide the top of the connector bracket under the tabs on the top of the bucket (see Figure 2.3).

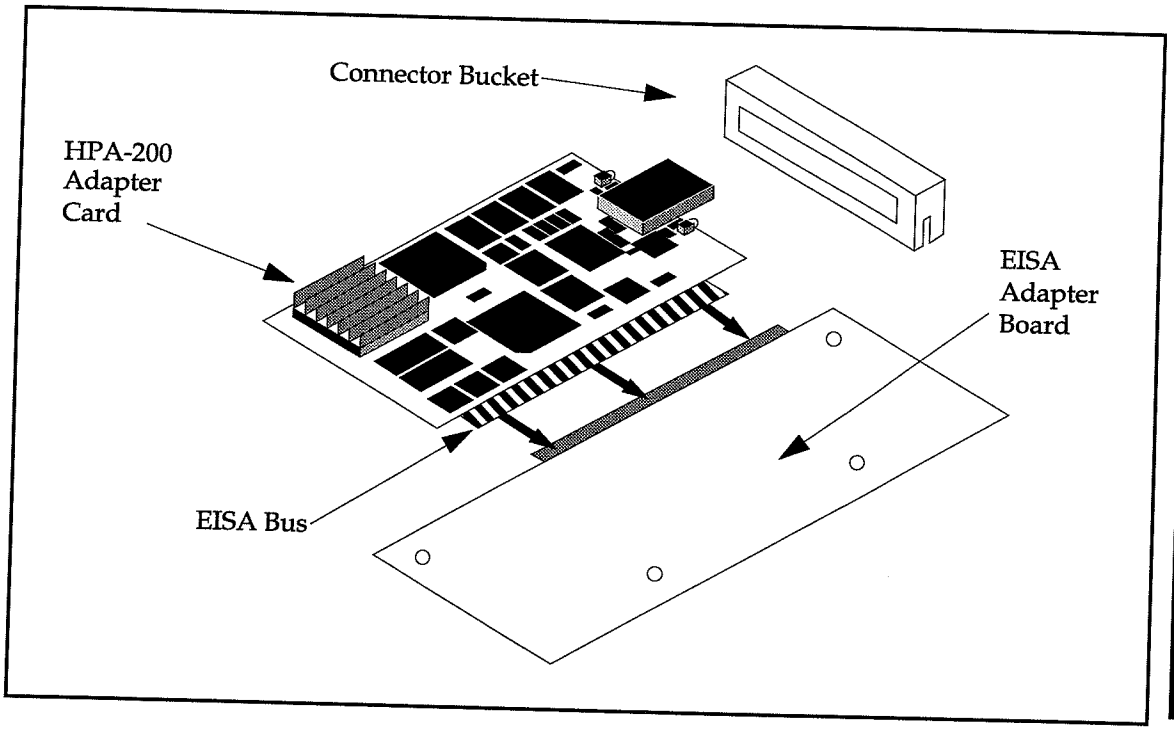


Figure 2.3 Preparing the EISA Adapter Board for the HPA-200

5. Insert the HPA-200 into the connector on the EISA adapter board. Push firmly to ensure a secure connection.

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6. Slide the connector bucket, which you attached to the HPA-200, partway into the channels of the connector slot on the rear of the system unit. Align the connector on the adapter board with the connector on the processor board, and carefully press the two connectors together. Ensure that the standoffs are aligned with the holes in the CPU board. Press on both the connector bucket and the adapter board to secure the assembly to the system unit (see Figure 2.4).

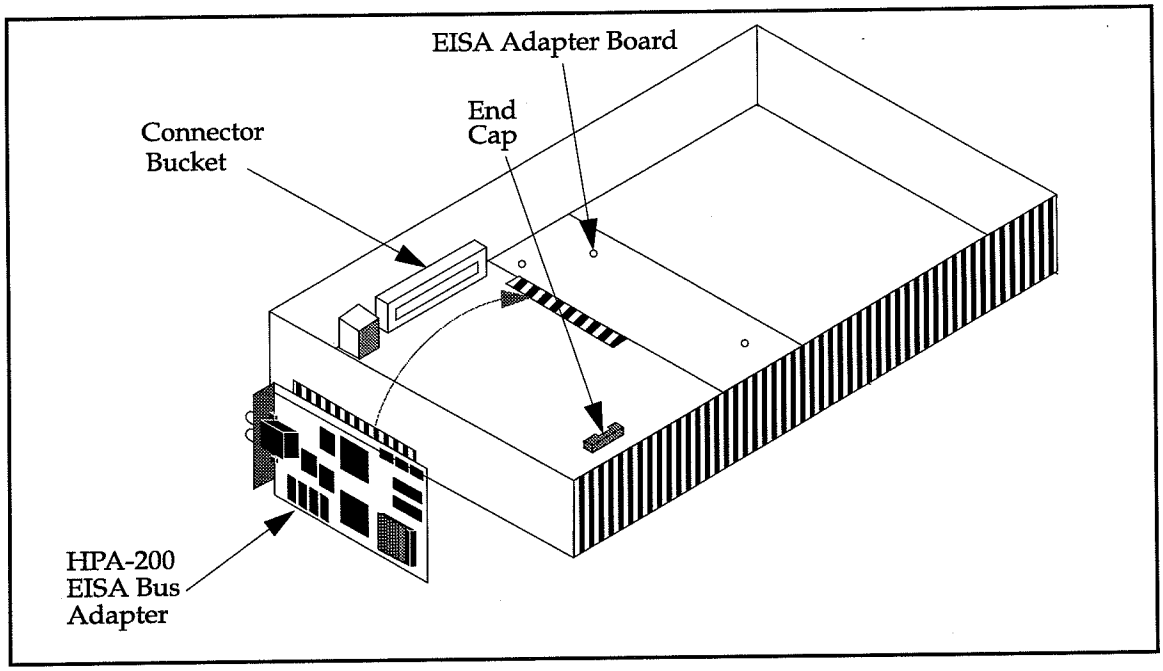


Figure 2.4 Installing the HPA-200

7. Pinch the sides of the end cap and slide it to the HPA-200. Fit the edge of the HPA-200 into the slot of the end cap to secure the board.
8. Close the system unit.
9. Connect the cabling to the HPA-200. Power on the system.

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2.4 HP 9000, Series 700, Model 720/730/735 Installation

This section provides the information necessary to install an HPA-200 into an HP 9000, Series 700, Model 720, 730 or 735 workstation/server.

2.4.1 Installing the HPA-200 Adapter Card

1. Shut down your system as indicated in Section 2.2, Halting the System.
2. Remove the power supply cover plate, as shown in Figure 2.5.

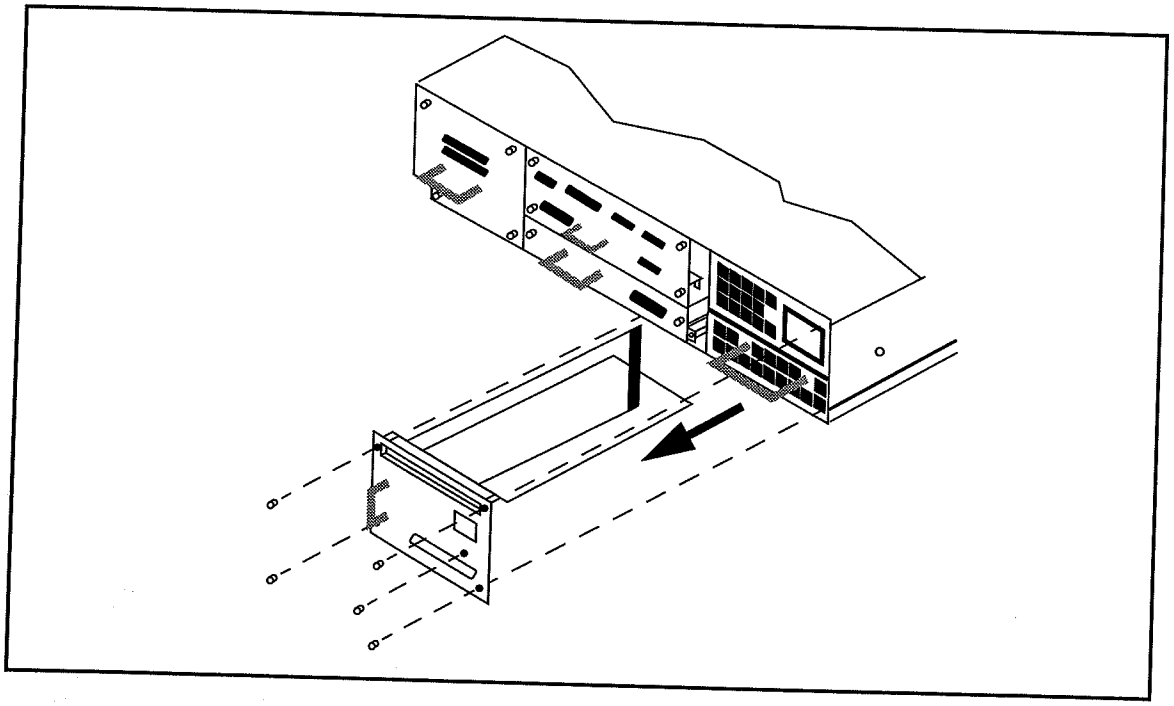


Figure 2.5 Removing the Power Supply Cover Plate

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3. Prepare the EISA Adapter Card Assembly to accept the HPA-200 by removing and saving the single retaining screw that secures the blank EISA slot cover in place on the adapter cover plate, as shown in Figure 2.6. Remove the blank EISA slot cover from the adapter cover plate.

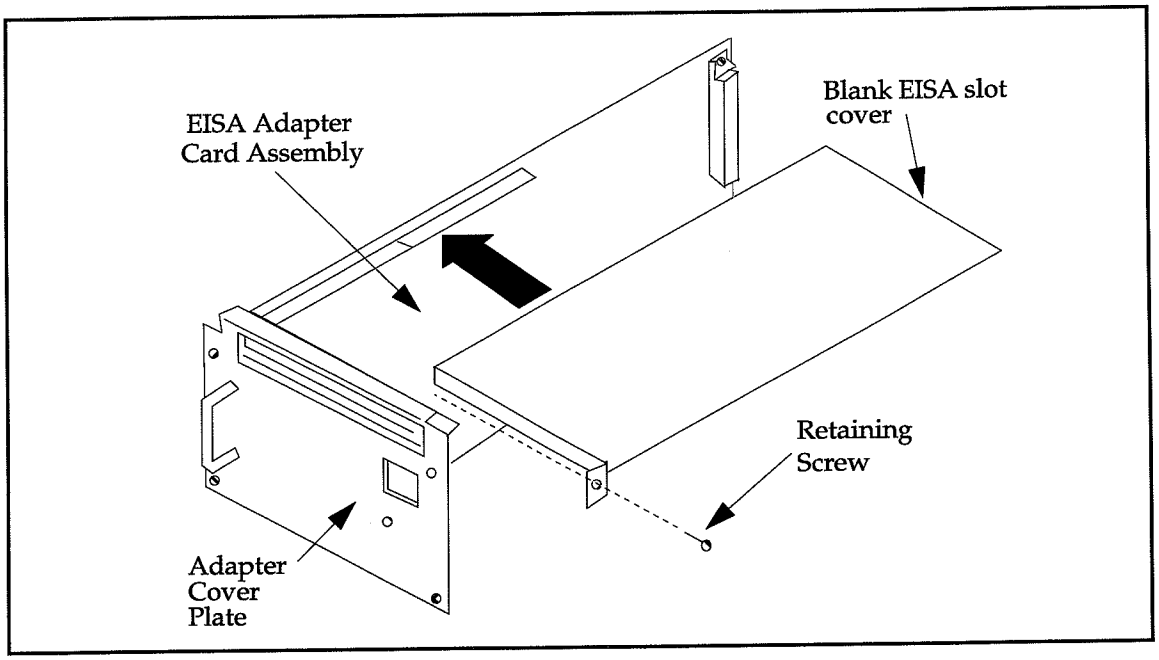


Figure 2.6 Preparing the Adapter for the HPA-200 Card

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4. Slide the HPA-200 into the adapter assembly. Make sure the EISA card is securely placed into the connector on the adapter card assembly, as shown in Figure 2.7.

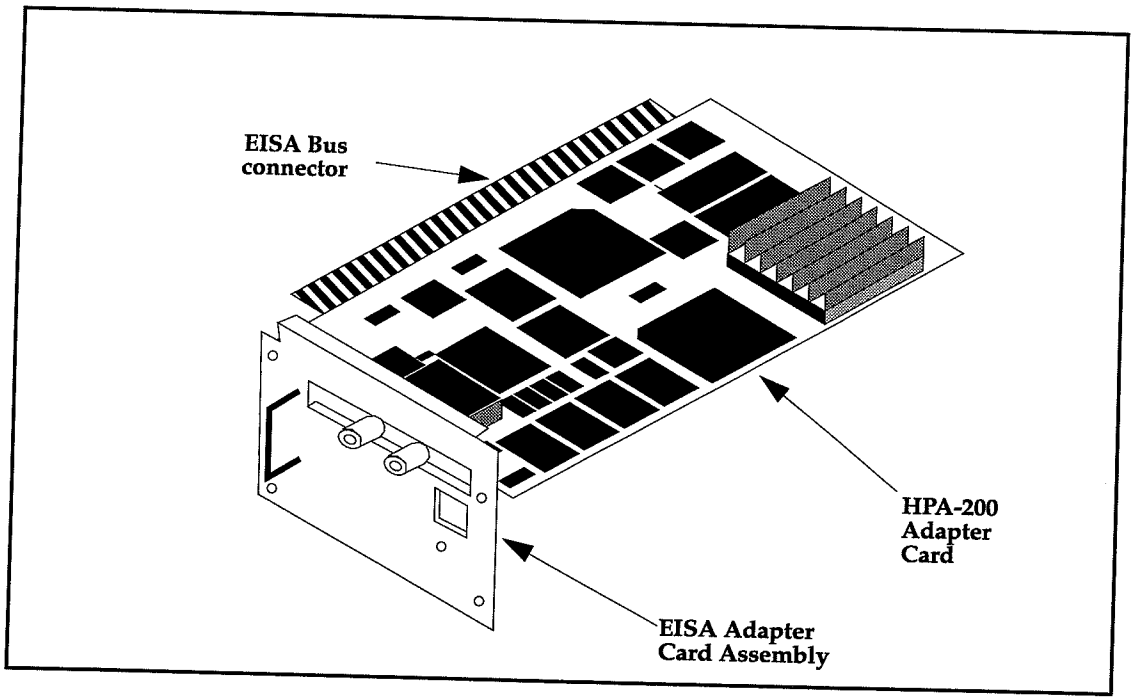


Figure 2.7 Installing the HPA-200

5. Re-install the single retaining screw (removed in step 3) to secure the HPA-200 adapter card to the EISA Adapter Card cover plate.
6. Install the power supply cover plate onto the system.
7. Connect the cable for the EISA device and reconnect the cable to the power supply on the system unit.
8. Power on the system.

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2.5 HP 9000, Series 700, Model 755 Installation

This section provides the information necessary to install an HPA-200 into an HP 9000, Series 700, Model 755 workstation/server.

2.5.1 Installing the HPA-200 Adapter Card

1. Shut down your system as indicated in Section 2.2, Halting the System.
2. Turn off the power to your system and any peripherals, and unplug their power cables.
3. Remove the top cover of the system card cage by removing the thumb screw at the back of the system, and sliding the top cover to the back and pulling it off, as illustrated in Figure 2.8.

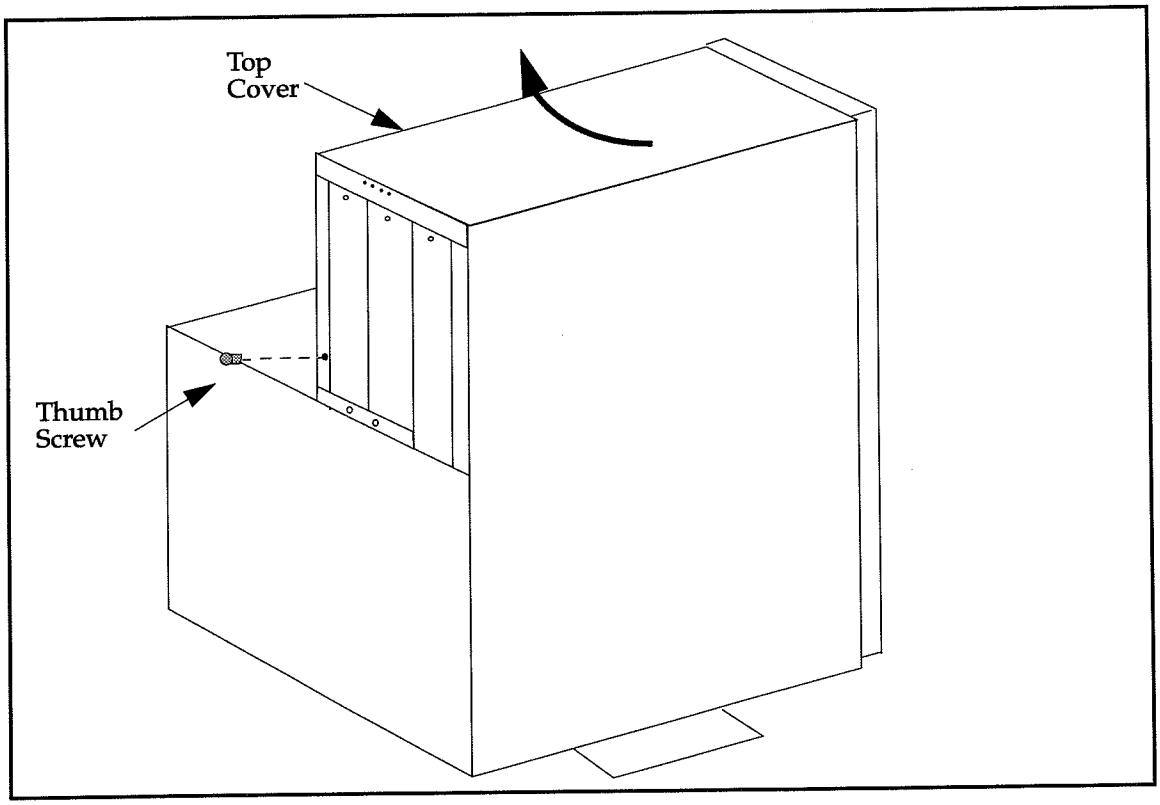


Figure 2.8 Opening the System Unit

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4. Remove the right-side cover as shown in Figure 2.9.

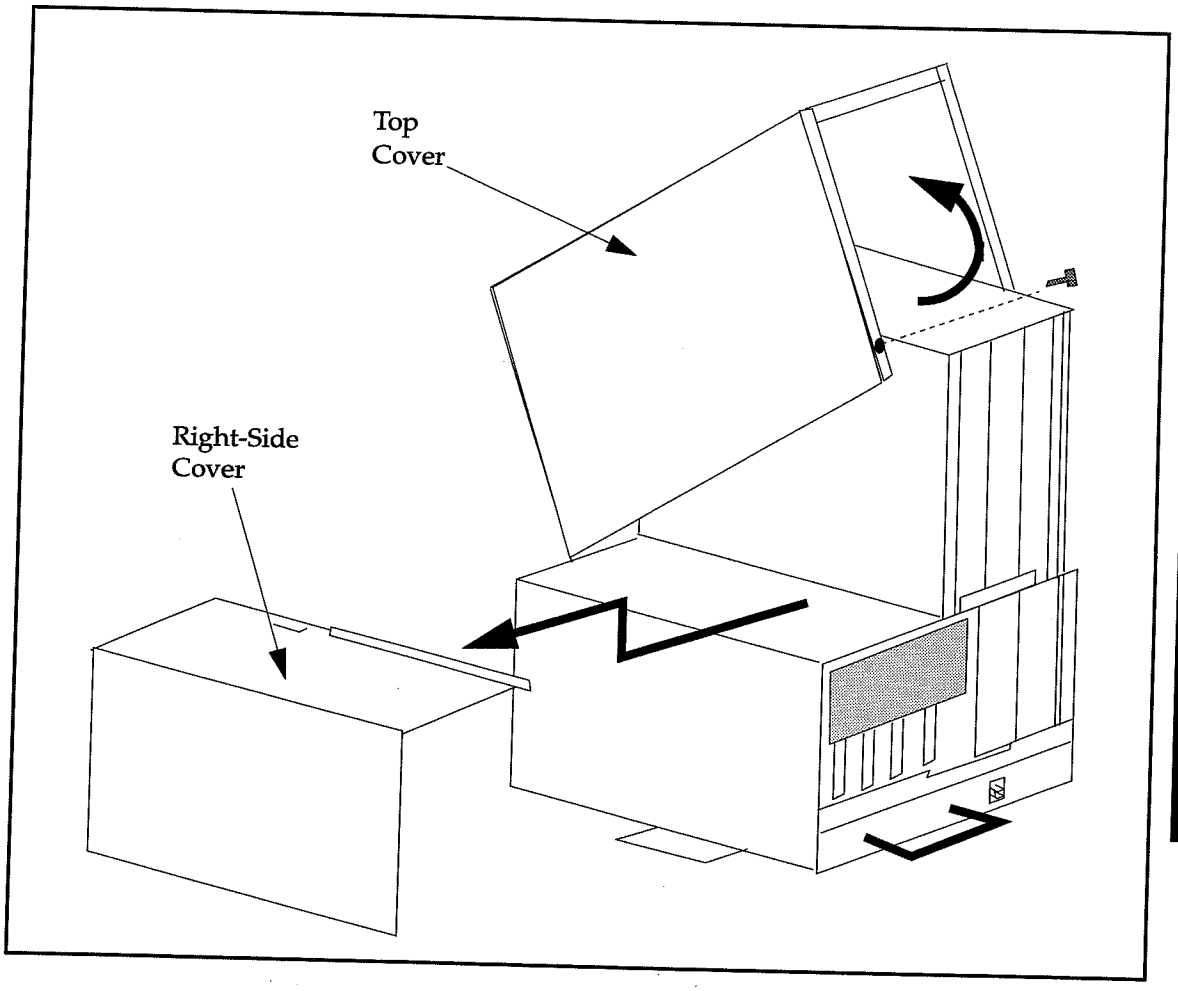


Figure 2.9 Removing the Right-Side Cover

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5. The RFI shield cover is removed by pressing down on the four tabs that fit into the center wall at the top edge of the shield and pulling the cover out as shown in Figure 2.10.

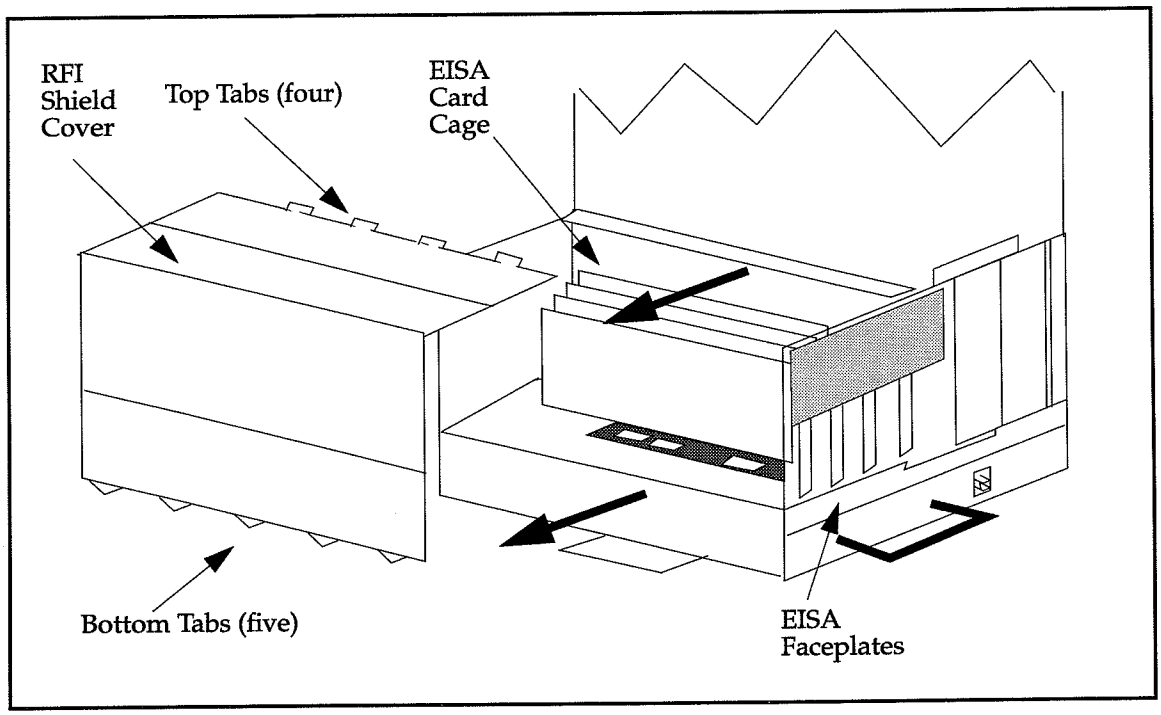


Figure 2.10 Removing the RFI Shield Cover

6. Remove the EISA faceplate on the EISA card cage slot where you plan to install the HPA-200 by removing the retaining screw that holds the faceplate to the card edge.
7. Insert the HPA-200 into the card cage and install the retaining screw.
8. Replace the RFI shield, the right-side cover, and the top cover.
9. Plug in any power cables and turn on your system.

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2.6 Generic Hardware Installation Instructions

These installation procedures were created to reflect the common steps needed for adapter card installations, regardless of the adapter card type or target system. If your particular system model is not covered in the installation section, these general procedures should assist you with your installation.

2.6.1 Unpacking Information

Upon receipt of, and before opening, your *ForeRunner* adapter card, inspect the package for any damage that may have occurred during shipping. If the package shows any signs of external damage or rough handling, notify your carrier's representative.

When unpacking the *ForeRunner* adapter card, be sure to keep all original packing materials. They may be needed for storing, transporting, or return of the product.

CAUTION



All products returned to FORE Systems, under warranty, must be packed in their original packing materials.

Verify the contents of your package. The following items should be included:

- *ForeRunner* Adapter Card;
- *ForeRunner* Software Media (with license);
- *ForeRunner* Adapter User's Manual;
- Anti-static Grounding Strap; and
- Warranty Registration Card.

If any of the above items are missing or damaged, please contact FORE Systems' Technical Support immediately.

Keep the *ForeRunner* adapter card in its anti-static protective bag until installation. Electronic components are subject to damage from even small amounts of static discharge. Therefore, be sure to have your equipment properly grounded.

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CAUTION



It is highly recommended that you use the included grounding strap when handling this, or any other computer components. Handle the *ForeRunner* adapter card only by the edges, avoiding all components and metal parts.

2.6.2 General Installation Procedures

Installation of a *ForeRunner* adapter card into a workstation/server is a simple procedure. Specific instructions are provided for certain models, and additionally, these generic instructions are provided for models without specific instructions. The adapter card installs into the bus connector/assembly in your system. You may have an assembly that the card installs into, or possibly just a connector that it attaches to.

NOTE: Whenever installing a *ForeRunner* adapter card into a workstation/server, always reference the workstation/server User's Manual for additional installation information.

2.6.3 Halting the System

Before installing a *ForeRunner* adapter card, your workstation should be halted and powered down. Follow the procedures for halting your system provided in the workstation/server User's Manual.

CAUTION



Do not turn off the power to your workstation without first performing this shutdown procedure. The workstation should be halted in an orderly manner. Always quit all open files and user processes. Improperly aborting an application may damage files.

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2.6.4 Installing the *ForeRunner* Adapter Card

Open the system case and identify the area containing the bus connector/assembly. Install the adapter card into the bus connector. Insure a proper fit when seating the card. Assemble the system case, reversing the steps used to open the system case for adapter card installation.

2.7 HPA-200 Installation Test

After installing the HPA-200 in your system, connect the appropriate fiber-optic or UTP cables to the receive and transmit connectors. You may then power-up your workstation/server. After your system boots, you can login and execute the following test to ensure that the HPA-200 card has been properly installed.

NOTE: This test assumes that you have already installed the HPA-200 software and configured the kernel. If you have not done so, proceed to Chapter 3, Software Installation and Kernel Configuration before executing the following command.

Login as root and execute the following command:

dmesg

In the output of this command you should see lines similar to the following:

```
Slot 1: Found EISA ATM, ID FSI2001
        fa0, 256 Kb ram 0 addr 0x2000000
        fa0, use IRQ 5 and LEVEL trigger
        fa0, mapped 256 Kb memory to host @ addr 0xfe000000
        fa0, HW version 1.1
        fa0, adapter serial number 10021
        Fore EISA ESI 0x2048112932
        fa0: FORE EISA/ATM Adapter at select code 0x41
        fa0, ATM initialized
```


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2.8 Product Registration Information

After you have successfully completed the installation process, please fill out the enclosed product registration card for the HPA-200, and return it to FORE Systems immediately.

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CHAPTER 3 Software Installation and Kernel Configuration

3.1 Software Installation

The HPA-200 device driver, ATM API library, installation and administration programs, and on-line manual pages, are contained on the software distribution tape. Software installation may be accomplished using the update program in two ways: in interactive mode, or via the command line.

3.1.1 Interactive Mode

NOTE: To use the update program in interactive mode, you must have an HP compatible terminal.

The software distribution tape is in update format which can be used by the update utility. This software is used with the following procedure:

1. Log in as root.
2. After you log in, type the following command:

/etc/update <ENTER>

The update main menu appears as on the following page:

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```
UPDATE                          Main Menu

            Highlight an item and then press "return" or "Select Item".
            To refresh the screen press CTRL-L.

_____________________________________________________________________

            Source: Tape device                 Destination: Local System
                    /dev/update.src
_____________________________________________________________________

          Change Source or Destination ->

            Select All Filesets on the Source Media ->
            Select Only Filesets Currently on your System ->
            Select/View Partitions and Filesets ...

            How to Use Update

[ Help ][       ][ Shell  ][Select ][ Local ][   ][   ][   ][ Exit ]
                              Item                            Update
```

3. Select the highlighted Change Source or Destination -> from the main menu by pressing the <ENTER> key. The menu below will then appear.

```
Change Source or Destination ->
          Change Source or Destination

            Highlight an item and then press "Return"
            or "Select Item".

            Update from Source to Destination:

            From Tape device to Local System ...
            From CD-ROM (directory) to Local System ...
            From Netdist Server to Local System ...
```


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4. In the above menu, select From Tape Device to Local System ... by pressing the <ENTER> key. The menu below will then appear.

```
UPDATE                  From Tape Device to Local System

        Modify the desired fields and press "Done".

Enter a "y" in the field to create or change the address of
/dev/update.src or specify the name of the device to update from.

Create or change the address of      Address of current source
/dev/update.src (y or n)  n                 major number: 47
                                             slot number:  0
Source:/dev/update.src                       bus address:  2
                                    unit number:  0
                                      volume number:  0

Destination Directory/_____________________
```

5. In the menu above, use the arrow keys to move the cursor to the end of the field Source: /dev/update.src. Use the backspace key to erase the default source (if necessary) and enter your particular drive information or the path where the file is located on the network file system. For example:

   /dev/rmt/<controller number> which accesses the DAT drive.

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6. Press the F4 key or use the mouse to click on Done on the bottom of the menu. If the source is accessible with the path information, the main menu appears, with the path changed.

```
UPDATE                                Main Menu

            Highlight an item and then press "return" or "Select Item".
            To refresh the screen press CTRL-L.

_____________________________________________________________________

            Source: Tape device                 Destination: Local System
                    /dev/rmt/dat4
_____________________________________________________________________

          Change Source or Destination ->

            Select All Filesets on the Source Media ->
            Select Only Filesets Currently on your System ->
            Select/View Partitions and Filesets ...

            How to Use Update

[ Help  ][       ][ Shell  ][Select ][ Local ][   ][   ][   ][ Exit ]
                              Item                            Update
```

7. On the main menu shown above, use the keyboard cursor controls to highlight Select All Filesets on the Source Media ->. Complete the selection by pressing the F4 key or clicking on Select Item at the bottom of the main menu.

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NOTE: The menu shown below is the standard HP UPDATE menu. Where a few software packages may take the several hours referred to in the caution, the update of the FORE software takes only a few minutes.

```
UPDATE                Select All Filesets on the Source Media

          Highlight an item and then press "Return" or Select Item".

          You have chosen to update your system by loading all of the
          filesets from the source: /dev/rmt/dat4
          onto the destination:

          This update might take several hours to complete.

          Would you like to:

          Start Loading Now ...
          Modify/View Partitions and Filesets ...
          Return to Main Menu
```

8. Select the default, the already highlighted Start Loading Now ... by pressing <ENTER>. The warning below will appear. Type in n and press <Enter>.

```
Summary of Warnings:

WARNING: Kernel Rebuild and system reboot is required.

Would you like more information? (y or n) n <Enter>
```

9. The next menu begins Despite the warning... At the end of this block of text is the question:

```
Start Loading Filesets now? y <Enter>
```

10. Press Enter. Once Enter is pressed, /etc/update starts loading the release software from the distribution tape, generates a new kernel, and reboots the system from the newly generated kernel. The last message to appear on the screen (before the reboot) is the text `Generating a new kernel, will reboot...`

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3.1.2 Command Line Method

An alternate method of updating the FORE software is to use the Hewlett-Packard update procedure without the HP menu system. This procedure can be run on both HP computers and those from other vendors. The HPA device driver, ATM API library, installation and administration programs, and on-line manual pages, contained on the software distribution tape or in an image file are all automatically loaded with this procedure.

- If the software distribution tape is in update format which can be used by the Hewlett- Packard update utility. The process is as follows:

  1. Log in as root.
  2. Once logged in, type the following command:

/etc/update -r -s /dev/rmt/<*controller number***> FORE-ATM <ENTER>**

This command starts loading the release software from the distribution tape, generates a new kernel, and reboots the system from the newly generated kernel. If the release software is located elsewhere than on the distribution tape, enter the complete path name to the file in place of /dev/rmt/<*controller number*>.

- If the release software is in an image file, enter the following command to load the software, generate a new kernel, and reboot the system from the newly generated kernel:

/etc/update -r -s <*release_image_file***> FORE-ATM <ENTER>**

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3.2 Kernel Verification

An indication that the kernel is functioning properly is when the system "finds" the FORE Systems adapter card and responds with the following (or similar) information:

```
Slot 1: Found EISA ATM, ID FSI2001
        fa0, 256 Kb ram 0 addr 0x2000000
        fa0, use IRQ 5 and LEVEL trigger
        fa0, mapped 256 Kb memory to host @ addr 0xfe000000
        fa0, HW version 1.1
        fa0, adapter serial number 10021
        Fore EISA ESI 0x2048112932
        fa0: FORE EISA/ATM Adapter at select code 0x41
        fa0, ATM initialized
```

If you encounter a problem with the IRQ setting, see the following section. If you encounter any other problems with the new kernel configuration, contact FORE Systems' Technical Support.

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3.3 Resetting the Interrupt Request (IRQ)

On some systems, there may be a conflict between the IRQ set on the HPA-200 and some other card. For example, graphics cards may also use an IRQ of 5. If there is no conflict, there is no need to read further in this section.

The HPA-200 card has software settable interrupt selections of 5, 6, 11 or 12. To check the interrupt currently selected, at a command line, type:

dmseg

to see which IRQ was selected for each HPA-200. If an HPA-200 had the ID file FSI2001 and IRQ of either 6 or 12 was selected, a warning message of the form, "`***fa0; WARNING: IRQ=6, CHECK CARD's JUMPER`," appears.

NOTE: HPA-200 adapters with the file ID FSI2001 are shipped with factory jumper settings of 5 or 11. If an IRQ of 6 or 12 is selected, then IRQ jumpers have to be physically adjusted.

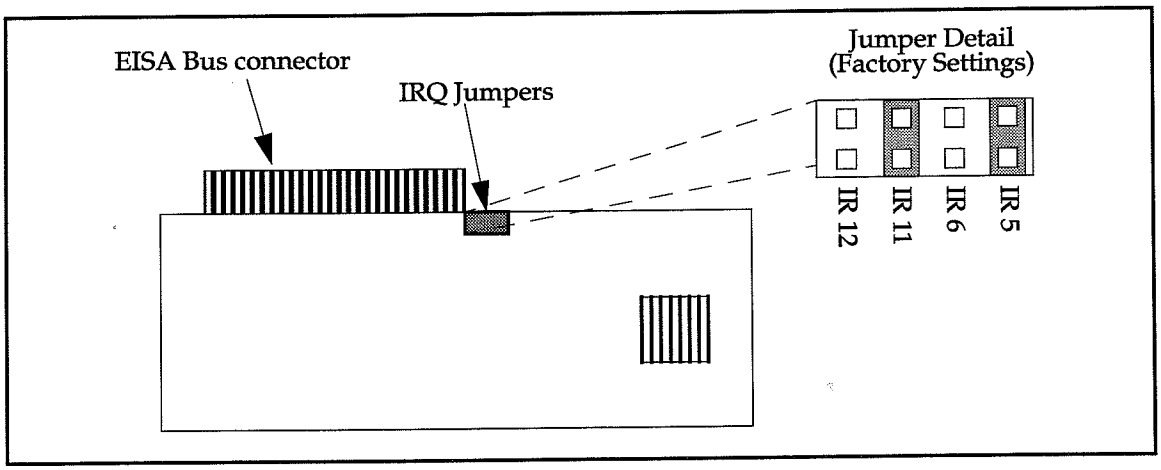


Figure 3.1 IRQ Jumper Setting for EISA Adapter Card

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CHAPTER 4 Network Interface Administration

This chapter provides network configuration information such as assigning an IP address, configuring your workstation as a multi-homed or ATM only workstation, and dynamic and static IP routing information for a multi-homed workstation.

4.1 Network Interface Configuration

After installation of the HPA-200 hardware and software, some additional configuration tasks must be performed before using the HPA-200 as an ATM network interface. First, a unique, legal IP address must be assigned to the network interface. The Internet address that is assigned to the HPA-200 interface should be within the subnet that is assigned to the ATM LAN by the system administrator.

If you are unsure of how to do so, it is strongly recommended that you consult the *HP Owner's Guide* for your particular system for more information about creating and configuring subnets. You should also consult your system administrator for additional help.

NOTE: The adapter cards receive only on VPI=0 (incoming virtual path). The incoming VCI may be from 1 through 1023.

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4.1.1 Network Interface Naming Conventions

The default name for a FORE IP interface is fa0. Subsequent interface names are fa1, fa2, and so on, depending on the number of installed adapter cards.

The default name for an emulated LAN interface is el0. Subsequent interface names are el1, el2, and so on, depending on the number of installed ELANs.

For a Classical IP interface, the naming convention begins with the prefix qa. Subsequent letters or numbers denote the physical unit number and/or the interface number:

- All Classical IP interfaces associated with physical unit zero will have a as the next letter.
- All of the Classical IP interfaces associated with physical unit one will have b as the next letter, and so forth.
- Each Classical IP interface has its virtual interface number as a suffix.

For example, using this naming convention, the name of the third Classical IP interface (virtual unit 2) on physical unit one is qab2.

NOTE: Throughout this chapter, when an example uses the interface name fa0, any qaxx, or elx interface name could also be used.

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4.1.2 Assigning IP Addresses During Reboots

To have your workstation correctly assign the IP addresses during reboots, edit the /etc/netlinkrc file. The text to be edited is presented below:

```
# ATM Adapter
# Two lines (one begins with "ATM_begin", the other begins with "ATM_end")
# are used to configure each ATM interface. They should be duplicated for
# multiple ATM interfaces.
#
# To enable effective operation:
#
# - remove all comment flags on the lines between the ATM_begin and
#   ATM_end lines.
#
# - edit empty <qaax> <ip_address> and <mask> fields as necessary.
#
# SEE ALSO: ifconfig(1m) man pages
#
#--- ATM_begin
#
#/etc/ifconfig <qaax> inet <ip_address> netmask <mask> up
#STATUS=$?
#if [ ! $STATUS -eq 0 ]
#then
#    net_init=1
#fi
#
#--- ATM_end
```

Be sure to uncomment the lines where the Classical IP interface has been defined.

You must also edit the /etc/hosts file on your workstation to add the IP host-name to address mapping for the IP_hostname_of_ATM_interface.

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4.2 Classical IP Configuration

4.2.1 Before You Begin

Before configuring a Classical IP interface, you should read through the entire installation and Classical IP configuration instructions.

NOTE: Detailed explanations of the various questions and responses that may appear in the configuration script are presented in Section 4.2.3.1.

If you are unsure of the responses to the questions on network configuration, please contact your network administrator. If you are a network administrator and are unsure of the responses to the questions, please call FORE Systems Technical Support.

For many installations, you will need to configure the software once. However, in some situations, you may need to establish a temporary kernel configuration and then, based on information obtained from the temporary configuration, reconfigure the software to establish the desired network setup.

4.2.1.1 Temporary Configuration

There is one case where the software may require a second Classical IP configuration:

- If the host into which the adapter was installed will be the ARP server and the ARP server ATM address is assigned via ILMI

For this case, the suggested procedure is to perform an initial Classical IP configuration answering most questions by accepting the defaults. The exceptions are the ATM address of the ARP server and the configuration of a Classical IP interface. For the ATM address, use a temporary number. For the Classical IP interface, respond y and configure just one, qaa0. These steps are more fully explained in Section 4.2.3.1.

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NOTE: If you will be using a host as an ARP server, this host MUST be configured first.

On the ARP server, once the software has been installed, and the system has rebooted, use the `atmarp -z qaa0` command to obtain the host's ATM address. Write down the ATM address or store this data in a file. It is easier to do a "cut-and-paste" from a file rather than retype a 40 character ATM address.

With the ATM address, you can perform the full installation on the ARP server and all client hosts, using all of the desired configuration parameters. If you ever need to reconfigure the network again, please remember that it is easier to obtain the ARP server address from a running system.

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4.2.2 Classical IP Configuration Script

It is often desirable to have a workstation perform the following tasks on reboot:

- Assign the ATM address of the ARP server (RFC 1577)
- Start ILMI daemon for address registration
- Start FORE's SNMP agent instead of the one from HP

To have your workstation automatically perform these tasks, FORE Systems has provided a configuration tool, configure_atm. This tool may also be used to alter your network behavior without re-installing your software.

4.2.3 Run configure_atm

To use configure_atm on your system, use the following procedures:

1. Log in as root.
2. Enter the following command:

   /usr/etc/fore/configure_atm

NOTE: A typical configuration session is shown below. If there is a default response to a given prompt, it will appear in brackets [ ]. The user may accept the default response by pressing the **<ENTER>** key. User input is shown in **bold**.

```
Would you like to use FORE's SNMP agent? [y] <Enter>
Would you like to use the standard UDP ports for SNMP(160/161)? [y] <Enter>
Will ILMI be used for Address Registration? [y] <Enter>
Would you like to configure Classical IP? [n] y <Enter>
Would you like to configure qaa0? [y] <Enter>
Enter the ATM address for the ARP server
0x47.0005.80.ffe100.0000.f115.04ca.002048102712.00 <Enter>
Would you like to configure qab0? [y] n <Enter>
Would you like to configure qac0? [y] n <Enter>
Would you like to configure qad0? [y] n <Enter>
```


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4.2.3.1 Configure ATM Script

After starting the Classical IP configuration program, configure_atm, you will be prompted for answers to a number of questions. These questions are shown below in courier font. During your individual software installation, you may not see all of the questions. The prompts that you do see depend on your environment and on answers to previous questions. In this section, the question will be shown first, and the explanations of effects of the possible replies are shown after the questions. A sample installation session is shown in Section 4.2.3.

```
Would you like to use FORE's SNMP agent? [y]
```

If you use the SNMP agent supplied by FORE Systems, you will have access to the FORE Systems Management Information Base (MIB). Using this in conjunction with applications such as ForeView, or other network management applications, enables you to remotely monitor your HPA-200 adapter card. Answering y to this question will cause snmpd to run. It is started on boot as defined with this configuration program. Answering n to this question will suppress execution of snmpd, and will circumvent the next three questions in the installation script.

```
Would you like to use the standard UDP ports for SNMP (161/162)? [y]
```

SNMP agents generally use port 161 to receive queries, and port 162 to receive trap messages. Only one agent can bind to these ports at a time. Therefore, in order to run a vendor-supplied SNMP agent at the same time as FORE's SNMP agent, one agent must run on a different set of ports. If you do not wish to run both SNMP agents, reply to this question with an n. If you reply to this question with a n the next two questions are asked.

```
UDP port to use to receive SNMP messages not containing TRAP-PDUs:
UDP port to use to send SNMP messages containing TRAP-PDUs:
```

These two questions ask for new UDP port numbers to use for SNMP queries and trap messages. In addition to supplying the new port numbers here, you must also configure any network management applications, such as ForeView, to query the agent using the new ports.

```
Will ILMI be used for Address Registration? [y]
```

The Interim Local Management Interface (ILMI) is a protocol used to dynamically assign a ATM address to a UNI 3.0 port. This ATM address is used in UNI 3.0 signalling messages to identify the workstation. If you plan to use UNI 3.0 signalling, it is recommended that you respond y to this question. If you choose to reply n and you will be using UNI 3.0 signalling or LAN emulation, you will need to manually configure an ATM address in the host and in the switch to which it is connected. You will be prompted for the ATM address of the host later in the installation process. See Section 5.2 for more

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information on ILMI and address registration.

ILMI is implemented as part of FORE Systems' SNMP agent. If you have chosen not to run this agent, you can still use ILMI. In this case, snmpd will be renamed to ilmid, and only the ILMI protocol will be active. If you have chosen to run FORE Systems' SNMP agent as well as ILMI, both protocols will be active. Either snmpd or ilmid is executed on bootup.

```
Would you like to configure Classical IP? [n]
```

Classical IP is a standard method for sending and receiving IP traffic over an ATM network. This protocol utilizes UNI 3.0 signalling to set up and tear down connections to other IP stations. If you would like to use this protocol, respond y to the question. In responding with y, the next question will be seen.

```
Would you like to configure qaa0? [y]
```

qaa0 is the name of an interface which will support Classical IP. If you will be using Classical IP, you should configure qaa0 by replying with y, then entering the ATM addresses as requested by the next two prompts. After configuration of qaa0 is complete, you will be prompted for configuration of qaa1. If you would like more than one Classical IP interface, reply y to the question about qaa1. If you would only like one interface, reply n. You will also be prompted to configure qaa2, and then qaa3, if you have configured all of the previous interfaces.

```
Enter the ATM address for the ARP server
```

The ARP server ATM address must be configured into each workstation (including the ARP server itself). It is suggested that you first configure the ARP server, and then configure all other hosts with the ARP server's ATM address. ARP server configuration is covered in detail in Chapter 5.

Any FORE Systems host or switch has the ability to be the ARP server for a network. You must have exactly one ARP server on each Classical IP network. You configure a host or switch to be the ARP server by specifying its ATM address as the ARP server's ATM address. When the host or switch sees that its ATM address matches the ARP server's ATM address, it will start acting as the ARP server for that Classical IP network.

The ARP server ATM address should be supplied by your system administrator. It is a 20 byte number, and must be unique. You should input it using 40 hexadecimal digits. You may precede the ATM address with a "0x", and you may use dots (periods) as separators, but neither is necessary. As an example:

```
0x47.0005.80.ffe100.0000.f115.0bab.002048102fe4.00
47.0005.80.ffe100.0000.f115.0bab.002048102fe4.00
47000580ffe1000000f1150bab002048102fe400
```


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are all valid ATM addresses. Remember that you must also configure this ATM address in the switch to which this host is directly connected.

When using ILMI for address registration on the ARP server, you will not know the ATM address that ILMI has assigned until installation is complete and the machine has rebooted. Until then, you should enter a temporary ATM address, such as 11111111111111111111111111111111111111111, (a 40 character string of ones) in response to this prompt. You can then continue with and finish the first installation.

After finishing the installation, you can determine the ATM address for the host by issuing the following command:

```
/usr/fore/etc/atmarp -z qaa0
```

Use the command:

```
/usr/fore/etc/atmarp -g qaa0
```

to get the ATM address of the ARP server.

Then, you should rerun configure_atm, entering the correct ATM address in response to the prompt. In either case, you should reboot your machine again so that the change will take effect.

NOTE: Write down (or save in a file) the ARP server ATM address, because you will need it to configure each of your workstations.

If you are not using ILMI for address registration, your system administrator will be able to supply you with the ATM address of the ARP server. Use this number in response to the prompt.

When finished, run

```
/etc/fore_atmrc nodownload
```

or reboot the system.

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4.3 HPA-200 Adapter in an Internet Protocol Network

The HPA-200 device driver supports the TCP/IP protocol suite as well as the ATM API. In order to use your HPA-200 adapter card in an IP network, you must set your workstation in one of two configurations:

1. Multi-homed with a network attachment to both ATM and Ethernet (or other legacy network technology)
2. ATM network only

This chapter assumes a working knowledge of TCP/IP, and, in particular, IP addressing and routing issues.

In the following discussion, two example Class C IP network addresses have been used. The network address aaa.aaa.aaa.XX is the ATM IP network, and the network address eee.eee.eee.XX is the Ethernet network. The network portion of the IP address must be different for the ATM and Ethernet networks.

A FORE Systems ASX switch can be configured to be multi-homed (i.e. both an ATM and Ethernet network attachment), and can be used to route IP traffic between the ATM and Ethernet networks. Consult the *ASX ATM Switch User's Manual* for information on this configuration.

NOTE: The addresses used should be specific to your network topology.

To proceed with your network configuration, you will need access to the following information:

- IP network number for the ATM network
- IP network addresses and names for each ATM and Ethernet interface. If you are installing the HPA-200 adapter card into a multi-homed environment, your Ethernet interface is probably already installed correctly.

NOTE: This text does not describe the steps required for the use of IP subnets. Consult your system administrator for this information.

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4.3.1 Multi-homing on ATM and Ethernet Networks

If you wish to have your workstation reside on both an ATM and Ethernet network, you must assign an IP hostname and address on different networks to each interface. Figure 4.1 illustrates the basic network topology for this type of configuration. In this example, to access the workstations on the ATM or Ethernet side of the network, you need only specify the IP hostname or address of the specific workstation.

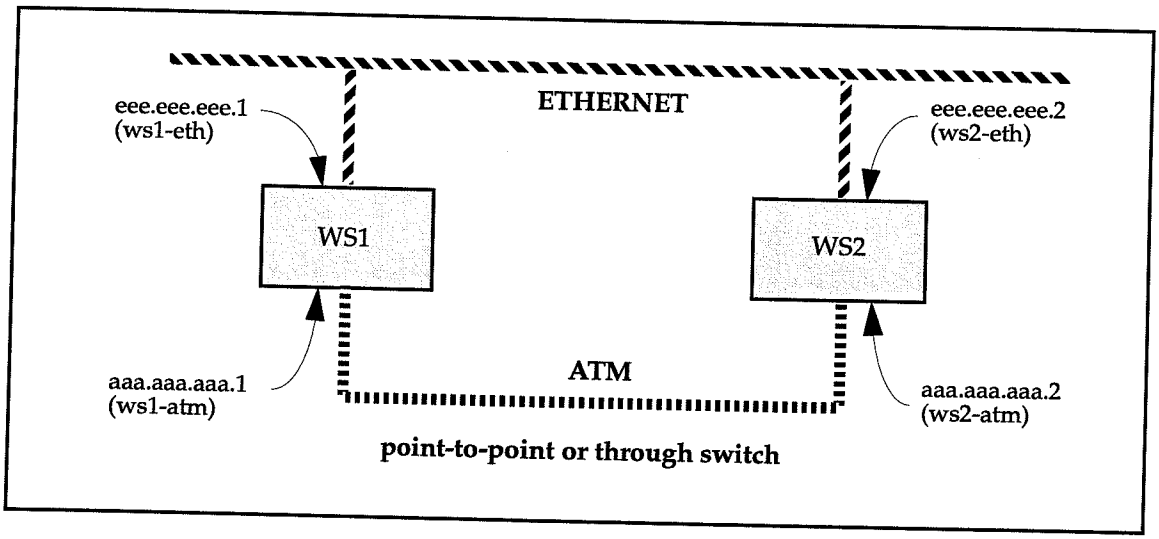


Figure 4.1 Multi-homing Network Configuration

The following is an example of multi-homing, using the ftp command to transfer a file, using either ATM or Ethernet. In this example, ws2 is the workstation to which you want to connect. To use the ftp command over ATM, type:

```
ftp ws2-atm
```

To use the ftp command over Ethernet, type:

```
ftp ws2-eth
```


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4.3.2 Configuring a Workstation as ATM-Only

If you wish to have a workstation on an ATM-only network, but still have access to workstations outside the ATM network, you will need to perform additional configuration to your workstation, the ASX ATM switch, and also the external workstation(s). Specifically, you will need to configure your workstation to enable it to recognize and reach the external workstation. The external workstation will need the same capabilities. Figure 4.2 below illustrates a basic network topology for this type of configuration.

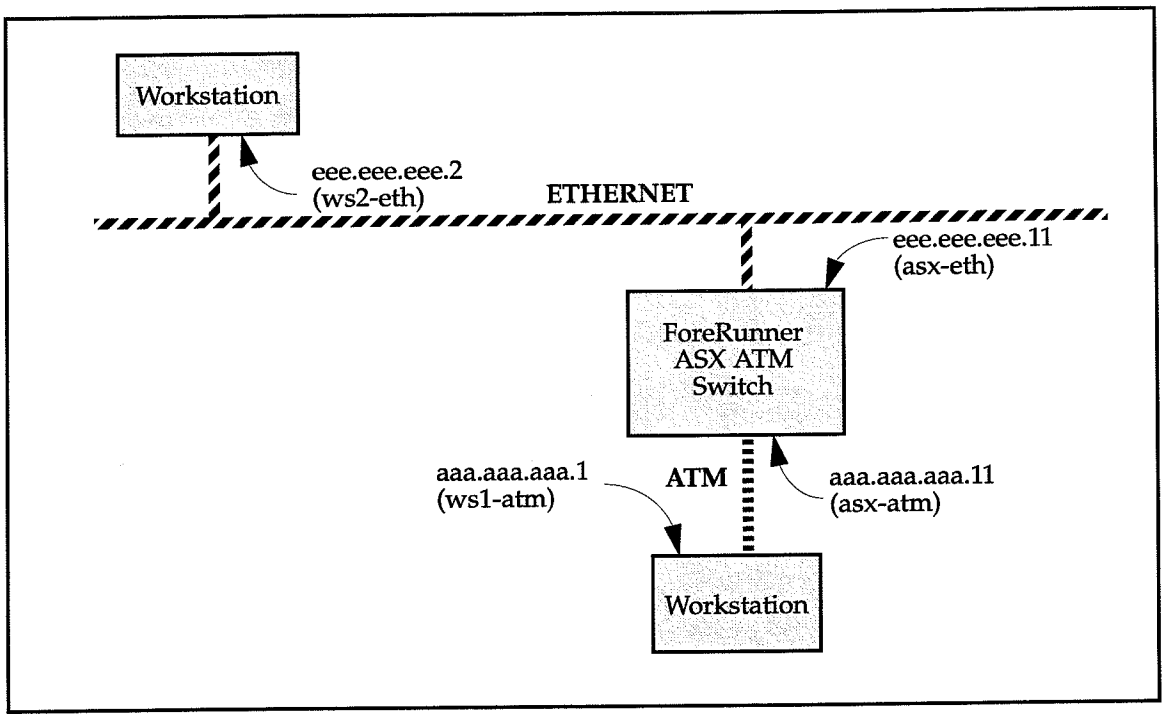


Figure 4.2 ATM Network with Access to Ethernet

As before, you will need to assign an IP address to your ATM interface on the ATM-only workstation. In this topology, the ASX switch is multi-homed and will be used to route IP traffic between the ATM and Ethernet networks.

To use the network in this configuration, you must set up the IP routing. There are two ways to handle the IP routing: dynamically and statically. The following section outlines these methods.

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4.3.3 Dynamic and Static IP Routing (ATM-Only Network)

4.3.3.1 Dynamic Routing

To use dynamic IP routing, the IP routing daemon (routed) must be run on all the workstations in the network that need to reach both the ATM and Ethernet nodes. The routing daemon will "listen" for routing information and update its routing tables accordingly.

If the routing daemon is used, the ATM-only workstation should be able to communicate to the Ethernet network nodes as soon as the routing tables are updated (typically every thirty seconds or so).

4.3.3.2 Static Routing

To set up a static route, first disable the routing daemon by preventing it from running. Then establish either a default route or a specific route, on both the ATM-only workstation and the Ethernet workstation.

1. To set up a default route, type the following on the ATM-only workstation:

   route add default asx-atm 1

2. Then type the following on the Ethernet workstation:

   route add default asx-eth 1

To maintain this default route, simply add the default route command into the file /etc/netlinkrc. To disable the routing daemon on the next reboot, enter the following command as root:

/sbin/chkconfig routed off

If you do not wish to use a default route, you can also use a specific route to accomplish the correct routing.

1. To do so, type the following on the ATM-only workstation:

   route add net eee.eee.eee asx-atm 1

2. Then type the following on the Ethernet workstation:

   route add net aaa.aaa.aaa asx-eth 1

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3. Once a route has been established, you should be able to ftp files from the Ethernet workstation to the ATM-only workstation by typing the following:

   ftp ws2-eth

4.3.4 Disabling Signalling

If your HPA-200 adapter is connected to a SPANS-capable device, you may ignore this step in configuring the IP PVC. If your HPA-200 adapter is not connected to another SPANS-capable device, such as a ForeRunner ASX ATM Switch, you must disable SPANS signalling in the device driver for that unit. Disabling the signalling informs the device driver that it may send and receive cells without knowing its physical address, which is typically supplied by the SPANS-capable device.

The atmconfig command can enable, disable, or report on the state of signalling (both SPANS and UNI 3.0) for a particular unit. The syntax is:

atmconfig <device>	display current configuration
atmconfig -s on <device>	enable SPANS signalling
atmconfig -s off <device>	disable SPANS signalling
atmconfig -u on <device>	enable UNI 3.0 signalling
atmconfig -u off <device>	disable UNI 3.0 signalling

For example, to disable SPANS signalling on device fa0, the following command should be entered:

atmconfig -s off fa0

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The configuration may then be checked by again using atmconfig to display the current configuration:

atmconfig fa0

```
SPANS:          disabled vpi=0 vci=15
CLS:            disabled vpi=0 vci=14
```

For more information on the atmconfig command, see Section 4.5.

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4.3.5 Configuring an Outgoing IP PVC

The first step in configuring an IP PVC connection is to set up the outgoing link to the destination IP host. The following parameters will need to be determined before you configure this part of the connection: outgoing device (typically fa0), destination IP hostname or address, VPI, VCI and AAL type (3/4 or 5). Once these have been determined, the atmarp command is used to configure the outgoing link using the supplied parameters as follows:

atmarp -s destination_ip_hostname device vpi vci aal_type

For example, to set up an outgoing connection from ws1-atm to ws2-atm using the fa0 device, VPI of 0, VCI of 100 and AAL5 you would specify:

atmarp -s ws2-atm fa0 0 100 5

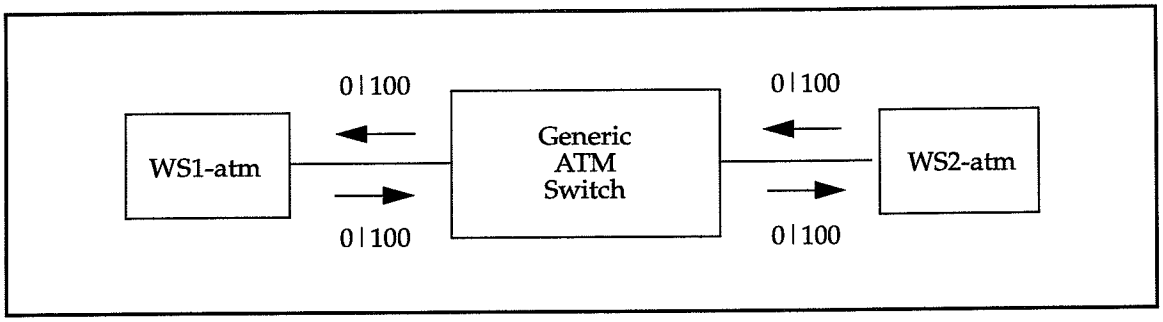


Figure 4.3 IP Permanent Virtual Circuit

You also need to set up an equivalent outgoing connection from ws2-atm to ws1-atm using the fa0 device. To set up this connection with VPI of 0, VCI of 100 and AAL5 type in:

atmarp -s ws1-atm fa0 0 100 5

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4.3.6 Configuring an Incoming IP PVC

The second step in configuring an IP PVC connection is to link an incoming VPI/VCI to the IP queue (see Figure 4.3). The following parameters should be determined before configuring this part of the connection: incoming device, VPI, VCI and AAL type (3/4 or 5). Once these have been determined, the atmarp command is used to configure the incoming link using the parameters as follows:

```
atmarp -l device vpi vci aal_type
```

For example, to set up an incoming connection to ws1-atm from ws2-atm using the fa0 device, VPI of 0, VCI of 100 and AAL 5, you would enter the following on host ws1:

```
atmarp -l fa0 0 100 5
```

This would link cells coming in on device fa0, on VPI/VCI of 0/100 using AAL5 to the IP queue on ws1-atm.

Similarly, to set up the incoming connection to ws2-atm from ws1-atm using the fa0 device, VPI of 0, VCI of 100 and AAL 5, you would enter the following on host ws2:

```
atmarp -l fa0 0 100 5
```

This command links cells coming in on device fa0, on VPI/VCI of 0/100 using AAL5 to the IP queue on ws2-atm.

For more information on the atmarp command, see Section 4.4.

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4.3.7 Verifying the PVC Configuration

The atmarp command can also be used to view the ARP cache in the device driver. This output can be used to view the ARP cache entry of the newly created PVC for verification. To view the ARP cache, enter:

atmarp -a

The following is displayed:

```
Outgoing connections:
fa0: ws2-atm (198.29.21.74): vpi.vci=0.100 aal=5
             switch.port=-.-
             flags=(PVC) encapsulation=NULL peak rate=(unlimited)
Incoming connections:
fa0: switch.port=-.- vpi.vci=0.100 aal=5 flags=(PVC) decapsulation=NULL
```

For a SPANS PVC, the incoming and outgoing connection should appear in the output with the "flags" indicating that this entry is a PVC. With a Classical IP PVC, there will only be an entry in the "Outgoing" section.

For more information on the atmarp command, see Section 4.4.

4.3.8 IP Multicasting Support

NOTE: The OS must support IP multicasting or have IP multicasting extensions installed.

Multicasting support per RFC 1112 specification is a standard feature. Multicasting is performed by the switch hardware. Multicasting can be performed over SVCs as well as PVCs. Multicast SVCs are created using the SPANS-UNI and SPANS-NNI protocols. Multicasting is also supported for LAN emulation using the UNI 3.0 protocol.

Applications wishing to use multicast SVCs join and leave multicast groups under their own control can use the standard socket options: IP_ADD_MEMBERSHIP and IP_DROP_MEMBERSHIP.

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There are two modes possible for PVCs. In the first case, a PVC is created for every multicast group to which the host wishes to send traffic. In the second case, one PVC is created to transmit traffic for all groups. This PVC can be viewed as the default multicast PVC. That is, if an explicit ATM ARP table entry is not found for a given IP multicast address, traffic will be sent on the default multicast PVC if it exists.

If a default multicast PVC does not exist, the host driver will automatically attempt to create a multicast SVC. Extensions to the host adapter management tool atmarp (see Section 4.4) were made to support multicast PVCs.

4.3.9 IP Load Balancing across Multiple Adapters

IP load balancing can make multiple adapters appear to be a single network interface. When load balancing is enabled, all IP traffic traveling over SVCs and destined for an ATM network will automatically be balanced (at connection set-up time, based upon the total peak bandwidth of all connections through an interface) across all FORE ATM interfaces attached to that same physical network. Balancing will occur on both incoming and outgoing connections, across different series and speeds of FORE adapters. The -b option in atmconfig(8c) is used to enable and disable IP load balancing. Section 4.5 contains complete information on atmconfig.

IP load balancing can also provide a means of fault tolerance. If an interface is configured down, all IP SVCs currently using that interface will be closed and then automatically re-opened and balanced across all interfaces currently alive.

NOTE: For purposes of bandwidth comparison, all Unspecified Bit Rate (UBR) IP connections are assumed to have a peak rate of 50 Mbps. The specific IP addresses assigned to multiple interfaces are not important to the load balancing operation. Each of the interfaces may be configured to be on the same subnet or different subnets.

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4.3.10 Driver Support for FORE IP Multicasting in a Routed Environment

NOTE: FORE IP multicasting is only available on platforms with OS support for IP multicast.

All Internet Group Membership Protocol (IGMP) messages are transmitted to all members of an IP multicast group using the connectionless service. This drastically reduces the number of VCs required (in the ATM network) for IP multicast support since a host which is strictly receiving from a group need not have a connection open for transmission to the group.

When a host opens a connection to transmit to an IP multicast group, it automatically adds the address DVMRP.MCAST.NET (224.0.0.4) as a member of that group. Since all IP multicast routers are members of the DVMRP.MCAST.NET group, routers now have the ability to route IP multicast packets from an ATM network to other networks.

4.3.11 Settable Peak Cell Rate for FORE IP SVCs

The peak cell rate for FORE IP SVCs can be set. Traffic over all FORE IP SVCs opened on a given interface will be limited to the peak cell rate specified for that interface. The -q option in atmconfig(8c) is used to set the peak cell rate to a specific value, or to turn off peak cell rate control. See Section 4.5 for more information.

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4.3.12 MTU Size

An interface's maximum transmission unit (MTU) can be set up to 65535 bytes. Certain operating systems have maximum values for the MTU, which in some cases are much smaller than 65535 bytes (for example, the maximum MTU size for the FORE API under SunOS 4.1.3 is 32763). On these systems an attempt to increase the MTU past the maximum value supported by the operating system will result in the MTU being set to the maximum supported value. The default MTU is 9188 bytes for FORE IP interfaces, 9180 bytes for Classical IP interfaces, and 1516 bytes for an emulated LAN interface (el0, el1, el2, etc.). A 65535 byte MTU is supported for AAL types null (0), four (4), and five (5).

CAUTION



Caution should be used when increasing the MTU. A large MTU increases the probability of cell loss, which, therefore, increases the probability of packet loss due to reassembly errors. Cell loss may increase due to buffer overflow in the network and on the adapter cards.

4.3.13 User Configurable ATM Network Interface Name

The name to be used for all FORE IP/SPANS interfaces can be chosen during installation. This feature allows users to customize their environment, but more importantly it allows FORE interfaces to be installed successfully along with other vendors' products which hard code their name as fa.

NOTE: The interface name can be a maximum of eight characters, subject to possible limitations of specific operating systems.

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4.4 atmarp(8c)

NAME

atmarp – manipulate Internet to ATM address mappings

SYNOPSIS

atmarp [-N] *hostname*

atmarp [-N] **–a**

atmarp –d *hostname*

atmarp –f

atmarp –s *hostname device vpi vci aal [encapsulation] [peak]*

atmarp –l *device vpi vci aal [decapsulation]*

atmarp –x *device vpi vci*

atmarp –c *hostname device vpi vci revalidate [peak]*

atmarp –r *hostname*

atmarp –m *device vpi vci aal [encapsulation] [peak]*

atmarp –u

atmarp –n *ATMaddress device*

atmarp –z *device*

atmarp –o *hostname ATMaddress device*

atmarp –p *ATMaddress device*

atmarp –g *device*

atmarp –t *device*

atmarp –v *device*

DESCRIPTION

The **atmarp** program displays and deletes Internet-to-ATM address translation table entries used by the ATM address resolution protocol. It also allows IP traffic to particular destinations to be routed over Permanent Virtual Circuits (PVCs). This functionality is only needed for special applications which may require the use of PVCs for IP traffic. This program does not actually control the creation of the PVCs.

If the single argument *hostname* is given, the ATM ARP entry for *hostname* is displayed. When used with the **–N** flag, the network address is displayed in numerical form. When the **–N** flag is not specified, both the symbolic and numerical forms are displayed.

OPTIONS

–a Display all of the current ATM ARP table entries. When used with **–N** flag, the network address is displayed in numerical form. When **–N** flag is not specified, both the symbolic and numerical forms are displayed.

–d Delete address mapping for specified hostname from the ATM ARP table. If an ATM connection is open to the specified host then the connection is closed.

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–f Delete all dynamic address mappings from the ATM ARP table and close all Switched Virtual Channels (SVCs) to all hosts in the table.

–s Set ARP entry for outgoing Permanent Virtual Channel (PVC). All traffic to *hostname* will be encapsulated based on *encapsulation* and sent via the *device* interface on VPI *vpi*, VCI *vci*, using AAL type *aal*. *device* must be one which supports SPANS signaling (e.g. **fa0**). Specifying *peak* will limit all traffic to *hostname to peak* kilobits per second. If *peak* is not specified, no rate control is applied.

–l Attach IP to an incoming PVC. All traffic received on the interface *device* with VPI *vpi*, VCI *vci*, and AAL type *aal* will be decapsulated based upon *decapsulation* and handed over to IP. *device* must be one which supports SPANS signaling (e.g. **fa0**).

–x Detach IP from an incoming SVC or PVC. IP traffic will no longer be accepted on the specified VPI and VCI.

–c Set ARP entry for RFC 1577 (Classical IP) Permanent Virtual Channel (PVC). Also attach IP to this PVC. All traffic to *hostname* will be sent via the *device* interface on VPI *vpi*, VCI *vci*, using AAL type 5. *device* must be one which supports Q.2931 signaling (e.g. **qaa0**). Specifying *peak* will limit all traffic to *hostname to peak* kilobits per second. If *peak* is not specified, no rate control is applied. The entry will be revalidated by sending an InARP request over the PVC at 15 minute intervals if *revalidate* is non-zero. To disable this feature, use 0 for the revalidate parameter.

–r Remove ARP entry for RFC 1577 (Classical IP) Permanent Virtual Channel (PVC). Also detach IP from this PVC. IP traffic will no longer be accepted on VPI/VCI associated with this entry.

–m Set IP multicast default outgoing PVC. All traffic destined for an IP multicast address not found in the ARP table will be encapsulated based on *encapsulation* and sent via the *device* interface on VPI *vpi*, VCI *vci*, using AAL type *aal*. Specifying *peak* will limit all traffic sent on the PVC to *peak* kilobits per second. If *peak* is not specified, no rate control is applied.

–u Remove IP multicast default outgoing PVC. All traffic destined for an IP multicast address not found in the ARP table will be sent over a multicast SVC, if one can be created to the appropriate multicast group.

–n Configure the ATM address for device *device*. The ATM address is specified as 40 hexadecimal characters, with or without a leading 0x and interspersed dots (e.g. 0x0102030405060708090a0b0c0d0e0f1011121314). NOTE: The last two digits will be ignored and qaa0 will get 00, qaa1 will get 01 etc.

–z Display the ATM address for device *device*. *device* must be one which supports Q.2931 signaling (e.g. **qaa0).**

–o Add an ATM–address–to–IP–address mapping to the ARP table. The ATM address is specified as 40 hexadecimal characters, with or without a leading 0x and interspersed dots (e.g. 0x01.0203.04.050607.0809.0a0b.0c0d.0e0f10111213.14). This creates a single ARP entry for *hostname* and is used to connect to hosts which do not support ARP.

–p Set the ARP server's ATM address for the device *device*. The ATM address is specified as 40 hexadecimal characters, with or without a leading 0x and interspersed dots (e.g. 01.0203.04.050607.0809.0a0b.0c0d.0e0f10111213.14).

–g Get the ARP server address that has been configured for the device *device*.

–t Tell whether or not we are the ARP server for *device's* IP subnet.

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–v Display ARP Server connection information for the device *device*. This information is useful for debugging. It includes the VPVC over which we are communicating with the ARP Server, the number of times we have unsuccessfully attempted to connect to the ARP Server, whether or not we are in the process of connecting to the ARP Server (meaning we have sent a SETUP but have not yet received a CONNECT or a RELEASE COMPLETE), and the number of Inverse ARP packets we have sent. *device* must be one which supports Q.2931 signaling (e.g. **qaa0).**

RESTRICTIONS

Currently *vpi* must be zero (0) and *vci* must be less than 1024 for all incoming PVCs. *aal* must be one of 3, 4, or 5. *encapsulation* must be one of null (no encapsulation, the default), llc_routed (IEEE LLC encapsulation for routed PDUs), or llc_bridged_8023 (IEEE LLC encapsulation for Ethernet/802.3 bridged PDUs). If *encapsulation* is specified as llc_bridged_8023 the following argument must be the 6-byte colon separated destination MAC address. *decapsulation* must be either null (no decapsulation, the default) or llc (IEEE LLC decapsulation).

The peak rate is based on the 48 byte payload of an ATM cell. The maximum data rate at the ATM Adaptation Layer for 100 Mb TAXI is 87.3 Mb/sec, 122.2 Mb/sec for 140 Mb TAXI, and 135.6 Mb/sec for SONET-OC3. This rate is limited by Physical Layer, ATM Layer, and Adaptation Layer overhead. Rate control is only available on FORE 200-series adapters. Attempts to use this optional parameter with 100-series adapters will result in an error.

EXAMPLE

The following example displays the address mapping for hostname *piranha1*. An ATM address is comprised of the ATM switch identifier and port number. The host may be specified by name or by number, using Internet dot notation.

```
example% atmarp piranha1
fa0: piranha1 (192.135.217.1): vpi.vci=0.32 aal=5
     switch.port=f1150ab4.6
     flags=() encapsulation=NULL peak rate=10000
```

RELEASE

FORE Systems Release: A_ForeThought_4.0.0 (1.32)+d

Release Date: Tue Feb 13 16:29:07 EST 1996

SEE ALSO

arp(8C), **cport**(8C), **cpath**(8C), **cchan**(8C)

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4.5 atmconfig

NAME

atmconfig – Interface/IP/SPANS/Q.2931/OC3 configuration tool for FORE ATM devices

SYNOPSIS

atmconfig *device*

atmconfig –m *mtu device*

atmconfig [**–s** | **–u** | **–p** | **–l**] [*on* | *off*] *device*

atmconfig –b [*on* | *off*]

atmconfig –f [*sonet* | *sdh*] *device*

atmconfig –i [*idle* | *unassigned*] *device*

atmconfig –t [*external* | *internal*] *device*

atmconfig –q [*peak(Kb/sec)* | *off*] *device*

DESCRIPTION

atmconfig is a tool to display the current configuration of an ATM device. The interface, IP, SPANS, Q.2931 and OC3 configurations may be viewed. It also can be used to enable and disable SPANS, IP load balancing, and IP multicast, as well as to modify the operation of an OC3 interface, where applicable.

If no action is indicated for the specified device, the configuration information for the device is displayed. The interface information includes the MTU. The IP information includes the state of load balancing and multicast. The SPANS information includes the state of the interface and the VPI and VCI values for SPANS signaling and connectionless messages. The Q.2931 information includes the state of the interface and the VPI and VCI values for Q.2931 signaling. If the media type for the ATM device is OC3, the current OC3 configuration is also displayed. For OC3, the current framing used, frame and stream scrambling state, device timing source, and loopback state are displayed.

OPTIONS

–m Set the MTU on the specified interface. The largest MTU permissible is 65535 bytes.

–s Enable/Disable SPANS signaling on the specified device.

–s Enable/Disable Q.2931 signaling on the specified device.

–b Enable/Disable IP load balancing. When load balancing is enabled, all IP traffic traveling over SVCs and destined for an ATM network will automatically be balanced (at connection setup time, based upon the total peak bandwidth of all connections through an interface) across all FORE ATM interfaces attached to that same physical network.

–p Enable/Disable IP multicast on the specified interface.

–l Enable/Disable OC3 internal loopback mode.

–f Set OC3 framing type to either SONET or SDH.

–i Set OC3 module to insert idle cells (ITU-T standard) or unassigned cells (ATM Forum and ANSI standard).

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–t Set OC3 timing source to external or internal.

–q Set/Disable IP SVC rate control on the specified device. This option is only applicable to a SPANS interface.

NOTES

Care should be taken when setting large MTUs since large packets increase the probability of packet loss due to reassembly errors from cell loss. Certain operating systems may not support the maximum ATM MTU. On these platforms, the interface MTU will be limited to the maximum allowed value. **atmconfig** cannot be used to dynamically change the interface MTU on Solaris platforms. On these machines, the -m option changes the MTU only for STREAMS traffic (including FORE Systems' API). For Solaris platforms, the interface MTU can be dynamically changed with the "mtu" option to ifconfig(1M), or can be set to "value" at boot time by adding "set fore_atm:fore_mtu=value" at the end of the system configuration file (e.g. /etc/system).

The use of IP SVC rate control limits the peak bandwidth of all IP SVC traffic out the specified interface. If peak rate is modified or disabled, the connection must be torn down (see atmarp (8c)) and re-established for the new rate to take effect.

Modifying OC3 parameters may cause communication problems. The parameters must agree with the parameters chosen at the far end or intermediate switching module.

ERRORS

No such device
This indicates that the specified device is invalid.

RELEASE

FORE Systems Release: A_ForeThought_4.0.0 (1.32)+d

Release Date: Tue Feb 13 16:29:07 EST 1996

SEE ALSO

atmarp(8c)

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CHAPTER 5 Configuring a Classical IP ATM Network

5.1 Introduction

This chapter describes how to design, configure, and maintain a Classical IP ATM network. The term classical indicates that the ATM network has the same properties as existing legacy LANs. That is, even though ATM technology allows for large globally connected networks, for example, it is only used in the LAN environment as a direct replacement of existing LAN technology. The classical model of LANs connected through IP routers is maintained in ATM networks. RFC-1577 provides the standard for Classical IP over ATM.

Classical IP over ATM is different than IP in legacy LANs in that ATM provides a virtual connection environment through the use of PVCs and/or SVCs. SVC management is performed via UNI 3.0 signalling. UNI 3.0 is a broadband signalling protocol designed to establish connections dynamically. UNI 3.0 uses Service Specific Connection Oriented Protocol (SSCOP) as a reliable transport protocol, and all signalling occurs over VPI: 0, VCI: 5. UNI 3.0 connections are bi-directional, with the same VPI/VCI pair used to transmit and receive. Currently, FORE Systems uses a subset of UNI 3.0 signalling as defined by the ATM Forum UNI 3.0 specification.

Once a Classical IP connection has been established, IP datagrams are encapsulated using IEEE 802.2 LLC/SNAP and are segmented into ATM cells using ATM Adaptation Layer type 5 (AAL5). In addition, the default Maximum Transmission Unit (MTU) is 9,180 bytes (the SNAP header adds 8 more bytes) with a maximum packet size of 65,535 bytes. There is currently no support for IP broadcast datagrams or IP multicast datagrams in a Classical IP environment.

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5.1.1 Logical IP Subnets

An important concept in Classical IP networks is that of a Logical IP Subnet (LIS). An LIS is a group of hosts configured to be members of the same IP subnet (that is, they have the same IP network and subnetwork numbers). In this sense, one LIS can be equated to one legacy LAN. It is possible to maintain several overlaid LISs on the same physical ATM network. Therefore, in a Classical IP ATM network, placing a host on a specific subnet is a logical choice rather than a physical one. In this type of environment, communication between hosts in different LISs is only permitted by communicating through an IP router which is a member of both LISs (as per RFC-1577).

The number of LISs, and the division of hosts into each LIS, is purely an administrative issue. Limitations of IP addressing, IP packet filtering, and administrative boundaries may guide a manager into establishing several LISs onto a single ATM network. Keep in mind, though, that communication between LISs must occur through IP routers.

5.1.2 Classical IP Interfaces

In order to support routing between multiple LISs, the host adapter software allows a host to be configured as a member of (and a router between) up to four distinct LISs per physical ATM interface. Each LIS membership is through a separate Classical IP virtual network interface. Existing system level IP routing configuration tools are used to control routing through each of the virtual interfaces in the same manner as routing among several physical interfaces. Note that even though each virtual interface associated with a given physical interface uses the same physical hardware, they are each configured separately with their own MTU, IP address, and ATM address.

The name of each of the Classical IP interfaces begins with `qa`. All of the Classical IP interfaces associated with physical unit zero will have `a` as the next letter. All of the Classical IP interfaces associated with physical unit one will have `b` as the next letter, and so forth. Finally, each Classical IP interface has its virtual interface number as a suffix. As an example of the above naming convention, the name of the third Classical IP interface (unit 2) on physical unit one is `qab2`.

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5.1.3 SPANS Interface

While each of the qa interfaces for a given physical interface is designed to support Classical IP using UNI 3.0 signalling, there also exists a SPANS interface (usually called fa, but user configurable) for each physical interface. The fa interface supports FORE IP on top of SPANS signalling. FORE IP allows communication using AAL4 or AAL5 with no encapsulation, uses a broadcast ARP for SPANS address resolution, and supports direct communication of all hosts on a physical ATM network without the use of IP routers. Since SPANS and UNI 3.0 signalling use different VCIs, a host can simultaneously support FORE IP over SPANS as well as Classical IP over UNI 3.0 on the same physical interface.

As a result of standard IP routing, all traffic sent out an fa interface will use FORE IP, while all traffic sent out a qa interface will use Classical IP. Each of the fa interfaces should be assigned an IP address on a subnet different than the subnets of any of the qa interfaces. It is permissible to place multiple fa interfaces on the same subnet, and the driver will load balance connections across these interfaces.

It is only necessary to configure the fa and qa interfaces if the specific service provided by that interface is required. A host sending only Classical IP need not configure the fa interfaces. Likewise, a host sending only FORE IP would not need to configure the qa interfaces. Both the fa and qa interfaces may be configured simultaneously, but they must be in separate subnets. Remember that Classical IP specific configuration changes can only be done with the qa devices, while SPANS specific configuration changes can only be done with the fa devices.

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5.2 Address Registration and ILMI

Before a host can establish connections over a physical interface, the host must know the ATM address for that interface. The primary purpose of Interim Local Management Interface (ILMI) is to discover and register these ATM addresses dynamically.

5.2.1 ATM Addresses

For private ATM networks, addresses uniquely identify ATM endpoints. The UNI 3.0 address format is modeled after that of an OSI Network Service Access Point.

Three address formats have been specified: DCC, ICD, and E.164. FORE implements the ICD ATM format. Per the UNI 3.0 specification, all private networks should accept initial call setup messages containing ATM addresses with any of the approved formats and forward the calls as necessary.

An ATM address consists of the following:

- a 13-byte network-side prefix - The prefix is the ATM prefix of the switch to which the host is attached.
- a seven-byte user-side part - This consists of the following:
  - a six-byte End System Identifier (ESI) - The ESI is the unique IEEE MAC address of the interface.
  - a one-byte selector - Although each virtual interface for a given physical interface uses the same prefix and ESI, the selector field is the part that indicates the number of the specific virtual interface. The selector field is 00 for qaa0, 01 for qaa1, 02 for qaa2, and 03 for qaa3.

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5.2.2 Operating with ILMI Support

FORE Systems switches running *ForeThought* software version 3.0 or greater provide support for ILMI. If ILMI is supported on all of the switches and hosts in a given network, when a switch boots up, ILMI enables the switch to discover all of the hosts attached to it and to send its ATM prefix associated with the port to those hosts dynamically. In return, the host prepends that prefix to its ESI and selector fields, forming a complete ATM address. The host then notifies the switch of its complete ATM address. These registration messages are sent and received over AAL5 using VPI: 0, VCI: 16. Once ILMI registration has been completed, then connection setup can occur.

If a host changes network ports after an ATM address has been registered for its interface, all existing connections will be closed. If the new port is on a different switch, a new ATM address (with a different network address prefix) will be registered. The host can then begin to establish new connections.

5.2.3 Operating without ILMI Support

If ILMI is not supported on a particular switch or host in a given network, then the ATM addresses must be manually configured. If a given switch does not support ILMI, it can not supply an ATM prefix to the hosts. Therefore, the user must assign a unique, valid prefix to the switch. Additionally, the same prefix should be used for all hosts in the LIS.

On the host, atmarp -n is used to configure the ATM address for a specific interface. The switch directly attached to this interface is then informed of this ATM address/port combination through commands in AMI. Once the host and network have both been informed of this ATM address/port pair, the host may begin signalling.

Once an interface's ATM address has been set, it is possible to change it by first running atmarp -n to set the new address, and then bringing the interface down and back up (ifconfig qaXX down; ifconfig qaXX up) for the address change to take effect.

5.2.4 Configuration

The choice to use ILMI for address registration is made at software installation time. Since ILMI uses SNMP as its management protocol, the use of ILMI is tied into snmpd. The choice can be made to run FORE's SNMP agent and use ILMI (snmpd), run FORE's SNMP agent without using ILMI (snmpd -n), or just use ILMI (snmpd -i or ilmid -i). The commands to run the chosen daemon, or to configure a host's ATM address statically when not running ILMI, are placed in the firmware download script rc.xxa200).

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5.3 ARP and ARP Servers

5.3.1 Theory

In order for a host to establish a connection to another host, it must first determine the other host's ATM address. ATMARP (ATM address resolution protocol) is the procedure used to resolve an IP address into an ATM address. Since the ATM standards do not currently support broadcast on an ATM LAN, address resolution is performed by direct communication with a special ARP server, rather than broadcasting ARP requests as is done in legacy LANs. Each LIS must have only one ARP server configured, but a single ARP server can be the server for several LISs. The process of defining a host as an ARP server is covered in Chapter 4.

Each host in an LIS must be configured with the ATM address of the host providing ARP service for its LIS. On a host ARP server, the ATM address of the ARP server can be obtained by running `atmarp -z` (remember to use the interface associated with the given LIS). The ARP server address is normally configured into each host at installation time (the appropriate commands are placed in `/etc/fore_atm`), but it may be done at any time by running `atmarp -p`. If the ARP server address is configured in `/etc/fore_atm`, it will be persistent across reboots, but if it is configured using `atmarp -p`, it will not be persistent across reboots.

Since only one ARP server can be functioning at a time in a given LIS, and since the ARP server's address is manually configured into each host, it is not possible to use multiple, redundant ARP servers to improve robustness. If an ARP server becomes nonfunctional, a new ARP server must be configured, and then each host within the LIS must be configured to use the new ARP server. To configure a new ARP server address on a host, run `atmarp -p` to set the new address, then bring the appropriate interface down and back up (`ifconfig qaXX down; ifconfig qaXX up`) for the change to take effect. Make this change to `/etc/fore_atm` so that the change will persist across reboots.

FORE's ATM switches also have the capability of being an ARP server. This process is described in the next section.

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5.3.2 Configuring a FORE Switch to be an ARP Server

To configure a FORE switch as an ARP server, perform the following steps:

1. Using the AMI on the switch, determine the ATM address of the switch with the command:

configuration atmarp> getnsap

```
qaa0 NSAP address: 47000580ffe1000000f21510a00020481510a000
```

The response from this command also shows the interface name to which the ATM address is attached.

2. Set the ATM address of the ARP server for the interface name (from step 1) to be the ATM address of that interface with the AMI command:

configuration atmarp arpserver> set <NSAPaddress> <interface>

For example:

configuration atmarp arpserver>
set 0x47.0005.80.ffe100.0000.f215.10a.00020481510a0.00 qaa0

NOTE: This example shows the Classical IP interface name of qaa0 used as the ARP server interface name. Any of the Classical IP interface names (qaa0 through qaa3) could be used as the ARP server name.

5.3.3 Configuring a Host to be an ARP Server

Typically, you would define a host as an ARP server during the initial system installation and configuration. This is fully explained in Chapter 4.

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5.3.4 Classical IP Operation

Once a host knows its own ATM address and the ATM address of its ARP server it will attempt to establish a connection to the ARP server, which will be used to send ARP requests and receive ARP replies. When the connection to the ARP server has been established, the ARP server sends an inverse ARP (InARP) request on the new VC to learn the host's IP address. When an InARP reply is received, the ARP server places that host's IP address to ATM address mapping in its ARP cache. Therefore, over time, the ARP server dynamically learns the IP to ATM address mappings of all the hosts in its LIS. It can then respond to ARP requests directed toward it for hosts in its LIS.

NOTE: In order for a host to communicate with an ARP server, it must have learned its own ATM address and have been configured with the ATM address of the ARP server.

A host will not be able to resolve the ATM addresses of hosts in its LIS unless it can communicate with its ARP server.

Since there is no mechanism for ARP servers to exchange mapping information with each other, it is imperative that each LIS be configured with only one ARP server.

When a host wants to communicate with another host in its LIS, it first sends an ARP request to the ARP server containing the IP address to be resolved. When an ARP reply is received from the ARP server, the host creates an entry in its ARP cache for the given IP address and stores the IP to ATM address mapping. This ARP cache entry will be marked as complete. To ensure that all of the IP to ATM address mappings known by a certain host are up-to-date, hosts are required to age their ARP entries. Every 15 minutes (20 minutes on the ARP server), a host must validate its ARP entries. Any ARP entries not associated with open connections are immediately removed.

A host validates its SVCs by sending an ARP request to the ARP server. A host validates its PVCs, and an ARP server validates its SVCs, by sending an InARP request on the VC. If a reply is not received, the ARP entry is marked invalid. Once an ARP entry is marked invalid, an attempt is made to revalidate it before transmitting. Transmission will proceed only when validation succeeds. If a VC associated with an invalid ARP entry is closed, the entry is removed.

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5.3.5 Operational Issues

Certain hosts in an LIS may not support Classical ARP. It is still possible to communicate with these hosts (and for these hosts to communicate themselves) by using static ARP entries. If a host does not support Classical ARP, its IP to ATM address mapping should be placed in its ARP server's cache as a static entry. This allows other hosts that do support Classical ARP to contact their ARP server as usual and obtain the correct address mapping. If a host that does not support Classical ARP wants to initiate connections, the IP to ATM address mappings of the destination hosts should be put in its ARP cache, again as static entries. By using static ARP entries in the above fashion, the ability for all hosts to communicate can be maintained.

There are some restrictions on the number of hosts that can be maintained dynamically. They are as follows:

- In the default configuration, a host can only have approximately 250 virtual connections open simultaneously. This means that an ARP server can only serve 250 clients, since each client must maintain a connection with its ARP server. This may be a limitation if the ARP server is servicing multiple LISs.
- It is possible to increase the number of connections allowed by using the AMI program (see the *ForeRunner ATM Switch Configuration Manual*).
- Hosts support a maximum of 1,024 connections per adapter.

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5.4 Classical IP PVCs

5.4.1 Theory and Configuration

Normally, ATM connections in a Classical IP environment are established dynamically using UNI 3.0. ARP, ILMI, and UNI 3.0 all work together as described previously to set up an SVC. If a host from another vendor does not support Classical ARP or ILMI, it is still possible to setup an SVC using work-arounds. If a host or switch in an LIS does not support UNI 3.0, however, it is not possible to establish an SVC. In this case, a Classical IP PVC can be used for communication.

On each of the hosts, `atmarp -c` is used to establish the PVC. An unused VPI/VCI pair must be chosen for each host. PVCs using the chosen VPI/VCI pairs must also be setup from each of the hosts to their connecting switch, and then on all of the switches between the two connecting switches.

NOTE: Both the incoming and outgoing connections are set up simultaneously on the host, but they must be set up individually on the switches. The same VPI/VCI pair is used by a host to send on the PVC as well as receive on the PVC. The IP datagrams are sent over the PVC using AAL5 with LLC/SNAP encapsulation.

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5.4.2 Revalidation and Removal

Normally, the device driver periodically checks that its PVCs are still established and functioning. A host revalidates a PVC every 15 minutes by sending InARP requests over the PVC, if the user specifies that revalidation should occur by choosing 1 as the revalidate option to atmarp -c. If non-FORE equipment supports revalidation, the same command, atmarp -c and the revalidate option of 1 must be used. If an InARP reply is not received, the revalidation fails, the PVC is marked invalid (as shown through atmarp -a), and communication over the PVC is no longer possible.

Once a PVC is marked invalid, an attempt is made to validate the PVC before transmitting. Transmission will proceed only when validation succeeds. It is possible to disable this revalidation feature by specifying 0 as the revalidate option to atmarp -c. This is often desirable when the remote end of the PVC (such as a video camera) does not support InARP.

A Classical IP PVC is removed on the host side using atmarp -r. Both the incoming and outgoing connections are removed simultaneously. The PVC must then be removed from each of the network switches involved.

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5.5 Debugging

The atmarp utility on the host provides a number of useful options to aid communication debugging. Some of this information can also be displayed on the switch using various AMI commands. If an equivalent AMI command is available, it will be listed here.

- On the host, atmarp -a shows the IP address of the entry, the associated ATM address if the mapping is known, the VPI/VCI pair for an established connection, and various flags. The "Classical IP" flag indicates connections using Classical IP over UNI 3.0. Two other flags are especially important for connection state: "incomplete" indicates that the IP to ATM address mapping is not yet known for the given IP address; "pending" indicates that a connection has not yet been established. On the switch, AMI command configuration atmarp show provides the same information.
- On the host, atmarp -z displays the ATM address of the given interface. If the host is using ILMI for address registration, the ATM address will be displayed as nonzero when the host has successfully registered its address with the network. On the switch, AMI command configuration atmarp getnsap interface provides the same information.
- On the host, atmarp -g displays the ATM address of the current ARP server for the LIS associated with the given interface. On the switch, AMI command configuration atmarp arpserver show interface provides the same information.
- On the host, atmarp -t indicates whether this host is the ARP server for the LIS associated with the given virtual interface. On the switch, AMI command configuration atmarp arpserver show interface provides the same information.
- On the host, atmarp -v displays the status of the ARP server connection. One of the first things to check in a trouble state is that a connection to the ARP server is fully established. If the ARP server connection is established, the ARP VPI/VCI will be nonzero. The CALLING_SERVER flag indicates whether or not an attempt is currently being made to connect to the ARP server. The retry count indicates the number of attempts to connect to the ARP server which have been unsuccessful since the last successful attempt. The InARP count indicates the number of InARP requests that have been sent on the ARP server connection without a response.

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5.6 Configuring the Network

In an ATM network, before any connections can be made, the two parties must know each other's ATM address in order to set up that connection.

To allow those connections to work, the ideal scenario is for all hosts and switches in the network to have support for both ILMI and for RFC-1577 (Classical IP over ATM). However, when using non-FORE equipment, this may not be the case. This section will describe how to configure a network with the following scenarios:

- Configuring a third-party host that has no ILMI or RFC-1577 support
- Configuring a third-party switch that has ILMI support
- Configuring a third-party switch that has no ILMI support, but has RFC-1577 support

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5.6.1 Third-Party Host with No ILMI and No RFC-1577 Support

In establishing this configuration, the third party equipment must support UNI 3.0 and have LLC/SNAP encapsulation. To configure a network with a third-party vendor's host (or an edge device) that does not support ILMI or RFC-1577 (as shown in Figure 5.1), perform the following steps:

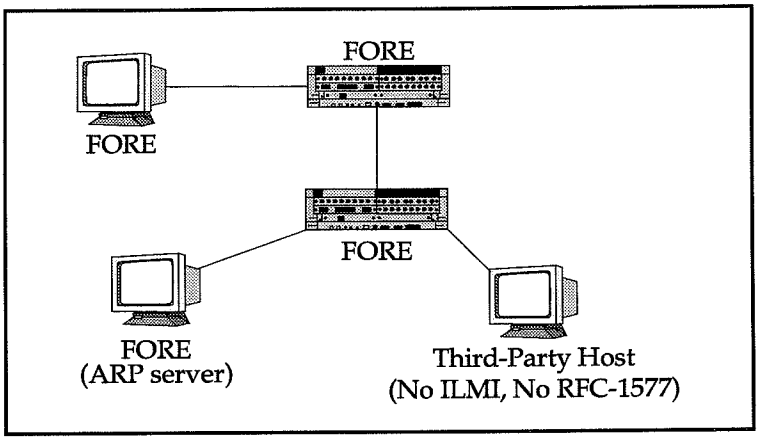


Figure 5.1 Configuring a Third-Party Host with No ILMI and No RFC-1577 Support

1. Before you begin this process, you must have already installed software on the FORE host which is the ARP server. FORE software must also be installed and running on the other FORE equipment.
2. Using the configuration software of the third-party host, assign an ATM address with the same prefix as its switch.
3. Configure the switch so that it has a static route to the third-party host using the following AMI command:

configuration nsap route new <NSAP> <mask> -port <port> -vpi <vpi>

   Be sure to use a mask value of 152.

4. Configure the ARP server (edit /etc/fore_atm) with a static IP to ATM mapping for the third-party host.

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5.6.2 Third-Party Switch with ILMI Support

To configure a network with a third-party vendor's switch that supports ILMI, (as shown in Figure 5.2), perform the following steps:

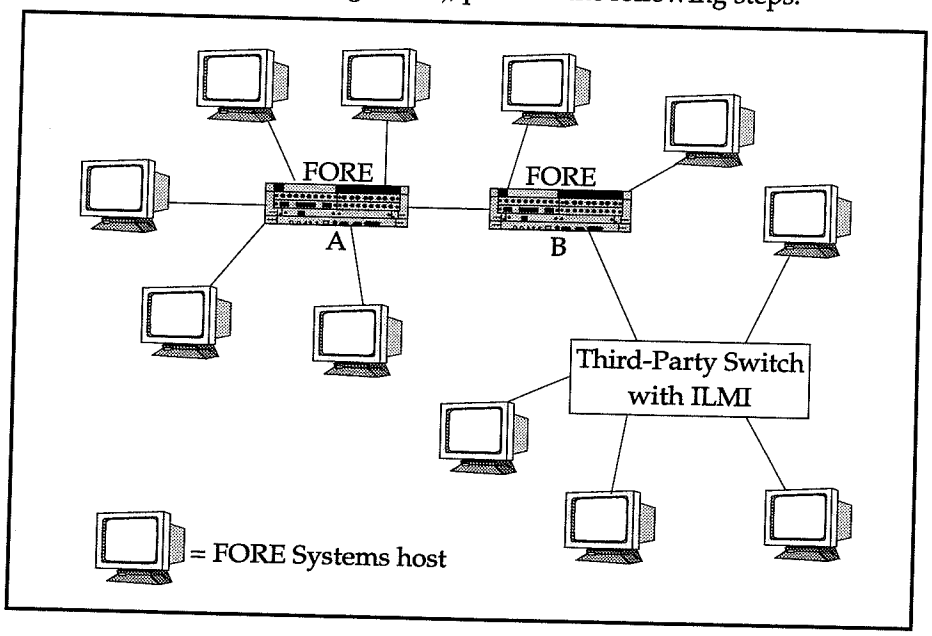


Figure 5.2 Configuring a Third-Party Switch with ILMI Support

1. This process assumes that FORE software has been installed on all hosts and that ILMI was set in the installation process. ILMI dynamically performs address registration for all of the hosts.
2. Refer to the *ForeRunner* ATM Switch Configuration manual for procedures to configure the following:
   a. Configure a static ATM route on FORE switch "B" to the third-party switch.
   b. Configure IISP on FORE switch "B."

   Be sure to use a mask value of 104.
3. Configure two static ATM routes on the third-party switch, one to each of the FORE switches using the switch vendor's configuration software.

   Be sure to use a mask value of 104.

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5.6.3 Third-Party Switch with RFC-1577 and No ILMI Support

To configure a network with a third-party vendor's switch that does not support ILMI, but does support RFC-1577 (as shown in Figure 5.3), perform the following steps:

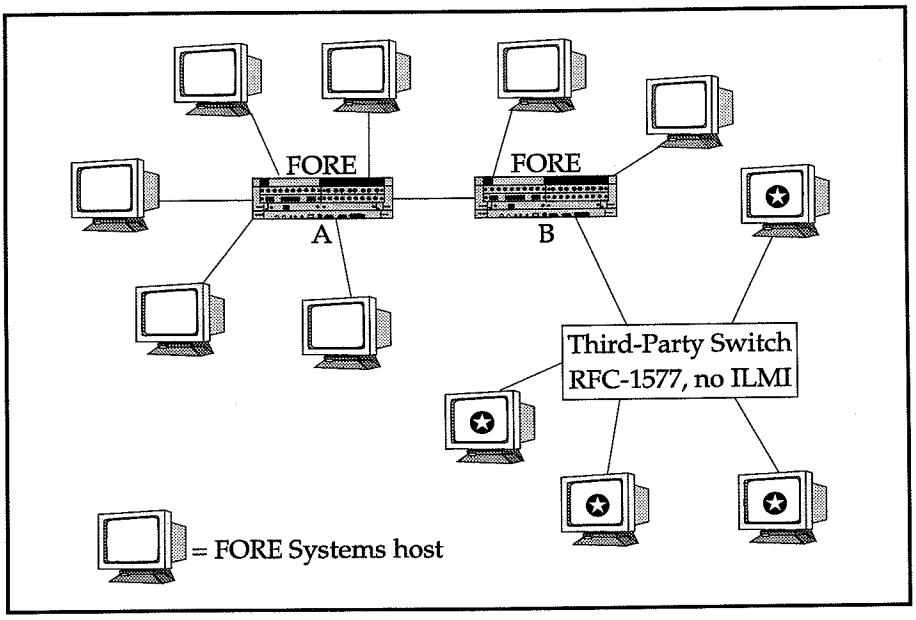


Figure 5.3 Configuring a Third-Party Switch with RFC-1577 and No ILMI Support

1. This process assumes that FORE software has been installed on all hosts and that ILMI was set in the installation process. ILMI dynamically performs address registration for all of the FORE hosts and switches.
2. Statically configure the ✪ hosts with ATM addresses (edit /etc/fore_atm), using the same switch prefix for all of the hosts.
3. Configure a static ATM route on FORE switch "B" to the third-party switch using the following AMI command:

configuration nsap route new <NSAP> <mask> -port <port> -vpi <vpi>

Be sure to use a mask value of 104. Also, be sure to use the same prefix that was used to configure the hosts.

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