ForeRunner® HE
ATM Adapters for IRIX® Systems
User's Manual

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Notices

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- **IEC 1000-4-3 -** "Electromagnetic compatibility for industrial-process measurement and control equipment Part 3: Radiate electromagnetic field requirements."
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TRADEMARKS

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Preface

This manual provides general product information, network configuration information and information on software administration capabilities of the *ForeRunner®HE* ATM adapters, as used with the IRIX 6.5 operating system, with the necessary information to install the adapter and accompanying *ForeThought* 5.1 software. This manual was created for users with various levels of experience. The procedures contained herein should be carefully read before attempting to perform the installation and configuration. If there are any questions or problems with installation or configuration, please contact the Silicon Graphics Product Support.

Chapter Summaries

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

Chapter 2 - Hardware Installation - Guides the user through the installation of the *ForeRunner* adapters. Included are hardware installation instructions, how to test to verify the proper installation, and product registration information.

Chapter 3 - Software Installation and Configuration - Contains the requirements and instructions for the installation and configuration of the adapter software for the IRIX operating system.

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

Chapter 5 - Configuring FORE IP - Discusses how to configure the *ForeRunner* adapters in a FORE IP network environment.

Chapter 6 - Configuring Classical IP - Discusses how to integrate ATM into legacy LANs.

Chapter 7 - Configuring an ELAN - Provides information on the methods for configuring emulated LANs.

Chapter 8 - Additional Administration Information - Provides information on administration commands and on-line manual pages supplied with the *ForeThought* 5.1 software.

Chapter 9 - Software Interfaces - Provides information about the XTI programming interface support that is provided with the *ForeRunner* adapter software.

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

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

Appendix B - ATM Network Configurations - Contains examples of various physical network configurations using *ForeRunner* adapters.

Appendix C - Tunable Parameters - This appendix provides information that can be used to better tune performance characteristics of ATM adapters running *ForeThought* 5.1 software.

Appendix D - Two-Node Origin200 and 2GB Octane Support - This appendix provides information that can be used to configure and tune for peak performance two node Origin200 and 2GB Octane systems.

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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 the screen during software installation or network interface administration appear in **Courier** font to distinguish them from the rest of the text.

```
Save Configuration Information? [y]
```

Important Information Indicators

To call 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 the 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 damage to the adapter, the system, or currently loaded software, and are 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 are indicated as:

CAUTION

Damage to the equipment and/or software is possible if these instructions are not followed.

Information contained in **NOTE** statements has been found important enough to be called to the special attention of the operator and are 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 the particular model.

Safety Agency Compliance

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

Safety Precautions

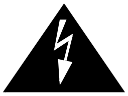
For personal protection, observe the following safety precautions when setting up the equipment:

- Follow all warnings and instructions marked on the equipment.
- Ensure that the voltage and frequency of the 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 the 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 Asynchronous Transfer Mode (ATM) Standard, LAN Emulation Over ATM (LANE), Multi-Protocol Over ATM (MPOA), and the following FORE *ForeRunner* adapters:

- HE155 and HE622 for the PCI bus

Hardware and software requirements and the contents of the adapter packages are also discussed.

1.1 Overview of the ATM Standard

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

1.2 Overview of LANE/MPOA

FORE System's *ForeThought* 5.1 software is compliant with the ATM Forum's *LAN Emulation Over ATM Version 2.0* specification. LAN Emulation (LANE) allows higher level protocols and LAN applications to interoperate, without modifications, with an ATM network.

The LANE components, running on the ATM network, interact to emulate an Ethernet or Token Ring LAN. This emulated Ethernet or Token Ring LAN is called an *emulated LAN (ELAN)*. 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 LANE/MPOA Client (LEC/MPC) 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* 5.1, the LANE services may operate on a FORE Systems switch, *PowerHub* 7000, or Solaris workstation. *ForeThought* 5.1 introduces support for Distributed LAN Emulation (DLE) which provides load-sharing and improved fault-tolerance within an ELAN.

LANE also is the foundation on which MPOA is built.

1.3 LANE Primer

LAN Emulation (LANE) is the foundation on which Multi-Protocol Over ATM (MPOA) is built. Therefore, before presenting an explanation of MPOA, an understanding of LANE components and their operation in an emulated LAN (ELAN) is needed.

1.3.1 LANE Components

An ELAN includes the following components:

LANE/MPOA Client (LEC/MPC)
The LEC/MPC can wear two different “hats”. When wearing its LEC “hat,” it simply communicates with other ELAN components (the LES and BUS) to resolve MAC addresses into ATM addresses. When it puts on its MPC “hat,” the additional function of the LEC/MPC in an MPOA-aware network is to source and sink internetwork shortcuts.

LAN Emulation Configuration Server (LECS)
Runs on a Solaris workstation or a FORE Systems switch. Maintains information about all ELANs within the administrative domain. When the LEC/MPC successfully communicates with the LECS, the LECS provides a list of ELANs which the LEC/MPC can join. The LECS may be configured with various MPOA parameters. LEC/MPCs that connect to LANE/MPOA services through an MPOA-aware

LECS are configured with these centrally-supplied MPOA parameters. LEC/MPCs that connect through an LECS that does not contain MPOA parameters still performs flow analysis and attempts inter-ELAN shortcuts according to user-editable or factory-default settings.

LAN Emulation Server (LES) Runs on a *PowerHub* 7000, a *ForeRunner* switch, or a Solaris workstation. Maintains information about the LEC/MPCs within a single ELAN and performs address resolution. The LES can be configured to support or disable MPOA operation in an ELAN. The LES accepts MPOA parameters from registering LEC/MPCs, and distributes MPOA parameters to LEC/MPCs in response to queries. (This is the mechanism used by LEC/MPCs to determine whether routers in the ELAN are MPOA-aware).

Broadcast and Unknown Server (BUS) Runs on a *PowerHub* 7000, a *ForeRunner* switch, or a Solaris workstation. Provides services within a single ELAN allowing broadcasts, multicast, and unknown unicasts. The BUS is MPOA-ignorant.

1.3.2 Example LANE Configuration

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

- UNIX and PC Workstations, each running a LEC/MPC. Each has a *ForeRunner* ATM adapter, the *ForeRunner* driver for the adapter, and one or more *ForeRunner* ELAN drivers installed.
- Two *ForeRunner* ASX-200BX switches running LESs, BUSs, and LECs. Each switch is also running an LECS. The LES/BUS pairs are configured as *peers* under Distributed LAN Emulation (DLE). The peer configuration allows the LEC/MPCs associated with a particular LES/BUS automatically to reconnect to the remaining functional peer if their “home” LES/BUS fails.
- A *Powerhub* 7000 running a LEC/MPC, and providing access to non-ATM networks.

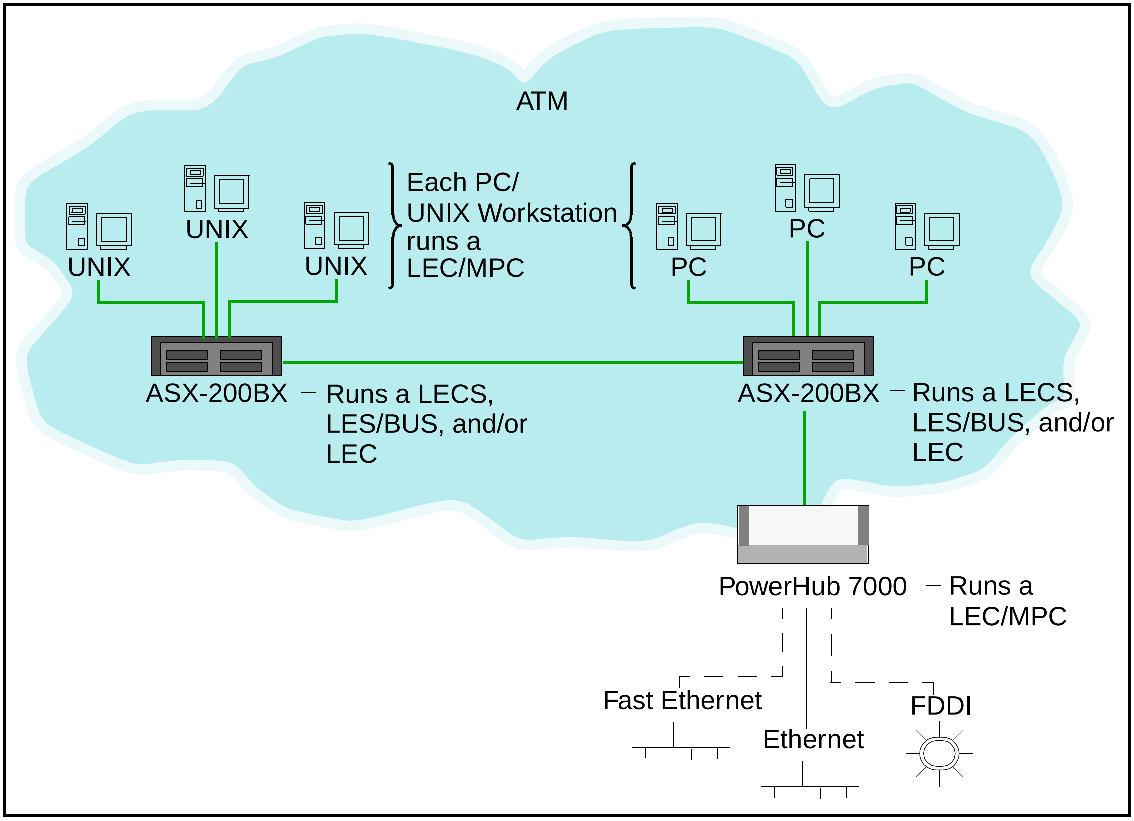

Figure 1.1 - Example ELAN

1.3.2.1 Initialization Process

NOTE

This section discusses the general aspects of LANE configuration. The specific capabilities of each FORE adapter is dependent on the operating system of the parent platform. Refer to *Chapter 7, Configuring an ELAN* for more detailed information.

Each LEC / MPC goes through the following process when it starts up:

1. The LEC / MPC obtains its own ATM address via address registration. Optionally, the ATM address can be manually specified.
2. The LEC / MPC establishes a connection to a LECS using an address obtained via ILMI, a well-known address, or the Permanent Virtual Circuit (0,17). Optionally, the LECS address can be manually specified.
3. The LEC / MPC requests the information needed to join a specified ELAN or the default ELAN. The LECS has information about available ELANs, what ELANs each LEC / MPC can join, and which ELAN the LEC / MPC should attempt to join first.

   If a LECS is not available, or if not being used, manually specify the information required to join a specific ELAN.
4. The LEC / MPC contacts the LES associated with the ELAN it wants to join and registers its MAC-ATM address pair. It also contacts the BUS associated with the ELAN. At this point, the LEC / MPC 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 (or Token-Ring) network. Refer to the following section for a description of how the LEC / MPC connects to other hosts on the ELAN.

1.3.2.2 Connection Process

To send packets to another host on the ELAN:

1. The LEC / MPC calls the LES to map the MAC destination address into an ATM address. (The LES maintains a mapping table of the address of all LEC / MPCs 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 LEC / MPC.
3. The LEC / MPC then opens up a point-to-point ATM connection to the destination host to send the packet.

1.3.2.3 Multicast and Broadcast Packets

The LEC / MPC sends outgoing multicast and broadcast packets to the BUS which uses a point-to-multipoint connection to send the packets to multiple ATM addresses in the ELAN.

1.3.2.4 Accessing Fast Ethernet and FDDI Networks

Note that the diagram in Figure 1.1 shows dotted lines from the *PowerHub* 7000 to the Fast Ethernet and FDDI networks. This is because the *PowerHub* does not use bridging to reach these networks but must route to them.

1.3.2.5 Multiple ELANs

It is possible to set up more than one ELAN in a FORE network. For each new ELAN, another LES/BUS instance must be configured for that LAN. On the access devices, bridge groups must be used to associate physical ports with ELANs on the ATM side.

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

1.3.2.6 Distributed LAN Emulation

To ensure that a single LES/BUS failure does not bring down an entire ELAN, *ForeThought* 5.1 introduces Distributed LAN Emulation (DLE). DLE allows the LES/BUS functions to be distributed among multiple interconnected LES/BUS instances called *peers*. In the example ELAN shown in Figure 1.1, the two LES/BUS pairs running in the switches function as peers in the same ELAN. The LEC/MPCs are distributed such that they are not all connected to the same server. With this arrangement, should one of the peer servers fail, the clients connected to the remaining server continue to maintain connectivity; while the clients that were connected to the failed server automatically reestablish connectivity to the ELAN within 60 seconds.

1.3.2.7 Automatic ELAN Selection

To simplify configuration of the ELAN, *ForeThought* 5.1 allows a host to join an ELAN without specifying an ELAN name. If the LECS has been configured to provide the required information, and an ELAN name to join was not manually specified when the ELAN driver was configured, the host initially attempts to join the ELAN specified by the LECS. The host successfully joins the ELAN if the LECS is available, the proper LES address for the ELAN has been specified in the LECS, and the LES and BUS are available.

1.3.2.8 Intelligent BUS

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

1.4 Introduction to Multi-Protocol Over ATM (MPOA)

Multi-Protocol Over ATM (MPOA) builds upon the foundation of LAN Emulation (LANE).

1.4.1 LANE Without MPOA

ATM networks co-exist with and support network applications which may not be ATM-aware. Consequently, ATM protocols are needed to monitor *legacy* network protocol (IP, IPX, Appletalk, etc.) packets and perform translation into ATM cells and circuits. This monitoring and translation can be performed in one of the following ways:

- in a host protocol stack *after* packet construction and *before* packet transmission
- in a LAN-to-ATM edge device *as* packets move through the network

LANE is one example of such a protocol. It resolves datalink layer addresses into ATM addresses and establishes circuits to the destination addresses. Network addresses *within* a subnet can be learned using LANE's broadcast support.

However, LANE relies on physical routers to deliver packets *across* subnets (see Figure 1.2). Because routers *must* examine – and modify – *every* packet, ATM cells *must* be reassembled into packets, modified, and re-segmented at *every* router hop. This process imposes significant transmission delays between the source and destination of the network traffic.

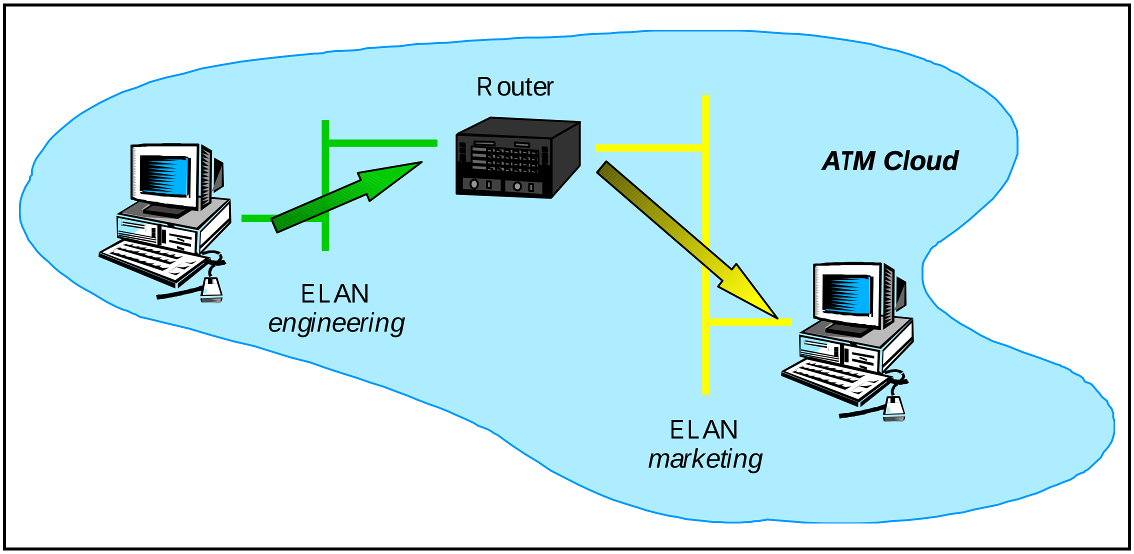

Figure 1.2 - LANE Without MPOA

Introduction

In addition to LANE, protocols such as IP can operate over an ATM network via the IETF Internetworking Over NBMA Networks (ION) Working Group's *Next Hop Resolution Protocol* (NHRP). NHRP allows the ATM network to be divided into Logical IP Subnets (LISs). Using NHRP, routers are still required to interconnect these subnets; but NHRP permits intermediate routers to be bypassed on the *data* path. NHRP allows entities called Next Hop Clients (NHCs) to send queries between different subnets. These queries are propagated using Next Hop Servers (NHSs) via paths found using standard routing protocols. Consequently, NHRP enables the establishment of VCC data paths across subnet boundaries *without requiring physical routers in the data path*.

1.4.2 Why MPOA?

The ATM Forum developed the Multi-Protocol over ATM (MPOA) specification to address the limitations of LAN Emulation. MPOA extends ATM support of legacy networks into the network layer. The main objective of MPOA is the efficient transfer of unicast data between subnet(s).

MPOA introduces LANE/MPOA Clients (LEC/MPCs) and MPOA Servers (MPSs) and defines the protocols that are required for LEC/MPCs and MPSs to communicate. LEC/MPCs issue queries for ATM addresses, and receive replies from the MPS using these protocols. MPOA also maintains interoperability with the existing infrastructure of routers. MPOA Servers use routers that run standard Internetwork Layer routing protocols such as OSPF, thus providing integration with existing networks.

ForeThought 5.1 implements MPOA for IP traffic. It does this by *adding* capabilities to LANE, *not* by replacing LANE. LANE/MPOA client drivers are extended LANE drivers. When handling traffic within the *same* ELAN and subnet, they function like LECs. However, when handling traffic that *crosses* subnets, LEC/MPCs initially work with MPSs to use MPS-established hop-by-hop circuits. Then, for traffic flows that exceed configurable limits, *shortcut* circuits are built that allow the traffic to traverse the route *without* the necessity of the router(s):

- reassembling packets from ATM cells
- modifying the packets
- and then re-segmenting the packets for transmission to the next hop.

Consequently, traffic flowing through a shortcut VCC moves at essentially wire speed from source to destination (see Figure 1.3).

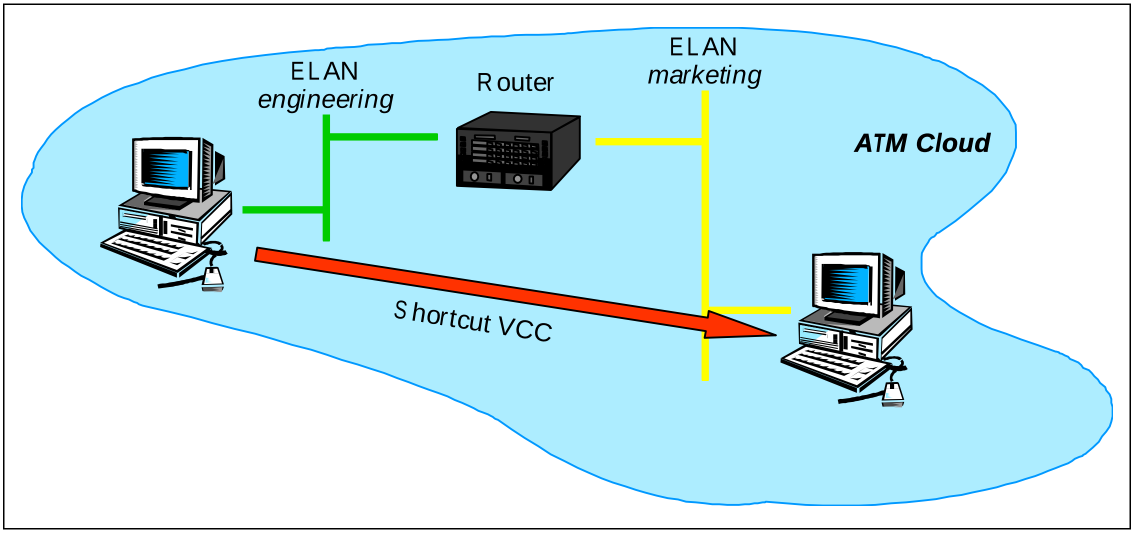

Figure 1.3 - LANE With MPOA

1.4.3 MPOA Components

MPOA requires LANE services for both ELAN traffic handling and MPOA configuration.

LANE/MPOA Client (LEC/MPC) The LEC/MPC can wear two different "hats". When wearing its LEC "hat," it simply communicates with other ELAN components (the LES and BUS) to resolve MAC addresses into ATM addresses. When it puts on its MPC "hat," the additional function of the LEC/MPC in an MPOA-aware network is to source and sink internetwork shortcut circuits. A LEC/MPC that is the source of a shortcut is known as an *ingress* LEC/MPC. A LEC/MPC that is the sink of a shortcut is known as an *egress* LEC/MPC. The LEC/MPC includes an NHRP Client (NHC).

An ingress LEC/MPC monitors traffic flow that is being forwarded over an ELAN to a router that contains an MPS. When the ingress LEC/MPC recognizes a flow rate (configurable) that could benefit from a shortcut (and thus bypass the routed path), it requests a shortcut to the destination. If a shortcut is available, the ingress LEC/MPC sets up a shortcut VCC, and forwards traffic for the destination over the shortcut.

An egress LEC/MPC receives internetwork traffic from other LEC/MPCs to be forwarded to its local interfaces/users. For traffic received over a shortcut, the egress LEC/MPC adds the appropriate encapsulation and forwards them via a LAN interface (that may be a bridge port, an internal host stack, etc.).

MPOA Server (MPS) An MPS includes an NHRP Server (NHS) and is the logical component of a router that provides internetwork layer forwarding information to LEC/MPCs. The MPS answers MPOA queries from ingress LEC/MPCs and provides encapsulation information to egress LEC/MPCs.

The MPS also converts between MPOA requests and replies, and NHRP requests and replies, on behalf of LEC/MPCs.

1.4.4 MPOA Example

The following are the basic requirements for establishing a shortcut across an MPOA-enabled network:

- there must be LEC/MPCs at each end of the network between which a shortcut is desired.
- the local router interface at each end must be running an MPS.
- a Next Hop Resolution Protocol (NHRP) path must exist between MPSs.

The following example illustrates a typical ATM network that allows MPOA shortcuts to be employed.

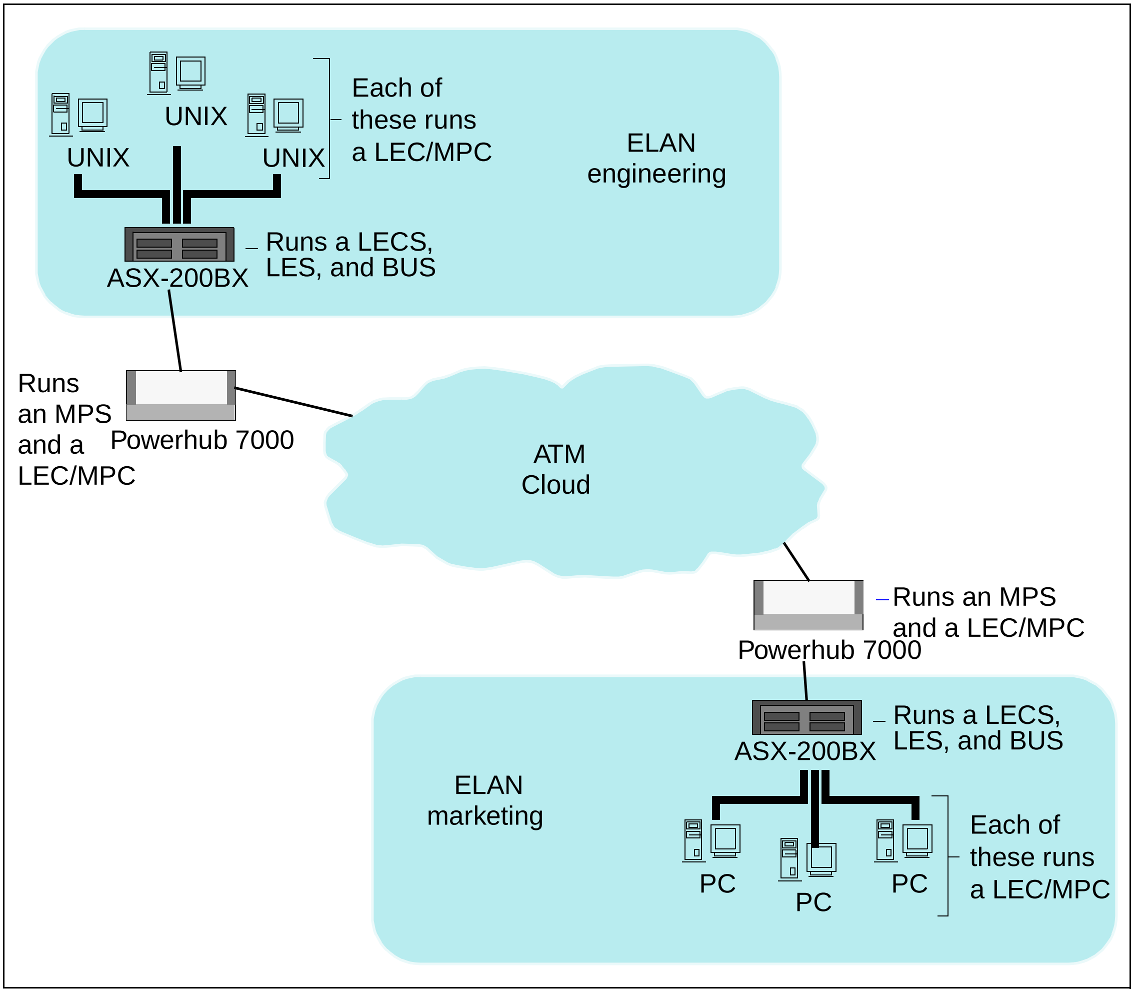

Figure 1.4 - MPOA Example Network

1.4.4.1 MPS Configuration

The network administrator must configure each MPS with the site-specific IP address matching the gateway address being used by LEC/MPCs in its ELAN.

The MPS on each *PowerHub* 7000 is configured as follows:

1. For each LANE/MPOA virtual port, specify an ELAN name. The LECS configuration must also be updated to allow the MPS to join these ELANs.

2. For each LANE / MPOA virtual port, specify an IP address.
3. Enable LANE / MPOA support.
4. Enable routing.
5. Save the configuration and reboot the MPS if necessary to make the changes effective.

Router table information need not be configured. The MPS gathers this information through routing protocol exchanges with other MPS's.

1.4.4.2 Initialization

When its host boots, *each* LEC / MPC automatically goes through the following sequence to establish a connection to the MPS.

1. The LEC / MPC registers via ILMI with the switch to which it is attached.
2. The LEC / MPC connects to an LECS to which it sends its own ATM address and the name of the ELAN it wishes to join (the ELAN name is an empty string unless the LEC / MPC has been site-configured with an ELAN name). The LEC / MPC also supplies a LANE 1.0 compliant parameter identifying itself as an MPOA-aware client.
3. Next, the LEC / MPC receives the following from the LECS:
   - the name of the ELAN to which it is assigned
   - the ATM address of the LES for the ELAN it is joining
   - the parameters containing the flow detection and shortcut establishment policies it is to use
4. The LEC / MPC then connects to its assigned LES, and provides the LES with a parameter identifying itself as MPOA-aware.
5. Finally, the LEC / MPC connects to the ELAN's BUS.

Once the LANE / MPOA connections are established, third-party network-layer protocol drivers on the host can establish network-layer connectivity. The methods these upper-layer drivers use to determine host IP addresses, default gateway, and backup gateway addresses vary depending on the third-party product. The LANE / MPOA driver itself permits these drivers to use BOOTP or DHCP to obtain IP configuration information.

1.4.4.3 Flow Analysis

On a LEC / MPC's host or edge device, IP packets with destinations *within* the host's subnet are sent using LANE 1.0 methods; i.e., the client puts on its LEC "hat" and works directly with its ELAN's services to connect with local destinations. Packets destined for *remote* subnets cause the LEC / MPC to put on its MPC "hat". This client is then referred to as an "ingress LEC / MPC".

Ingress LEC / MPCs associate destination IP addresses with shortcut circuits. Ingress LEC / MPCs use configurable parameters called *flow descriptors* to determine *whether* and *when* to trigger creation of shortcut circuits. The ingress LEC / MPC also monitors the most recent use of a shortcut circuit to determine when to tear down the shortcut. Specifically, when an ingress LEC / MPC sends a packet:

1. If a shortcut circuit *already exists* to the IP destination, the LEC / MPC sends the packet over this circuit.
2. If no shortcut circuit exists, the LEC / MPC determines *whether* shortcuts to this IP address are allowed. If shortcuts to the destination IP address are *not* allowed, the LEC / MPC sends the packet to the gateway router.
3. If no shortcut circuits exist, *and* shortcuts to the IP address *are* allowed, the LEC / MPC determines if the packet traffic flow exceeds the shortcut enable trigger value (set by the flow descriptors) for the destination IP address's flow. If the flow exceeds the trigger value, the LEC / MPC tries to establish a shortcut circuit to the destination LEC / MPC (called the egress LEC / MPC). If the flow does not exceed the trigger value, the ingress LEC / MPC simply sends the packet traffic to the gateway router.

1.4.4.4 Making a Shortcut

When the ingress LEC / MPC determines that the packet traffic flow exceeds the shortcut-enable trigger value, the ingress LEC / MPC tries to establish a shortcut circuit to the egress LEC / MPC. The following describes how a shortcut is set-up:

1. The ingress LEC / MPC initiates the shortcut creation process by sending a request, called a next hop resolution protocol (NHRP) request, to the MPS it uses as a gateway router (this MPS is called the *ingress* MPS). This NHRP request includes the destination's IP address and asks for the corresponding ATM destination address.
2. This request is passed along hop-by-hop until it reaches the final MPS (called the *egress* MPS) on the route to the destination IP address.
3. The egress MPS looks up the ATM address corresponding to the destination IP address, and returns the destination ATM address in a NHRP response hop-by-hop to the ingress LEC / MPC.
4. When the ingress LEC / MPC receives the NHRP response containing the destination's ATM address, it first checks if a shortcut circuit to that ATM address already exists. If a shortcut circuit to that address already exists, it sends the packets via the existing shortcut circuit. If no shortcut circuit exists it opens a new shortcut circuit and begins sending packets over it to the destination.

1.4.4.5 Shortcut Teardown

Application programs and networking protocol stacks are MPOA-ignorant and therefore do not tear down shortcut circuits when the shortcut is no longer needed. Therefore the MPOA layer itself tears down seldom-used shortcuts to avoid circuit exhaustion in the client and network. When a shortcut is idle for a period exceeding a set limit, the shortcut is torn down.

1.5 *ForeRunner* Adapter Overview

The *ForeRunner* adapter is a high performance adapter designed for use in a Silicon Graphics-system running the IRIX 6.5 operating system. These adapters provide ATM connectivity for host systems and supports evolving signalling and AAL standards.

The HE adapters feature special-purpose AAL5 Segmentation and Reassembly (SAR) hardware and scatter-gather DMA. With the HE adapters, users can add ATM networking capabilities to their applications, leaving the low-level ATM cell processing, segmentation and reassembly, and signalling to the adapter's hardware and device driver. In addition, the adapters provide transparent support for TCP/IP, Switched Virtual Circuits (SVCs) through the SPANS and UNI 3.0 or 3.1 signalling protocols, Permanent Virtual Circuits (PVCs), LAN Emulation (LANE), an ATM Applications Programmer Interface (API), and an SNMP agent for network management.

1.5.1 Hardware Overview

The *ForeRunner* HE adapters, shown in Figure 1.5, support high-quality image, full-motion video, CD-quality audio, and high speed data communications.

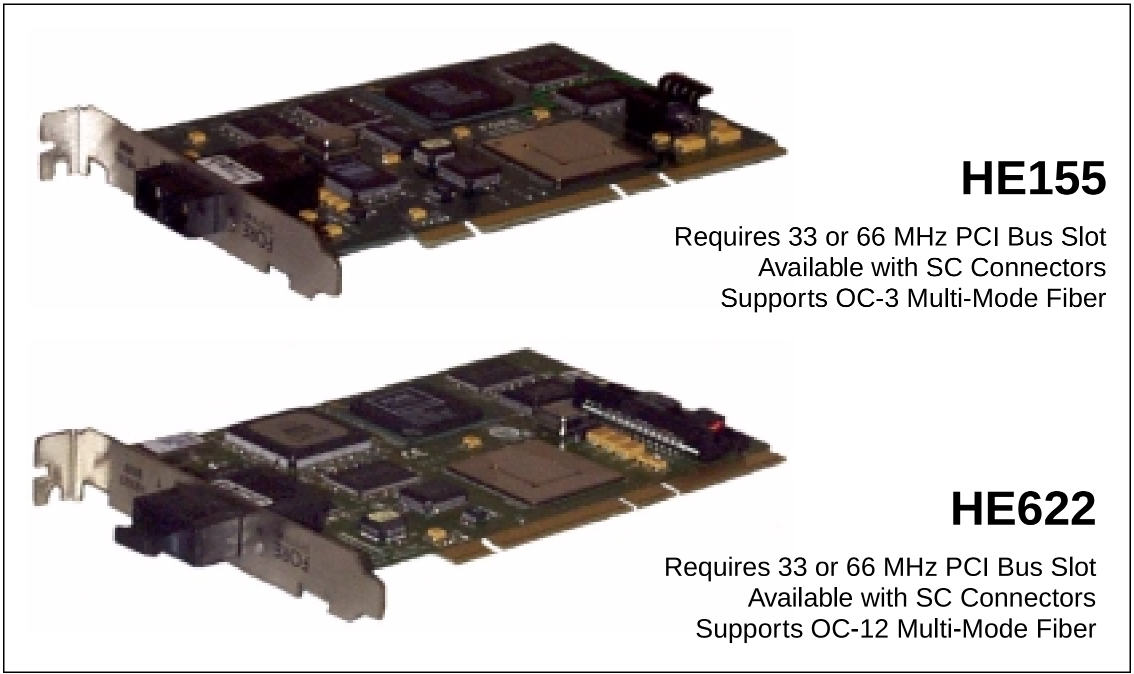

Figure 1.5 - HE Series Adapters

ATM networking capabilities can be added to applications, leaving the low-level ATM cell processing, segmentation and reassembly, and signalling to the adapter hardware and device driver.

1.6 Software Overview

ForeRunner adapters use *ForeThought's* market-proven support for TCP/IP protocols, 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 driver software implements:

- SPANS Switched Virtual Circuits (SVC) signalling protocol that provides applications with end-to-end ATM connectivity including on-demand access to *ForeRunner* ATM switch multicast functions.

- ATM Forum-compliant Simple Network Management Protocol (SNMP) Management Information Base (MIB) which can be accessed by any SNMP network management system.
- Supports UNI 3.0 and UNI 3.1 signalling standards.
- Compliant with ATM Forum *LAN Emulation over ATM, Version 2.0*.
- XTI API library, supplied with the adapter, offers applications access to unique features of ATM such as guaranteed bandwidth reservation, per-connection selection of AAL0 (null), 3/4 or 5 and multicasting with dynamic addition and deletion of recipients.

1.6.1 Advanced Cell Processor Architecture

The Advanced Cell Processor Architecture provides optimized on-board cell processing functions including segmentation and reassembly (SAR). 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.

1.6.2 Software Features

The 5.1 release of *ForeThought* software supports the ATM Forum *LAN Emulation Over ATM, Version 2.0* standard. The particular features supported include:

- LAN Emulation Clients
- Multiple Virtual LANs
- Ethernet emulation
- Multi-Protocol Over ATM

Additional software features include:

- Distributed LAN Emulation
- FORE IP load balancing
- FORE IP automatic failover
- Support for UNI 3.0 and 3.1 signalling
- Support for Classical IP
- UNI load balancing
- UNI automatic failover
- XTI API

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

1.7 Supported Platforms

The HE adapters can be installed in any of the supported platforms listed in Table 1.1. Refer to the IRIX® ATM *ForeThought®* 5.1 Release Notes for detailed information as to the supported platforms, configurations, and limitations.

Table 1.1 - Supported Platforms

Adapter	Bus Type	Supported Platforms
HE155	Any available 33 or 66MHz PCI slot.	Octane, O2, Origin200, Origin2000, and Onyx2
HE622		Origin200, Origin2000, and Onyx2

1.8 Unpacking Information

Before unpacking the adapter, 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 the carrier's representative.

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

CAUTION

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

Verify the package contents against the shipping list. If any items are missing or damaged, please contact your service provider immediately.

CAUTION

The *ForeRunner* adapter contains static-sensitive devices. Keep the adapter in its protective bag until installation. Electronic components are subject to damage from even small amounts of static discharge. Therefore, be sure to have the equipment properly grounded. Be sure to use an anti-static grounding strap and properly ground the equipment when installing the adapter.

1.9 HE155 Adapter Specifications

Table 1.2 lists the capabilities and physical parameters of the HE155 adapter.

Table 1.2 - HE155 Adapter Specifications

Hardware	
ATM Support	UBR, CBR, VBR and ABR OC-3c (155 Mbps) full-duplex
Memory	2 Mbytes Synchronous DRAM
DMA Support	384 bytes (write), 768 bytes (read) Maximum Burst Size
Environmental	Operating Temp: 0° to 40° C (to 10,000 ft.) Operating Humidity: 20 to 80% RH non-condensing Storage Temp: -40° to +70° C (to 30,000 ft.)
Architecture	
PCI Bus	PCI 2.1, 33 MHz, 32-bit addressing, 32 or 64 bit data 3.3 or 5V Single slot PCI short form factor.
ATM Support	*ForeThought* software including, MPOA, LANE 1.0/2.0 and CLIP (RFC1577). AAL5, AAL1 (via AAL0) UNI 3.0/3.1
Power Requirement	12 watts
Cabling and Connectors	Duplex 62.5/125µ multi-mode fiber (2,000 meters max, 10 dB loss); SC connectors
Host Interface	Full bus mastering, dynamic burst sizing, multiple programming interrupts, receive queue prioritization, TCP checksum calculation.
Memory	2 Mbytes Synchronous DRAM; Supports 4K VCs
Compliance	
Emissions and Electrical	UL1950/CSA 950, EN60950, EN60825, IEC 825.1
Compliance	IEC 825.2 EMI: FCC Part 15, Class A, EN55022 Class A, VCCI Class 1, TS016 EMC: EN50082-1, EN50022

1.10 HE622 Adapter Specifications

Table 1.3 lists the capabilities and physical parameters of the HE622 adapter.

Table 1.3 - HE622 Adapter Specifications

Hardware	
ATM Support	UBR, CBR, VBR and ABR OC-12c (622 Mbps) full-duplex
Memory	2 Mbytes Synchronous DRAM
DMA Support	384 bytes (write), 1536 bytes (read) Maximum Burst Size
Environmental	Operating Temp: 0° to 40° C (to 10,000 ft.) Operating Humidity: 20 to 80% RH non-condensing Storage Temp: -40° to +70° C (to 30,000 ft.)
Architecture	
PCI Bus	PCI 2.1, 33/66 MHz, 32-bit addressing, 32 or 64 bit data 3.3 or 5V Single slot PCI short form factor.
ATM Support	*ForeThought* software including, MPOA, LANE 1.0/2.0 and CLIP (RFC1577). AAL5, AAL1 (via AAL0) UNI 3.0/3.1
Power Require-ment	12 watts
Cabling and Connectors	Duplex 62.5/125µ multi-mode fiber (2,000 meters max, 10 dB loss); SC connectors
Host Interface	Full bus mastering, dynamic burst sizing, multiple programming interrupts, receive queue prioritization, TCP checksum calculation.
Memory	2 Mbytes Synchronous DRAM; Supports 4K VCs
Compliance	
Emissions and Electrical	UL1950/CSA 950, EN60950, EN60825, IEC 825.1
Compliance	IEC 825.2 EMI: FCC Part 15, Class A, EN55022 Class A, VCCI Class 1, TS016 EMC: EN50082-1, EN50022

Table 1.4 - System Limitations

Description	Limiting Value
Maximum number of streams open	255
Maximum number of connections per adapter	4096
Number of LEC/MPCs supported per adapter	16 (maximum)
Number of ELANs supported	16 (maximum)
Number of DLE LES/BUS peers per ELAN	10 (maximum)
Number of clients supported by each LES/BUS	100 (maximum)
Maximum MTU size	65535 bytes (varies with selected protocol)
Incoming/outgoing (receive/send) VPI support	12-bits available for VPI/VCI

1.11 Cable Specifications

The HE155 and HE622 adapters are available with a Multi-Mode Fiber (MMF) interface. Table 1.5 lists the fiber optic cabling specifications for MMF interfaces.

Table 1.5 - Fiber-Optic Specifications

Description	Specification
Connector Style	SC
Core Diameter	62.5 µm
Fiber Diameter	125 µm
Wavelength	1310 nm
Loss characteristic	~0.5 dB / km
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, derate the power budget by 4dB.

CHAPTER 2 Hardware Installation

This section is designed to assist in the installation of the adapter in a Silicon Graphics workstation. This chapter also contains handling and registration information. Please read all information carefully before attempting the installation.

2.1 General Installation Procedures

Installation of the adapter is a simple procedure and differs slightly for the various systems. Refer to the appropriate manual listed in Table 2.1 for installation procedures related to the appropriate platform type.

NOTE

Only SGI trained System Support Engineers (SSE's) are qualified to install, remove or replace XIO/PCI boards.

Table 2.1 - Related Silicon Graphics Manuals

Platform	Manual Title	Part Number	Refer To
Origin2000 and Onyx2 (Deskside and Rackmount)	Origin2000 and Onyx2 Deskside and Rackmount Installation Instructions	108-0155-004	Chapter 6
O2	O2 Workstation Hardware Reference Manual	007-3275-003	Chapter 2
Origin200 and Origin200 GIGAchannel	Origin200 and Origin200 GIGAchannel Maintenance Guide	007-3708-001	Chapter 2
OCTANE	OCTANE Workstation Owner's Guide	007-3435-002	Chapter 4

WARNING!

It is highly recommended that the included grounding strap be used when handling the adapter, or any other computer component. The wrist grounding strap is just one portion of maintaining a static free environment. Be sure to follow all necessary precautions to prevent an accidental static discharge which may damage the computer or any of its components. Handle the adapter by the edges to minimize direct contact with components and metal parts.

2.2 Halting the System

Before installing the adapter, the workstation should be halted and powered down.

WARNING!

The workstation should be halted in an orderly manner. Always quit all open files and user processes. Improperly aborting an application may damage files.

The system should be halted using the following routine:

1. Save all work and quit any applications.
2. If the system is not using a graphical user interface (GUI), enter **/etc/shutdown**, at a system prompt, to halt the system. Go to step 7.
3. If the system is using a GUI, place the cursor over the word **system** in the toolchest. The toolchest is in the upper left corner of the screen.
4. Press the left or right mouse button to view the System submenu.
5. Drag the cursor down the menu until **System Shutdown** is highlighted, then release the mouse button.
6. Place the cursor over the button labeled **Yes**, and click the mouse button. After a few minutes the following message is displayed:

   ```
   Okay to power off the system now.
   Press any key to restart.
   ```

   This indicates that it is safe to turn off the system.
7. Turn off the system power switch.

8. For additional information on halting a Silicon Graphics workstation, refer to the owner's guide provided with the system or visit the Silicon Graphics, Inc., web page at: **`http://techpubs.sgi.com`**.

CHAPTER 3 Software Installation and Configuration

This chapter provides detailed procedures to install the *ForeThought* software and to configure the device driver. In order to use the HE155 or HE622 adapter, a new kernel must be created, containing the device driver. This must be done to enable support of the Internet Protocol (IP) suite and the user-level X/Open Transport Interface (XTI) Application Programming Interface (API).

3.1 Installation Requirements

The following requirements need to be met to ensure proper installation of the *ForeThought* software:

- IRIX 6.5.3 or later
- Root password
- Installation of a HE155 or HE622 adapter

3.2 Installation and Configuration

Before installing and configuring the *ForeThought* software, read through the installation and configuration instructions contained in Section 3.2.1.

If unsure of the responses to the questions on network configuration, please contact the network administrator or your service provider.

For many installations, the software needs to be configured only once. However, in some situations, it may be necessary to establish a temporary kernel configuration and then, based on information obtained from the temporary configuration, reconfigure the software to establish the desired network set-up.

3.2.1 Installation

The adapter device driver for the IRIX operating system, ATM API library, installation and administration programs, and on-line man pages, are contained on the CDROM supplied by Silicon Graphics, Inc.

Table 3.1 lists the modules that can be installed or uninstalled using the **swmgr** or **inst(1m)** software installation utilities.

Table 3.1 - *ForeThought* for IRIX Software Modules

Module	Contents	Requires
FORECore	Core components	N/A
FOREDrv	Card drivers	FORECore
FORESpans	SPANS Signalling	FORECore
FOREUni	UNI Signalling, ILMI, SD-API, Connection Manager	FORECore
FOREclip	Classical IP	FOREUni
FOREip	FORE IP	FORESpans
FOREmpoa	MPOA/LAN Emulation	FOREUni
FORExti	XTI Application Programming Interface	FOREUni

Only those packages desired, or required by other packages, need to be installed. For example, if the system is running LANE only, the **FORESpans** and **FOREip** modules are all that is required to be installed. The other modules could be omitted from the installation (see Section 3.2.1.1). *ForeThought* 5.1 utilities and man pages are installed in **/etc/fore/** and **/opt/FOREatm/**. The **/opt/FOREatm/** directory contains the following directories:

/bin
/conf
/examples
/include
/lib
/man

Figure 3.1 through Figure 3.3 illustrate a default installation of the *ForeThought* 5.1 packages. User inputs are indicated in bold face, e.g., **y<Enter>**.

NOTE

If there is a default response to a given prompt, it appears in brackets **[ ]**. The user may accept the default response by pressing the **<Enter>** key.

The device drivers, installation and administration programs, and on-line manual pages are contained on the software distribution CD-ROM. The following steps summarize the software installation process. The screens appear as they would in the normal installation process.

1. Prior to installing the software, the user must be logged in as **`root`**.
2. If installing from the CDROM and the media daemon, **`mediad`**, is running, loading the CD-ROM into the drive results in the automatic mounting of its file system. Proceed to Step 3. If **`mediad`** is not running, consult the *IRIX Admin: Peripheral Devices* manual for more information on mounting a CDROM.
3. Begin the installation by entering:

   `inst -f <`*`path to distribution directory`***`>`**

   Output similar to the following is displayed on the console:

```
root@O2000# inst -f /dist/test/atmft5.1[Enter]

Default distribution to install from: /usr/tmp/ft51.tardist

For help on inst commands, type "help overview".


Inst 3.6 Main Menu

 1. from [source ...]            Specify location of software to be installed
 2. open [source ...]            Specify additional software locations
 3. close [source ...]           Close a software distributions location
 4. list [keywords] [names]      Display information about software subsystems
 5. go                           Perform software installation and removal now
 6. install [keywords] [names]   Select subsystems to be installed
 7. remove [keywords] [names]    Select subsystems to be removed
 8. keep [keywords] [names]      Do not install or remove these subsystems
 9. step [keywords] [names]      Interactive mode for install/remove/keep
10. conflicts [choice ...]       List or resolve installation conflicts
11. help [topic]                 Get help in general or on a specific word
12. view ...                     Go to the View Commands Menu
13. admin ...                    Go to the Administrative Commands Menu
14. quit                         Terminate software installation

Inst> l|list|4[Enter]
```

Figure 3.1 - Software Installation Screen

4. Entering either **`l`, `list`** or **`4`**, and then pressing the **`<Enter>`** key causes the pick-list of packages available for installation, as shown in Figure 3.2, to be displayed.

NOTE

On PCI-based systems, the HE driver is installed as a default. The user can modify the pick-list, if desired, by deselecting the driver that does not apply (refer to Section 3.2.1.1). If multiple adapters are installed, the respective software products must be installed.

```
ForeThought 5.1 for IRIX 6.5
============================

Do you wish to run the optional installation startup script?
1. Run the installation startup script now
2. Ignore the startup script
3. Show the contents of the startup script
4. Help/Show the introductory "README" statement again
Please enter a choice [1]: 1[Enter]
Reading product descriptions ..  13%
Reading /var/inst/hist
Reading product descriptions ..  25%
Setting distribution to /usr/tmp/ft51
Reading product descriptions .. 100% Done.
View:      distribution
Status:    N=new, U=upgrade, S=same, D=downgrade
Stream:    maint
Selection: i=install, r=remove, k=keep

Subsystem Types [bdroc]:  b=reBoot needed, d=Default, r=Required, o=overlay,
c=Client only

i N  FORECore.sw.core [bd]         956+  ForeThought Core Software, 5.1
i N  FOREDrv.sw.he [bd]            176+  ForeThought HE Card Driver Software,
                                         5.1
  N  FOREDrv.sw.pca200e [b]        196+  ForeThought PCA-200E Card Driver
                                         Software, 5.1
i N  FOREDrv.sw.utils [bd]         132+  ForeThought Common Card Driver
                                         Utilities, 5.1
  N  FOREDrv.sw.vma200e              0   ForeThought VMA-200E Card Driver
                                         Software, 5.1
i N  FORESpans.sw.spans [bd]       140+  ForeThought SPANS Signalling Software, 5.1
i N  FOREUni.sw.uni [bd]          1740+  ForeThought UNI Signalling Software, 5.1
i N  FOREclip.sw.clip [bd]         304+  ForeThought Classical IP Software, 5.1
i N  FOREip.sw.ip [bd]             204+  ForeThought FORE IP Software, 5.1
i N  FOREmpoa.sw.mpoa [bd]        1324+  ForeThought MPOA Software, 5.1
i N  FOREXti.sw.xti [bd]           388+  ForeThought XTI API Software, 5.1

Disk space summary (Kbytes):            / /usr/people  /irix6.4 /irix6.5.2m
urrent free space                 2007356     1418100   1005212     2183248
- Selections net change               308+          0         0           0
- Temporary inst overhead           13532+          0         0           0
= Minimum free during install      1993516     1418100   1005212     2183248

Free space after reboot            2007048     1418100   1005212     2183248

Inst> g|go|5[Enter]
```

Figure 3.2 - Software Installation Pick-List

Software Installation and Configuration

5. Enter **g, go,** or **5**, and then press the **<Enter>** key to initiate the installation. The display shown in Figure 3.3 is displayed.

```
Reading fileset information ..   8%
Pre-installation check ..  16%
Checking space requirements ..  24%
Installing/removing files ..  24%
Installing new versions of selected FORECore.sw subsystems
Installing/removing files ..  27%

* Copyright (c) 1998 FORE Systems, Inc., as an unpublished work.
*
* All rights reserved.
*
* U.S. Government Restricted Rights.  If you are licensing the
* * (or any successor regulations).

Installing/removing files ..  41%
Installing new versions of selected FOREDrv.sw subsystems
Installing/removing files ..  50%
Installing new versions of selected FORESpans.sw subsystems
Installing/removing files ..  52%
Installing new versions of selected FOREUni.sw subsystems
Installing/removing files ..  58%
Installing new versions of selected FOREclip.sw subsystems
Installing/removing files ..  62%
Installing new versions of selected FOREip.sw subsystems
Installing/removing files ..  67%
Installing new versions of selected FOREmpoa.sw subsystems
Installing/removing files ..  76%
Installing new versions of selected FORExti.sw subsystems
Installing/removing files ..  94%
Running exit-commands ..  94%
Automatically reconfiguring the operating system.


Reboot to start using the reconfigured kernel.
Running exit-commands ..  99%
Checking dependencies .. 100% Done.
Installations and removals were successful.

You must restart your system to complete the installation.

You may continue with installations or quit now.

Inst> q|quit|14[Enter]
Requickstarting ELF files (see rqsall(1)) .. 100% Done.
```

Figure 3.3 - Software Installation Messages

6. Screens similar to the above appear for each set of packages installed. If the software installation is complete, enter **quit** to exit the **inst** process. Continue with Section 3.2.3 to configure the software.

3.2.1.1 Deviations

The IRIX installation utility provides the ability to de-select modules from the default selections. For example, to de-select the FORESpans module, enter the following:

k FORESpans.sw.spans

Entering **l** following the above command changes the display in Figure 3.2, indicating the display as shown in Figure 3.4. Notice that the **i** (install) indicator is now missing from the FORESpans.sw.spans entry.

```
.
.
.
i N FOREDrv.sw.utils [bd]         132+  ForeThought Common Card Driver
                                        Utilities, 5.1
  N FORESpans.sw.spans [bd]       140+  ForeThought SPANS Signalling Software, 5.1
i N FOREUni.sw.uni [bd]          1740+  ForeThought UNI Signalling Software, 5.1
.
.
.
```

Figure 3.4 - Modified Installation Pick-List

3.2.1.2 Software Conflicts

In the event that a module from Table 3.1 is installed that requires a higher-level module to also be installed, but the higher-level module was not included in the installation, the following messages are displayed. After resolving the conflict, the installation continues when the **g** (go) command is issued, as shown in Figure 3.5.

Figure 3.5 displays the conflict received when the **FOREip** module was set for installation but **FORESpans** was removed from installation.

Software Installation and Configuration

```
Inst> g[Enter]
ERROR: Conflicts must be resolved.

FOREip.sw.ip cannot be installed because of missing prerequisites:
  1a. Do not install FOREip.sw.ip (5000000)
  1b. Also install FORESpans.sw.spans (5000000 - 5000000).


Resolve conflicts by typing "conflicts choice choice ..."
or try "help conflicts"

Inst> con 1a[Enter]
No conflicts

Inst> g
Reading fileset information ..   8%
Pre-installation check ..  16%
Checking space requirements ..  24%
Installing/removing files ..  24%
Installing new versions of selected FORECore.sw subsystems
Installing/removing files ..  28%
.
.
.
```

Figure 3.5 - Resolving Software Conflicts

3.2.1.3 Hardware Conflicts

If during the installation process a warning message similar to the following appears, refer to *Section 10.1, Installation Conflicts* for procedures to resolve the conflict.

```
Warning: major number collision -- 79
```

3.2.2 Installation Completion

If no errors are received during the installation process described above, continue with *Section 3.2.3, Configuration* to configure the *ForeThought* 5.1 software modules and adapter. If errors are received, refer to *Chapter 10, Troubleshooting*, for possible error resolution or contact your service provider.

3.2.3 Configuration

NOTE

If this is the first installation of *ForeThought 5.x* software on this system, it is necessary to reboot the system to create `/dev` files before continuing with the configuration.

Configuration of the installed *ForeThought* for IRIX modules is accomplished through the use of the **`configure_atm`** script. Configuration of each of the above components is controlled by its own script. Each of these individual scripts are called from the **`configure_atm`** main menu shown in Figure 3.6. Begin the configuration by entering the following command:

`/opt/FOREatm/bin/configure_atm`

```
ForeThought ATM Software Configuration

The following modules are available:
1  ForeThought ATM Core Software

2  ForeThought UNI signalling Software

3  ForeThought MPOA / LAN Emulation Software

4  ForeThought Legacy Application QoS Software

5  ForeThought Classical IP Software

6  ForeThought SPANS signalling Software

7  ForeThought FORE IP Software

8  ForeThought ATM Card Drivers

Select module(s) you wish to configure ('all' for all, 'q' to quit) [q]:
```

Figure 3.6 - `configure_atm` Script Main Menu

Entering the number that corresponds to the component to be configured, and pressing the **`<Enter>`** key, executes the configuration script for that component. Entering **`all`** and pressing the **`<Enter>`** key causes all installed modules to be configured. Pressing the **`<Enter>`** key without selecting an option causes `configure_atm` to exit.

3.2.3.1 Typical Configuration Session

NOTE

Answering **y** to a question calls a configuration script for that component. The component scripts prompt for information to configure each component. The following sections present a typical configuration session for each of the component listed in Figure 3.6.

The following screens address questions that must be answered for proper driver configuration, and contain samples of the text displayed during configuration. User inputs are indicated in bold e.g., **engineering<Enter>**.

NOTE

In the following examples, **all** was answered at the prompt shown in Figure 3.6.

NOTE

The default response to a given prompt appears in brackets **[ ]**. Pressing the **<Enter>** key accepts the default response to a particular question.

3.2.3.1.1 ATM Core Software

The first general question asked by the ATM core software module of the **configure_atm** script allows FORE's SNMP agent (Figure 3.7) to be configured.

```
ForeThought ATM Core Software Configuration

Run FORE's SNMP agent? [y] <Enter>

Should the SNMP agent listen on the standard UDP port? [y] <Enter>

Configure SNMP community strings? [n] <Enter>
```

Figure 3.7 - Configuring ATM Core Software

3.2.3.1.1.1 Questions and Responses

The prompts that are presented while configuring the core software depend on the environment and on answers to previous questions. In this section, the question is shown first, and the explanations of effects of the possible replies are shown after the questions.

```
Run FORE's SNMP agent? [y]
```

If the SNMP agent supplied by FORE Systems is used, access is granted to the FORE Systems Management Information Base (MIB). Using this in conjunction with applications such as *ForeView*, or other network management applications, enables the adapter to be monitored remotely. Answering **y** to this question causes the SNMP Daemon (**snmpd**) to run. Answering **n** to this question suppresses execution of **snmpd**, and the other two statements in the installation script are not presented.

```
Should the SNMP agent listen on the standard UDP port? [y]
```

SNMP agents generally use port 161 to receive queries, and port 162 to send 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 both SNMP agents are not to be run, reply **y** to this question. If both must be run, reply no **[n]** to this question and continue with the next.

This statement prompts for a new UDP port number to use for SNMP queries and trap messages. In addition to supplying the new port numbers here, any network management applications, such as *ForeView*, must be configured to query the agent using the new port.

```
Configure SNMP community strings? [n]
```

The default response to this question is no **[n]**. If the default is selected, the remaining statements in this section do not appear. If **y** is the answer, the following appears:

```
Enter community string for get: [public]
Enter IP address for get (return to end):

Enter community string for set: [private]
Enter IP address for set (return to end):
```

Enter the appropriate community strings and corresponding IP addresses for **get** and **set**. The configuration is then echoed thus:

```
Current Configuration:
    get: public
    set: private
Do you want to modify configuration? [n]
```

Answering **y** allows the SNMP configuration to be changed. Answering **n** ends the core configuration portion of the script.

3.2.3.1.2 UNI Signalling Software

When the ATM core software configuration is completed (Section 3.2.3.1.1), the next module to be configured is UNI signalling. Figure 3.8 shows the questions and default responses for UNI signalling configuration.

```
ForeThought UNI signalling Software Configuration

Use ILMI for ATM address registration? [y] <Enter>

Use ILMI to autoconfigure UNI versions? [y] <Enter>

Enable UNI failover and load balancing? [y] <Enter>

Establish failover groups dynamically? [y] <Enter>

Configure UNI signalling VC? [n] <Enter>
```

Figure 3.8 - Configuring UNI Signalling

3.2.3.1.2.1 Questions and Responses

The prompts presented while configuring the UNI signalling software depend on the environment and on answers to previous questions. In this section, the question is shown first, and the explanations of effects of the possible replies are shown after the questions.

`Use ILMI for ATM address registration? [y]`

The Interim Local Management Interface (ILMI) is a protocol used to dynamically assign a Network Service Access Point (ATM) address to a UNI 3.0 or 3.1 port. This ATM address is used in UNI 3.0 and 3.1 signalling messages to identify the workstation. If UNI 3.0 or 3.1 signalling is to be used, respond **y** to this question. If **n** is replied and UNI 3.0 or 3.1 signalling is not to be used, an ATM address in the host and in the switch to which it is connected must be manually configured. A prompt for the ATM address of the host is presented later in the installation process.

`Use ILMI to autoconfigure the UNIs? [y]`

This prompt appears only if **y** was answered to the previous question. If **y** is answered, the next four prompts do not appear. If **n** is answered, the following prompt appears:

`Configure ATM addresses statically? [y]:`

Answering **y** results in the following prompt:

`Enter ATM address for physical unit 0:`

Enter the ATM address for unit 0. Answering **n** results in the question being repeated for unit 1 (if more than one FORE ATM adapter is installed).

```
Configure the UNIs? [y]
```

Answer **y** to manually configure the UNI signalling type.

```
Enter UNI version for physical unit 0 (3.0, 3.1, auto): [auto]
```

Respond with the UNI version adapter unit 0 is to use (**3.0**, **3.1,** or the default **auto**). This prompt repeats for each physical adapter in the system.

```
Configure UNI signalling VC? [n]
```

Enter **n** to accept the default signalling parameters for physical unit 0 (AAL 5 on VPI, VCI of 0, 5; and a peak cell rate of 0). The next four questions do not appear. If **y** is answered, the following prompt appears:

```
Enter UNI signalling VPI for physical unit 0: [0]
```

Press **<Enter>** to accept the default. Otherwise enter the VPI for physical unit 0.

```
Enter UNI signalling VCI for physical unit 0: [5]
```

Press **<Enter>** to accept the default. Otherwise enter the VCI for physical unit 0.

```
Enter UNI signalling AAL for physical unit 0: [5]
```

Press **<Enter>** to accept the default. Otherwise enter the AAL type for physical unit 0.

```
Enter UNI signalling peak cell rate for physical unit 0: [0]
```

Press **<Enter>** to accept the default. Otherwise enter the peak cell rate for physical unit 0. (The default value of 0 signifies UBR signalling.)

```
Enable UNI failover and load balancing? [y]
```

Systems that have more than one adapter unit installed and connected to the same physical ATM network can take advantage of automatic adapter failover and load balancing. When UNI failover/load balancing is enabled, multiple functional adapters in a system balance outgoing connections and the ATM network balances incoming connections across each of the adapters.

In addition, if one (or more) of the adapters fails, the driver automatically detects this condition, clears the connection state for those connections on the failed adapter, and then establishes new connections on demand using an alternate adapter in the failover group.

NOTE Classical IP, emulated LAN and XTI interfaces, because they are associated with an adapter unit number when created, also take advantage of load balancing/failover (if enabled).

Respond **n** if UNI failover and load balancing is not to be enabled. Otherwise, answer **y**.

```
Establish failover groups dynamically? [y]
```

A failover group consists of the set of adapters that are connected to the same physical ATM network. Accepting the default **y** enables each adapter to “discover” which of the other adapters is connected to the same physical ATM network and consequently belong to the same failover group. Responding **y** also ends the UNI Signalling configuration portion of the **configure_atm** installation. Respond **n** if failover groups are not to be established dynamically. The following prompt appears:

```
Enter physical units in this failover group (return to end):
```

Enter the adapter unit numbers (separated by spaces) that are in this failover group. This prompt recurs until the **<Enter>** key is pressed with no unit numbers specified.

NOTE

Refer to *Section 4.2, UNI Load Balancing and Failover* for additional information on UNI load balancing and failover.

3.2.3.1.3 MPOA/LAN Emulation Software

The topology of the ELAN or ELANs to administer should be known. The following information must be supplied when running this portion of the script:

- Whether or not Lan Emulations Clients (LECs) are to use a LAN Emulation Client Server (LECS), and if so, whether they are to contact the LECS via the “well-known” address or a supplied ATM address.
- The name of each ELAN for which a LEC is to be configured.
- The unit number of the adapter that each ELAN interface uses for connections.
- If a LECS is not being used, the ATM address of the LES associated with each ELAN for which a LEC is configured.

The following portion of the script represents a typical new LAN emulation configuration. If **n** is answered to the first question, the remainder of this section of the installation script does not appear. Responses to the following questions are system-specific and must be determined by the system administrator prior to configuring an emulated LAN.

```
ForeThought MPOA / LAN Emulation Software Configuration
======================================================================

Would you like to use an LECS to retrieve configuration information? [y]
Use the well-known LECS address? [y] <Enter>

An Automatic ELAN is a special case, where you do not specify
the ELAN to join. The ELAN is decided by the Administrator by
configuring the LECS database.
Would you like to configure an Automatic ELAN? [y] <Enter>
Enter Interface name [el0]: <Enter>
Enter unit number [0]: <Enter>
Would you like to enable MPOA? [y] <Enter>

WARNING: el0 has no IP address configured

Enter ELAN name to configure (return to end): <Enter>

======================================================================

Current Configuration Information ...

LECS ATM Address:        well-known

ELAN:                    Automatic ELAN
Interface Name:        el0
Physical Unit Number:  0
LAN Type:              ethernet
MPOA Status:           enabled

======================================================================

Do You Want To Modify Configuration Information? [n] <Enter>
Save Configuration Information? [y] <Enter>
Saving /etc/fore/fore_lanem.conf ...
```

Figure 3.9 - Configuring MPOA/LAN Emulation

3.2.3.1.3.1 Questions and Responses

The prompts presented while configuring LAN emulation depend on the environment and on answers to previous questions. In this section, the question is shown first, and the explanations of effects of the possible replies are shown after the questions.

```
======================================================================
               FORE Systems LAN Emulation Configuration
======================================================================

***** No Configuration Information *****
```

If LAN Emulation has not been configured previously, the **`No Configuration Information`** message appears. If emulated LANs have been configured, current configuration information appears, followed by:

```
Do You Want To Modify Configuration Information? <y/[n]>
```

If LAN Emulation is to be configured or modified, respond with **`y`**. Answering **`n`** ends the LAN Emulation Configuration process.

NOTE

Detailed information about the establishment of an emulated LAN (ELAN) is available in the on-line **`elconfig`** man page. The **`elconfig`** man page text is also available for reference in *Section 8.2.10, elconfig(8)* of this manual. Note that a host may join more than one ELAN. A LEC/MPC must be configured for each ELAN it is to join.

```
An Automatic ELAN is a special case, where you do not specify
the ELAN to join. The ELAN is decided by the Administrator by
configuring the LECS database.
Would you like to configure a Automatic ELAN? [y]
```

Answer **`y`** if an Automatic ELAN is to be configured. If **`n`** is answered, the following three prompts do not appear.

```
Enter Interface name [el0]:
```

Enter the ELAN interface name or **`<Enter>`** to accept the default name.

```
Enter unit number [0]:
```

Enter unit number of the adapter that the ELAN interface named in response to the previous prompt is to use or **`<Enter>`** to accept the default unit number.

```
Would you like to enable MPOA? [y]
```

Answer **`y`** if this ELAN is to participate in MPOA.

```
Enter ELAN name to configure (return to end):
```

The name of the emulated LAN to configure (for example, **marketing**) is entered in response to this prompt.

```
Enter Interface name [el1]:
```

Enter the ELAN interface name or **<Enter>** to accept the default name.

```
Enter unit number [0]:
```

Enter unit number of the adapter that the ELAN interface named in response to the previous prompt is to use or **<Enter>** to accept the default unit number.

```
Enter LES address Manually? [n]
```

Answer **y** if the ATM address that the ELAN named in the previous prompt is to use when communicating with the LES is to be entered. Answer **n** if ELAN members are to use the LECS to discover the ATM address of the ELAN's LES.

```
Would you like to enable MPOA? [y]
```

Answer **y** if this ELAN is to participate in MPOA.

```
Enter ELAN name to configure (return to end):
```

If another ELAN is to be configured, enter the ELAN name here. Otherwise, press the return key to end ELAN configuration.

```
======================================================================
Current Configuration Information ...
======================================================================
Current Configuration Information ...

ELAN:                         Automatic ELAN
       Interface Name:        el0
       Physical Unit Number:  0
       LAN Type:              ethernet
       MPOA Status:           enabled
       IP Address:            170.2.2.212

ELAN:                    "marketing"
       Interface Name:        el1
       Physical Unit Number:  0
       LAN Type:              ethernet
       MPOA Status:           enabled
       IP Address:            170.2.4.111
======================================================================
Do You Want To Modify Configuration Information? [n]<Enter>
```

Answer **y** to change, delete, or add LAN emulation configuration information. Answering **n** produces the following prompt.

```
Save Configuration Information? [y]
```

Answer **y** to save the configuration information. The system responds with a line indicating the configuration information is being saved in a file called **/etc/fore/fore_lanem.conf**. Answer **n** to abort the LAN emulation configuration.

3.2.3.1.4 Legacy Application QoS Software

NOTE

The prompt for configuring Legacy Applications Quality of Service (LAppQoS) parameters appears only if ELANs were configured in the previous section.

If ELANs have been configured, QoS parameter configuration prompts are presented. Figure 3.10 shows a typical session for configuring QoS parameters.

NOTE

Detailed explanations of the various options and parameters for the lappqos command are given in the on-line **lappqos** man page. The text of the **lappqos** man page is also given in *Section 8.2.11, lappqos(8)*.

```
ForeThought Legacy Application QoS Software Configuration

Configure QoS parameters for the ELANs? [n]<Enter>
```

Figure 3.10 - Configuring LAppQoS

3.2.3.1.4.1 Questions and Responses

The prompts presented while configuring QoS depend on the environment.

```
LAppQoS configuration requires an editor, but neither
the EDITOR nor the VISUAL environment variable is set.
```

If an editor is not specified in the EDITOR environment variable, a prompt is presented to supply one. The script then sets it as the editor, and opens the LAppQos configuration file in it for editing. The syntax for the lappqos command is presented along with an example command string. The appropriate commands and parameters must be supplied for each of the ELANs that Quality of Service parameters are to be configured.

NOTE

Detailed LAppQoS information and syntax is available in the **lappqos** man page. The **lappqos** man page is also reproduced in *Section 8.2.11, lappqos(8)* of this manual.

When the command lines are finished for each of the ELANs for which QoS parameters are to be configured, save the file and quit the editor.

3.2.3.1.5 Classical IP Software

When done configuring QoS (Section 3.2.3.1.4), Classical IP configuration questions are presented.

```
ForeThought Classical IP Software Configuration

Would you like to add a Classical IP interface? [n]

No changes.  Abort Classical IP configuration? [y]
```

Figure 3.11 - Configuring Classical IP

3.2.3.1.5.1 Questions and Responses

The prompts presented while configuring Classical IP depend on the environment and on answers to previous questions. In this section, the question is shown first, and the explanations of effects of the possible replies are shown after the questions.

`Configure Classical IP? [n]`

Answer **y** configure Classical IP. Answering **n** ends this process.

`Would you like to add a Classical IP interface? [n]`

If **n** is answered to this question, a prompt is presented to abort Classical IP configuration. If the answer is **y**, the following prompt appears.

`Enter unit number [0]:`

Enter the unit number of the adapter that the Classical IP interface being configured is to use, or **<Enter>** to accept the default unit number.

`Enter Interface name [ci0]:`

Enter the Classical IP interface name, or **<Enter>** to accept the default name.

`Enter the ATM address of the ARP Server for CLIP interface "ci0"`

Enter the ATM address of the ARP server that this CLIP interface is to use.

```
Enter the MTU size for CLIP interface "ci0" [9180]:
```

Enter the Maximum Transmission Unit (MTU) size for the CLIP interface being configured. The default value is 9180.

```
Warning: ci0 has no IP address configured
```

This statement appears as a reminder that an IP address needs to be configured for the CLIP interface being added.

```
Would you like to add another Classical IP interface? [n]
```

Answer **y** to add another CLIP interface. Answering **n** causes the current CLIP configuration to be presented. For example:

```
======================================================================

Current Configuration Information ...

       Physical Unit Number:0
       CLIP Interface Name:ci0
       ARP Server ATM Address:0x47.0005.80.ffe100.0000.f21c.121d.0020481c121d.20
       MTU Size:9180

======================================================================

Do You Want To Modify Configuration Information? [n]
```

Answer **y** to modify the CLIP configuration just entered. Answering **n** results in the following question.

```
Save Configuration Information? [y]
```

Answer **y** to save the CLIP configuration in the file **/etc/fore/fore_clip.con**f.

3.2.3.1.6 SPANS Signalling Software

When the Classical IP software configuration is complete (Section 3.2.3.1.5), SPANS signalling configuration prompts are presented if **all** was selected at Figure 3.6.

```
ForeThought SPANS signalling Software Configuration

Configure the SPANS signalling VC? [n]
```

Figure 3.12 - Configuring SPANS Signalling

3.2.3.1.6.1 Questions and Responses

The prompts presented while configuring SPANS signalling depend on the environment and answers to previous questions. In this section, the question is shown first, and the explanations of effects of the possible replies are shown after the questions.

```
Configure SPANS signalling? [n] y
```

Enter **y** to configure SPANS signalling. If **n** is entered, the remaining prompts do not appear.

```
Configure the signalling VC? [n] y
```

Enter **y** to configure the signalling VC. If **n** is entered, the remaining prompts do not appear.

```
Enter SPANS signalling VPI for unit 0: [0]
```

Enter the SPANS signalling VPI for unit 0 (default value is zero).

```
Enter SPANS signalling VCI for unit 0: [15]
```

Enter the SPANS signalling VCI for unit 0 (default value is **15**).

```
Enter SPANS signalling AAL for unit 0: [4]
```

Enter the SPANS signalling AAL type for unit 0 (default value is **4**).

```
Enter SPANS signalling peak cell rate for unit 0 (Kbps): [none]
```

Enter the SPANS signalling peak cell rate for unit 0 (default value is **none**).

3.2.3.1.7 FORE IP Software

When done configuring SPANS signalling (Section 3.2.3.1.6), FORE IP configuration prompts are presented.

```
ForeThought FORE IP Software Configuration

Enter the name for the FORE IP interfaces [fa]:

Enable FORE IP load balancing/failover? [y]

Enter failover poll interval (sec): [5]

Enter failover poll duration (sec): [10]

Configure FORE IP interface MTUs? [n]

Configure FORE IP SVC peak cell rates? [n]

Configure the FORE IP connectionless VC? [n]
```

Figure 3.13 - Configuring FORE IP

Software Installation and Configuration

3.2.3.1.7.1 Questions and Responses

The prompts presented while configuring FORE IP depend on the environment and answers to previous questions. In this section, the question is shown first, and the explanations of effects of the possible replies are shown after the questions.

```
Enter the name for the FORE IP interfaces [fa]:
```

The ATM interfaces are called **fa** or the specified name.

```
Enable load balancing/failover? [y]
```

Accepting the default, **y**, enables FORE IP load balancing and failover. If **n**, the following two prompts do not appear.

```
Enter failover poll interval (sec): [5]
```

Enter the FORE IP failover polling interval (default is 5 seconds).

```
Enter failover poll duration (sec): [10]
```

Enter the FORE IP failover polling duration (default is 10 seconds).

```
Configure interface MTUs? [n]
```

If the default is entered, **n**, the next prompt does not appear, and the MTU size remains the default **9188**.

```
Enter interface MTU for fa0: [9188]
```

Enter the maximum transmission unit size for **fa0** (default value is **9188**).

```
Configure SVC peak cell rates? [n]
```

If the default is entered, **n**, the next prompt does not appear, and the SVC peak cell rate remains the default zero.

```
Enter SVC peak cell rate for fa0: [0]
```

Enter the SVC peak cell rate for **fa0** (default value is zero).

```
Configure the FORE IP connectionless VC? [n] y<Enter>
```

Enter **y** to configure the FORE IP connectionless VC. If **n** is entered, the remaining four prompts do not appear.

```
Enter connectionless VC VPI for fa0: [0]
```

Enter the connectionless VC VPI for fa0 (default is zero).

```
Enter connectionless VC VCI for fa0: [14]
```

Enter the connectionless VC VCI for fa0 (default is 14).

```
Enter connectionless VC AAL for fa0: [4]
```

Enter the connectionless VC AAL type for fa0 (default is 4).

NOTE

The HE622 only supports AAL 5. If connecting to a FORE Systems switch, i.e., ASX-200BX, ensure that the switch port is configured to support signalling on AAL5.

Enter connectionless VC peak cell rate for fa0: [none]

Enter the connectionless VC peak cell rate for fa0 (default is **none**).

3.2.3.2 ATM Card Drivers

When the FORE IP configuration questions have been completed (Section 3.2.3.1.7), the adapter card driver configuration prompts are presented. The following section describes the questions, and available responses, to configure the HE adapter.

3.2.3.2.1 HE Adapters

If `FOREDrv.sw.he` was installed (see Figure 3.2) and the system contains an HE155 or HE622 adapter, the following prompts are presented.

```
ForeThought ATM Card Driver Configuration

Enter the number of VPI bits for unit 0: [0]

Enter PMD framing for unit 0 (sonet, sdh): [sonet]

Enter PMD cell insertion type for unit 0 (unassigned, idle): [unassigned]

Enter PMD clock source for unit 0 (internal, external): [internal]
```

Figure 3.14 - Configuring the HE Adapter

3.2.3.2.1.1 Questions and Responses

The prompts presented while configuring the HE adapter depend on the environment and answers to previous questions. The question is presented first followed by the possible options. The default is shown in **[ ]**. The defaults can be accepted by pressing the `Enter` key.

`Enter the number of VPI bits for unit 0: [0]`

Enter the number of VPI bits for unit 0. The default is **0**. This question is repeated for each physical adapter installed in the system.

`Enter PMD framing for unit 0 (sonet, sdh): [sonet]`

Enter the PMD framing type for adapter unit 0. The default is **sonet**. This question is repeated for each physical adapter installed in the system.

```
Enter PMD cell insertion type for unit 0 (unassigned, idle): [unassigned]
```

Enter the PMD cell insertion type for unit 0. The default is **unassigned**. This question is repeated for each physical adapter in the system.

```
Enter PMD clock source for unit 0 (internal, external): [internal]
```

Enter the clock source for adapter unit 0. The default is **internal**. This question is repeated for each physical adapter installed in the system.

3.2.4 Removal

It is not necessary to remove a previous installation if the system is being upgraded to *ForeThought* 5.1. The **inst** software installation package cleans up the old version of software during the installation process.

To manually remove all installed FORE packages, enter:

versions remove “FORE*”

The following messages are displayed on the console:

```
Reading product descriptions .. 100% Done.
Pre-installation check ..   8%
Checking space requirements ..  16%
Installing/removing files ..  16%
Removing selected FOREDrv.sw subsystems
Installing/removing files ..  26%
Removing selected FOREUni.sw subsystems
Installing/removing files ..  33%
Removing selected FOREXti.sw subsystems
Installing/removing files ..  50%
Removing selected FORECore.sw subsystems
Installing/removing files ..  67%
Removing selected FOREclip.sw subsystems
Installing/removing files ..  72%
Removing selected FOREmpoa.sw subsystems
Installing/removing files ..  85%
Removing selected FORESpans.sw subsystems
Installing/removing files ..  87%
Removing selected FOREip.sw subsystems
Installing/removing files ..  94%
Running exit-commands .. 100% Done.
Installations and removals were successful.
```

CHAPTER 4 Network Interface Administration

This chapter provides network configuration information such as assigning an IP address, configuring UNI load balancing and failover, configuring the 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 installing the *ForeRunner* adapter hardware and software, some additional configuration tasks must be performed before using the adapter 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 adapter interface should be within the subnet that is assigned to the ATM LAN by the system administrator.

If unsure of how to do so, it is strongly recommended that the Silicon Graphics *IRIX Site and Server Administration Guide* be consulted for more information on creating and configuring subnets. Consult the system administrator for additional help.

4.1.1 Naming Conventions

Table 4.1 lists the default names assigned to interfaces supported by *ForeThought* adapter software.

Table 4.1 - Default Interface Names

Interface Type	Default Name	Comments
FORE IP	fa*x*	Where *x* represents the unit number. The first unit configured is assigned number 0. Subsequent units are 1, 2, etc.
Emulated LAN	el*x*	
Classical IP	ci*x*	

Network Interface Administration

NOTE

Throughout this chapter, when an example uses the interface name **fa**, any **ci**, or **el** interface name, or a user-defined interface name if the default was changed using **configure_atm**, could also be used, depending on the protocol being configured.

4.1.2 Configuring the *ForeRunner* Adapter Network Interface

After the adapter has been installed and the system is again up and running, the interface can be assigned an IP address by issuing:

ifconfig fa0 <*internet address*> **netmask** <*netmask_value*> **broadcast** <*broadcast_value*> **up**<Enter>

Please note that the **ifconfig** line may differ from this example if using a separate subnet for the ATM LAN. Specifically, the arguments for netmask and broadcast may be different. (See the **ifconfig(1M)** man page.)

Once the interface is configured, use the **ping** command to verify the connection and to confirm the presence of others connected to the network.

4.1.3 Assigning IP Addresses During Reboots

To have a workstation correctly assign IP addresses during reboots, modify the initialization configuration. In this example, it is assumed that **foo-atm** has also been defined as an alias. For example, the following changes could be made:

1. In **/etc/config/netif.options**, add the lines:

```
if2name=fa0
if2addr=foo-atm
```

2. Create **/etc/config/ifconfig-2.options** with the line:

```
up netmask 0xffffff00
```

3. Add **foo-atm** to **/etc/hosts** file on the workstation to add the IP hostname to address mapping for the ATM interface.

4.2 UNI Load Balancing and Failover

Systems that have more than one *ForeRunner* adapter unit installed and connected to the *same physical ATM network* can take advantage of UNI load balancing and failover (LB/FO). Adapters are collected into *failover groups*. A failover group consists of a set of adapters that are connected to the same physical ATM network. When enabled, UNI load balancing distributes incoming and outgoing connections over the available adapters. Outgoing connections are balanced by the host driver. Incoming connection load balancing may be controlled by the network device(s) that are connected to the host adapters.

NOTE

ForeThought 5.1 running on *ForeRunner* switches and devices running ATM Forum PNNI support incoming connection LB/FO.

CAUTION

Avoid using LB/FO in networks utilizing Interim-Interswitch Signalling Protocol (IISP) links between the host adapters and switch(s) (IISP relies on established static routing tables). Also, connecting multiple adapters in a multihomed host to a single third-party switch is not supported.

In addition, if one (or more) of the *ForeRunner* adapters in a failover group fails, the host driver automatically detects this condition, clears the connection state for connections on the failed adapter, and then establishes new connections on demand from the UNI signalling user via an alternate functional adapter in the failover group.

NOTE

Use of LB/FO permits the system administrator to configure LANE/MPOA interfaces or Classical IP interfaces on hosts containing multiple *ForeRunner* adapters to take advantage of connection load balancing and the redundancy that failover groups provide. This is done by assigning each interface to the desired adapter unit number when creating the interface.

UNI LB/FO is distinct from FORE IP load balancing and failover which are covered later in this chapter

4.2.1 Configuring

LB/FO can be enabled to establish failover groups either dynamically (default state) or statically. When enabled dynamically, the host driver establishes failover groups by discovering which of the host adapters are connected to the same physical ATM network. Failover groups can also be set statically by the system administrator.

There are two methods for configuring UNI load balancing and failover:

1. Using the **`configure_atm`** script.
2. At the command line using the **`uniconfig`** command.

The first method is described in Chapter 3. The second method is described in the following section.

NOTE

Since LB/FO is configured on an adapter basis, there are no IP configuration procedures required.

4.2.1.1 Command-Line Configuration

LB/FO is administered at the command line using the **`uniconfig set failover`** command. For example, to enable LB/FO and establish failover groups *dynamically* on a host containing three *ForeRunner* adapters connected to a *ForeRunner* switch, enter the following command:

```
uniconfig set failover -state dynamic
```

Messages similar to the following should display as the failover group members discover each other and form the group:

```
NOTICE: UNI failover: (1) merged with (2)
NOTICE: UNI failover: (0) merged with (1, 2)
```

To check the UNI configuration for this host enter the following command:

`uniconfig show`

Output is similar to the following displays:

```
UNI parameters for unit 0
=========================
VPI/VCI                : 0/5
AAL type               : 5
QoS                    : UBR
UNI configured version : auto
UNI operating version  : 3.1
SSCOP operational state : operational
Primary ATM address    : 47.0005.80.ffe100.0000.f21a.366b.0020480637ae.00

UNI parameters for unit 1
=========================
VPI/VCI                : 0/5
AAL type               : 5
QoS                    : UBR
UNI configured version : auto
UNI operating version  : 3.1
SSCOP operational state : operational
Primary ATM address    : 47.0005.80.ffe100.0000.f21a.366b.0020480678d0.00

UNI parameters for unit 2
=========================
VPI/VCI                : 0/5
AAL type               : 5
QoS                    : UBR
UNI configured version : auto
UNI operating version  : 3.1
SSCOP operational state : operational
Primary ATM address    : 47.0005.80.ffe100.0000.f21a.366b.00204806354e.00

UNI failover configuration
==========================
Status: dynamic
Groups: (2, 1, 0)
```

As shown, the dynamically established failover group for this host contains all of the adapters. Should the connections through one of the adapters fail (broken cable, failed switch port, failed adapter, etc.), LB/FO allows the driver to re-establish connectivity through either of the remaining operational adapters.

To enable LB/FO and establish failover groups *statically* on a host containing three *ForeRunner* adapters, two of which are connected to *ForeRunner* switches in the same network, the third connected to a third-party switch in a different network, enter the following command:

`uniconfig set failover -state static -group 1 2`

Output similar to the following should display as the failover group is established:

```
NOTICE: UNI failover: (1) merged with (2)
```

The **`uniconfig show`** displays the following failover configuration information:

```
UNI failover configuration
==========================
Status: static
Groups: (2, 1) (0)
```

In the configuration set above, if adapter unit 2 were to fail (perhaps the cable between the adapter and the switch is severed), **`uniconfig show`** would display:

```
UNI failover configuration
==========================
Status: static
Groups: (2*, 1) (0)
```

The asterisk indicates the failed condition of unit 2. More importantly, because LB/FO is enabled on this host, the connections that had been using adapter unit 2 may now be automatically re-established though adapter unit 1.

To disable UNI load balancing and failover, enter the following command:

`uniconfig set failover -state off`

4.3 *ForeRunner* Adapter in an IP Network

The adapter's device driver supports the TCP/IP protocol suite as well as the ATM API. In order to use the *ForeRunner* adapter card in an IP network, set the 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.

NOTE The addresses used should be specific to the network topology.

To proceed with the network configuration, access to the following information is necessary:

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

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

4.3.1 Multi-homing on ATM and Ethernet Networks

If the workstation is to reside on both an ATM and Ethernet network, 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 workstations on the ATM or Ethernet side of the network, specify the IP hostname or address of the specific workstation.

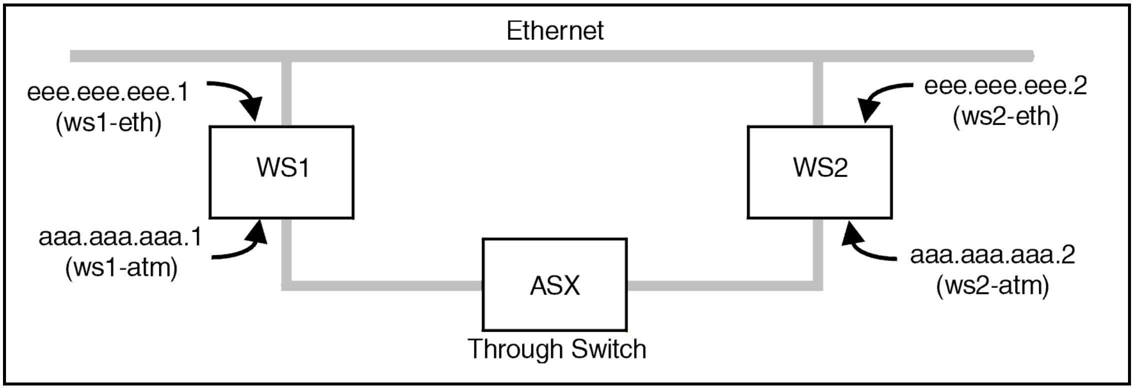

Figure 4.1 - Multi-homing Network Configuration

The following is an example of multi-homing, using the `ftp` command to transfer a file via either ATM or Ethernet. In this example, `ws2` is the workstation being connected to. To use the **`ftp`** command over ATM, enter:

```
ftp ws2-atm
```

To use the **`ftp`** command over Ethernet, type:

```
ftp ws2-eth
```

4.3.2 Configuring a Workstation as ATM-Only

If the workstation is on an ATM-only network, but still has access to workstations outside the ATM network, it is necessary to add an ATM-to-Ethernet router and perform additional configuration on the workstation and external workstation(s). Specifically, the workstation and switch must be configured to enable them to recognize and reach the external workstation(s). The external workstation(s) needs the same capabilities. Figure 4.2 illustrates a basic network topology for this type of configuration.

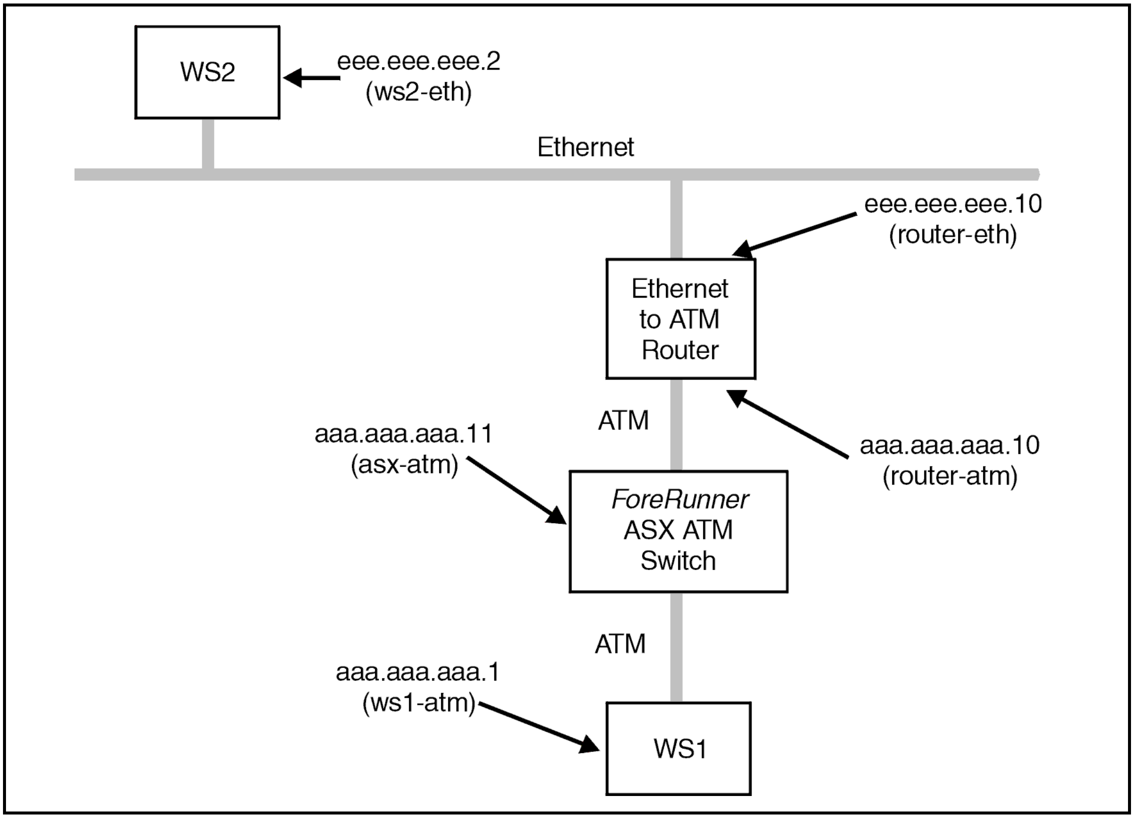

Figure 4.2 - ATM Network with Access to Ethernet

As before, assign an IP address to the ATM interface on the ATM-only workstation. In this topology, the ATM-to-Ethernet router is used to route IP traffic between the ATM and Ethernet networks.

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

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 are multi-homed. The routing daemon "listens" 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, enter the following on the ATM-only workstation:

   `route add default router-atm`

2. Enter the following on the Ethernet workstation:

   `route add default router-eth`

To maintain this default route, simply add the route to the **`/etc/config/static-route.options`** file (refer to the `route(1M)` man page for details). If a default route is not to be used, specify a specific route to accomplish the correct routing.

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

   `route add -net eee.eee.eee router-atm`

2. Enter the following on the Ethernet workstation:

   `route add -net aaa.aaa.aaa router-eth`

3. Once a route has been established, files can be transferred using **`ftp`** between the Ethernet workstation and the ATM-only workstation by entering the following on the ATM host:

   `ftp ws2-eth`

To maintain this route across reboots, add the appropriate “route” command to **`/etc/config/static-route.options`** (refer to the `route(1M)` man page for details).

CHAPTER 5 Configuring FORE IP

5.1 Configuring an Outgoing FORE 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 need to be determined before configuring this part of the connection: outgoing interface (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 hostname device vpi vci aal
```

For example, to set up an outgoing connection from `ws1-atm` to `ws2-atm` using **fa0**, VPI of 0, VCI of 100 and AAL5, specify on host `ws1-atm`:

```
atmarp -s ws2-atm fa0 0 100 5
```

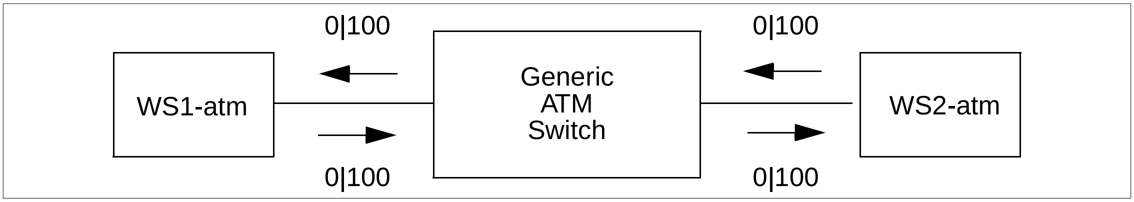

Figure 5.1 - IP Permanent Virtual Circuit

It is also necessary to set up an equivalent outgoing connection from `ws2-atm` to `ws1-atm` using **fa0**. To set up this connection with VPI of 0, VCI of 100 and AAL5, enter the following on host `ws2-atm`:

```
atmarp -s ws1-atm fa0 0 100 5
```

5.1.1 Configuring an Incoming FORE IP PVC

The second step in configuring an IP PVC connection is to link an incoming VPI/VCI to the IP queue (see Figure 5.1). The following parameters should be determined before configuring this part of the connection: incoming interface, 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 **fa0**, VPI of 0, VCI of 100 and AAL 5, enter the following on host `ws1`:

atmarp -l fa0 0 100 5

This command links cells coming in on **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 **fa0**, VPI of 0, VCI of 100 and AAL 5, enter the following on host `ws2`:

atmarp -l fa0 0 100 5

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

For more information on the **atmarp** command refer to *Section 8.2.4, atmarp(8)*.

5.1.2 Verifying the FORE IP PVC Configuration

The **atmarp** command can also be used to view the ARP cache in the device driver. This command 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 appears in the output with the "flags" indicating that this entry is a PVC.

For more information about the **atmarp** command, see *Section 8.2.4, atmarp(8)*.

5.1.3 FORE IP Multicasting Support

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.

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

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.

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 is sent on the default multicast PVC if it exists.

If a default multicast PVC does not exist, the host driver automatically attempts to create a multicast SVC. Extensions to the host adapter management tool **atmarp** (see *Section 8.2.4, atmarp(8)*) were made to support multicast PVCs.

5.1.4 FORE IP Load Balancing and Automatic Failover

FORE 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 is automatically 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 occurs on both incoming and outgoing connections, across different series and speeds of FORE adapters.

FORE IP load balancing can also provide a means of fault tolerance called Automatic Failover. If an interface is configured down, all IP SVCs currently using that interface are closed. New connections are created on demand, and balanced across all interfaces currently alive. When an interface fails, all connections across it are broken. Therefore, fault-tolerant applications must account for the possibility of broken connections.

The **`atmconfig -b`** command is used to enable and disable FORE IP load balancing and automatic failover (FORE IP load balancing and automatic failover are enabled by default.). The **`atmconfig -g`** command is used to set the frequency at which the network interface is verified to be operational (default is five seconds). The **`atmconfig -h`** command sets the time to spend retrying a failed interface before declaring the interface down (default is ten seconds). *Section 8.2.5, atmconfig(8)* contains complete information on **`atmconfig`**.

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.

5.1.5 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 is limited to the peak cell rate specified for that interface. The **`-q`** option in **`atmconfig`** is used to set the peak cell rate to a specific value, or to turn off peak cell rate control. Refer to *Section 8.2.5, atmconfig(8)* for more information.

5.1.6 IP MTU Size

An interface's maximum transmission unit (MTU) can be set up to 65535 bytes. The default MTU for FORE IP interfaces is 9188 bytes. A 65535 byte MTU is supported for AAL types null (0), four (4), and five (5). Refer to *Section 8.2.5, atmconfig(8)*, or *Section 8.2.8, clipconfig(8)* man pages for the appropriate syntax to set the IP MTU size. In the case of LANE, the MTU is provided by the LES, depending on the Maximum Frame Size (MFS) of the joined ELAN.

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.

5.1.7 User Configurable FORE IP Network Interface Name

The name to be used for all FORE IP interfaces can be chosen during configuration. 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** using the **configure_atm** command line utility.

NOTE

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

CHAPTER 6 Configuring Classical IP

6.1 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 from 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 or UNI 3.1 signalling. UNI 3.0 and 3.1 are broadband signalling protocols designed to establish connections dynamically. UNI 3.0 and 3.1 use Service Specific Connection Oriented Protocol (SSCOP) as a reliable transport protocol, and all signalling occurs over VPI: 0, VCI: 5. UNI 3.0 and 3.1 connections are bi-directional, with the same VPI/VCI pair used to transmit and receive.

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.

6.1.1 Logical IP Subnets

An important concept in Classical IP networks is that of a Logical IP Subnet (LIS). An LIS consists of 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 that communication between LISs must occur through IP routers.

6.1.2 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 16 distinct LISs. 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 default name of each of the Classical IP interface begins with **`ci`**. The interface names are also user-configurable.

NOTE

If the machine contains multiple *ForeRunner* adapters connected to the same ATM network, you can take advantage of UNI load balancing and failover when configuring the CLIP interfaces. UNI load balancing and failover allows the driver to automatically manage outgoing connections over multiple physical adapters; and to dynamically re-establish connections through another adapter in the machine if the adapter carrying the original connection should fail. See *Section 4.2, UNI Load Balancing and Failover*.

6.2 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.

6.2.1 ATM Addresses

For private ATM networks, addresses uniquely identify ATM endpoints. The UNI 3.0 and 3.1 address format is modeled after that of an OSI Network Service Access Point.

Three address formats have been specified: DCC, ICD, and E.164. Per the UNI 3.0 and 3.1 specifications, 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 consisting of a six-byte End System Identifier (ESI). The ESI is the unique IEEE MAC address of the interface and a one-byte selector.

6.2.2 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 appends the 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 are closed. If the new port is on a different switch, a new ATM address (with a different network address prefix) is registered. The host can then begin to establish new connections.

6.2.3 Operating without ILMI Support

If ILMI is not supported on a particular switch or host in a given network, the ATM addresses must be manually configured. If a given switch does not support ILMI, it cannot 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 attached to that switch.

On the host, use **`/opt/FOREatm/bin/uniconfig`** 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. The UNI signalling type (3.0, 3.1, or auto) must then be set. The UNI type may also be set as part of the configuration session (see Chapter 3). Once the host and network have both been informed of this ATM address/port pair, the host may begin signalling.

6.3 ARP and ARP Servers

6.3.1 Theory

In order for a host to establish a connection to another host, it must first determine the other host's ATM address. ATM address resolution protocol (ATMARP) is used to resolve an IP address into an ATM address. 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.

Each host in an LIS must be configured with the ATM address of the ARP server providing ARP services for its LIS. The ATM address of the ARP server can be obtained by running **/opt/FOREatm/bin/clipconfig show** (remember to use the interface associated with the given LIS). The ARP server address is normally configured into each host when the **configure_atm** script is run (the appropriate commands are placed in **/etc/rc2.d/S99clip**). Entering **/opt/FOREatm/bin/clipconfig add [-arpserver** <*arpserver_address*>**]** creates a Classical IP interface with the specified ARP server address.

NOTE

The ARP server address persists across reboots if configured in **/etc/rc2.d/S99clip**. If configured using **clipconfig**, it does not persist across reboots.

Since only one ARP server can be functioning at a time in a given LIS, and since the ARP server address is manually configured in 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 new CLIP interfaces for each host within the LIS must be created to use the new ARP server.FORE Systems' switches also have the capability of being configured as an ARP server. This process is described in the following section.

6.3.2 Configuring a FORE Switch as an ARP Server.

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

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

```
configuration atmarp>getnsap
```

```
qaa0 NSAP address: 470000580ffe1000000f21510a00020481510a000
```

   The response from this command also displays 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
0x47.00005.80.ffe100.0000.f215.10a.00020481510a0.00 qaa0
```

NOTE

This example shows the CLIP interface name **qaa0** used as the ARP server interface name. Any of the CLIP interface names (**qaa0** through **qaa3**) could be used as the ARP server name.

6.3.3 Classical IP Operation

Once a host knows its own ATM address, and the ATM address of its ARP server, it attempts to establish a connection to the ARP server, which is 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 cannot 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 is 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 re-validate it before transmitting. Transmission proceeds only when validation succeeds. If a VC associated with an invalid ARP entry is closed, the entry is removed.

6.3.4 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.

Use the **cliparp add -address** command to add a static ARP entry, as follows.

```
cliparp add -address host atm_addr interface
```

6.4 Classical IP PVCs

6.4.1 Theory and Configuration

Normally, ATM connections in a Classical IP environment are established dynamically using UNI 3.0 or 3.1. ARP, ILMI, and UNI 3.0 or 3.1 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 set up an SVC using work-arounds. If a host or switch in an LIS does not support UNI 3.0 or 3.1, 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, **`/opt/FOREatm/bin/cliparp add -pvc`** 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 set up from each of the hosts to their connecting switch, and then on all of the switches between the two connecting switches.

NOTE

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

6.4.2 Re-validation and Removal

Normally, the device driver periodically checks that its PVCs are still established and functioning. A host re-validates a PVC by sending **`InARP`** requests over the PVC. If the user specifies that re-validation should occur by specifying a time with the **`-reval`** option (used with the **`/opt/FOREatm/bin/cliparp add -pvc`** command), i.e., when creating a PVC, **`-reval 10`** causes the PVC to be re-validated every ten minutes. If an **`InARP`** reply is not received, the re-validation fails, the PVC is marked invalid, 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 proceeds only when validation succeeds. It is possible to disable this re-validation feature by not specifying the `reval` option to **`/opt/FOREatm/bin/cliparp -pvc`**. This is often desirable when the remote end of the PVC (such as a video camera) does not support **`InARP`**.

Configuring Classical IP

A Classical IP PVC is removed on the host side using **/opt/FOREatm/bin/cliparp delete -pvc**. Both the incoming and outgoing connections are removed simultaneously. The PVC must then be removed from each of the network switches involved.

NOTE The **clipconfig set** command can be used to change the ARP server address or mtu in addition to setting up a PVC's only ARP server interface.

cliparp show [interface] [-n]

cliparp add -pvc vpi vci llc_encap interface [host]
[-reval revalidation_time]
[[-qos ubr -pcr PCR]|
[-qos cbr -pcr PCR]|
[-qos abr -pcr PCR [-mcr MCR] [-icr ICR]]]

where `llc_encap` is (`llc_bridged dst_mac_addr|llc_routed`)

cliparp add -address host atm_addr interface

cliparp delete -all|interface|-address host interface|
-pvc vpi vci interface

clipq [-l] [-u unit] arp-server-addr

clipstat [-u unit] arp-server-addr [interval [rows]]

cliparpd [-f] [-unit unit] [-selector sel]
[-address well-known|atm_addr]

6.5 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 describes how to configure a network with the following scenarios:

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

6.5.1 Third-Party Switch with ILMI Support

To configure a network with a third-party vendor's switch that supports ILMI, (as shown in Figure 6.1), perform the following steps:

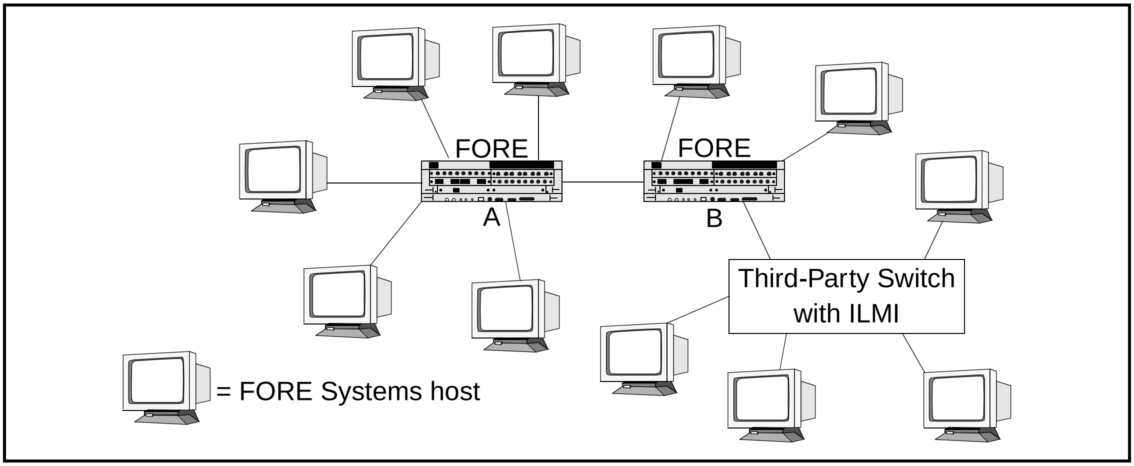

Figure 6.1 - Configuring a Third-Party Switch with ILMI Support

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.

6.5.2 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 6.2), perform the following steps:

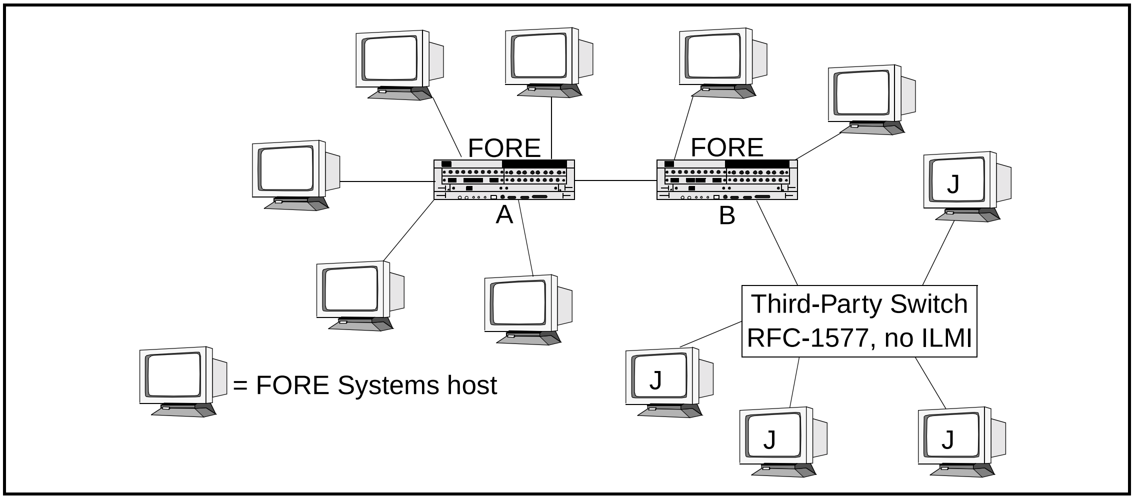

Figure 6.2 - Configuring a Third-Party Switch with RFC-1577 and No ILMI Support

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, 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.

4. 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.

CHAPTER 7 Configuring an ELAN

7.1 Introduction

This chapter describes how to design, configure, and maintain an Emulated LAN (ELAN) over an ATM network. An ELAN provides communication of user data frames among all members of the ELAN, similar to a physical LAN. One or more ELANs may run simultaneously (and independently) on the same ATM network.

Each ELAN is composed of a set of LAN Emulation Clients (LECs), a LAN Emulation Configuration Server (LECS), and at least one LAN Emulation Server (LES) and Broadcast and Unknown Server (BUS) pair (also referred to as a co-located BUS or an intelligent BUS). In *ForeThought* 5.1, the LECS may reside either in a *ForeRunner* ASX or LE155 switch or in a UNIX workstation running Solaris 2.5, 2.5.1, 2.6, or 2.7. The LES/BUS pair may reside either in a *PowerHub* 7000, *PowerHub* 8000, *ForeRunner* ASN-9000, *ForeRunner* switch, or on a UNIX workstation running Solaris 2.5, 2.5.1, 2.6, or 2.7. An additional software feature is Distributed LAN Emulation (DLE), which provides load sharing and fault tolerance for the ELAN.

ForeThought 5.1 supports emulation of Ethernet (IEEE 802.3) and Token Ring (IEEE 802.5) ELANs. Each Ethernet LEC can reside on an ATM host system (PC, UNIX workstation, ATM switch, *PowerHub* 7000, or ES-3810). Token Ring LECs are only supported on AIX based UNIX workstations.

7.2 Emulated LAN Components

The components of an ELAN include LECs, and LAN Emulation services consisting of a LECS, a LES, and a BUS. Although the ATM Forum specification allows the LES and BUS to be located on different devices, more intelligent traffic handling is possible when they are located on the same device. *ForeThought* 5.1 requires that the LES and BUS be co-located (residing on the same device).

The LECS may reside in the same physical system as the LES/BUS or in a separate physical system. For example, the LECS could reside in a switch, while the LES/BUS reside in a workstation. In *ForeThought* 5.1, the LECS is supported only on *ForeRunner* switches and on systems running the Solaris operating system. The LES/BUS are supported only on *ForeRunner* switches, *PowerHub* 7000, *PowerHub* 8000, *ForeRunner* ASN-9000, and systems running the Solaris operating system. The functional interconnections of a simple ELAN consisting of two LECs, an LECS, a LES, and a BUS are shown in Figure 7.1.

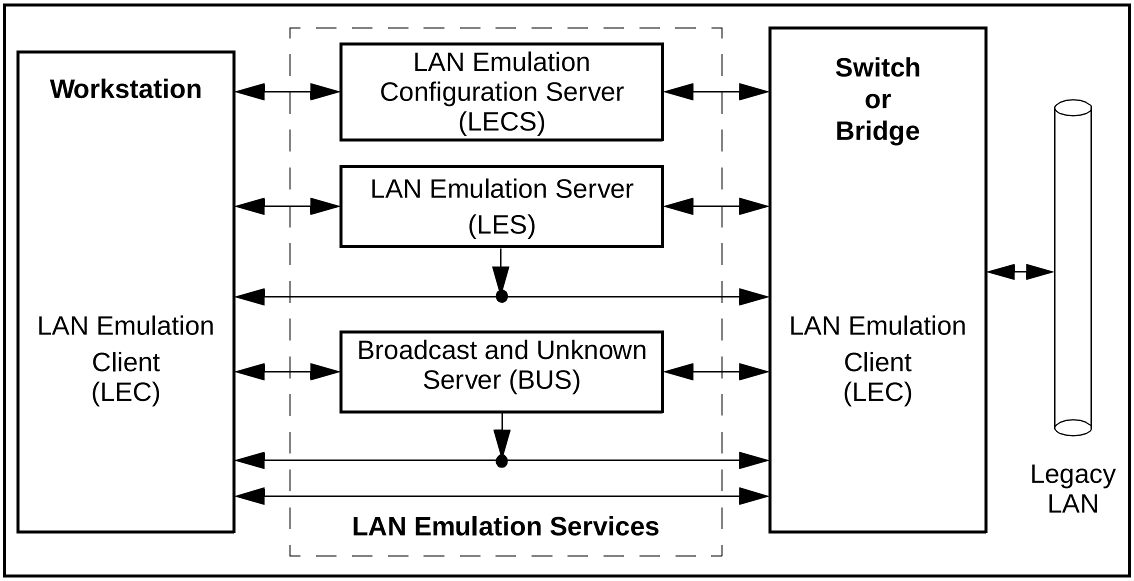

Figure 7.1 - Basic Emulated LAN Interconnections

7.2.1 LAN Emulation Client (LEC)

The LEC is the component in an end system that performs data forwarding, address resolution, and other control functions when communicating with other components within the ELAN. It also provides a MAC level emulated Ethernet or Token Ring interface and appears to higher level software as though a physical interface is present. Each LEC must register with both the LES and BUS associated with the ELAN it wishes to join before it may participate in the ELAN. To participate in multiple ELANs, an end system must have multiple LECs. *ForeThought* 5.1 supports up to 16 LECs on adapter cards running IRIX.

7.2.2 LAN Emulation Configuration Server (LECS)

The LECS is responsible for the initial configuration of LECs. It provides information about available ELANs that a LEC may join, together with the address of the LES associated with each ELAN. Using DLE, the user may also configure the LECS to associate multiple LES/BUS pairs with a given ELAN. This feature allows LECs to use a single, anycast address to reach one of the other DLE peer servers for their ELAN if their local server goes down. Normal address resolution through *ForeThought* Private Network-to-Network Interface (PNNI), ATM Forum PNNI, or IISP locates the closest, active LES which is using the anycast address.

7.2.3 LAN Emulation Server (LES)

The LES implements the control coordination function for the ELAN and provides the service of registering and resolving MAC addresses to ATM addresses. A LEC registers its own address with the LES and also queries the LES when the client wishes to resolve a MAC address to an ATM address. The LES either responds directly to the client or forwards the query to other clients. There may be more than one instance of an active LES per ELAN.

7.2.4 Broadcast and Unknown Server (BUS)

Unlike traditional shared-media LAN architectures such as Ethernet or Token Ring, ATM is connection based. Therefore, it has no built-in mechanism for handling connectionless traffic such as broadcasts, multicasts, and unknown unicasts. In an ELAN, the BUS is responsible for servicing these traffic types by accepting broadcast, multicast, and unknown unicast packets from the LECs via dedicated point-to-point connections, and forwarding the packets to all of the members of the ELAN using a single point-to-multipoint connection. (Unknown unicast packets are packets that the sending station broadcasts because it does not yet know the ATM address for the packet's destination MAC address. There may be more than one instance of an active BUS per ELAN. Using *ForeThought* 5.1 each BUS must be a co-located BUS (also referred to as an intelligent BUS or a LES/BUS pair), which allows the BUS to use the LES's registration table to direct unicast traffic.

7.3 Emulated LAN Operation

This section describes the operation of an ELAN and its components from the point of view of a LEC. The operation of an ELAN may be divided into three phases:

1. Initialization
2. Registration and Address Resolution
3. Data Transfer

ELAN components communicate with each other using ATM connections. LECs maintain separate connections for traffic control functions and data transfer. The following connection types are used by the LEC when operating in an ELAN:

- *Configuration-Direct Connection*: a bidirectional point-to-point VCC set up by the LEC to the LECS.
- *Control-Direct Connection:* a bidirectional point-to-point VCC set up by the LEC to the LES. This connection must be maintained for the duration of the LEC's participation in the ELAN.
- *Control-Distribute Connection*: a unidirectional point-to-multipoint VCC set up by the LES to the LEC. This connection must be maintained for the duration of the LEC's participation in the ELAN.
- *Multicast-Send Connection*: a bidirectional point-to-point VCC set up by the LEC to the BUS for sending multicast data to the BUS. The LEC must attempt to maintain this connection while participating in the ELAN.
- *Multicast-Forward Connection*: a unidirectional point-to-multipoint VCC set up from the BUS to LECs participating in the ELAN. This VCC must be established before a LEC participates in an ELAN. The LEC must attempt to maintain this connection while participating in the ELAN.
- *Data-Direct Connection*: a bidirectional point-to-point VCC set up between LECs that want to exchange unicast data traffic.

For the following discussion, refer to Figure 7.2.

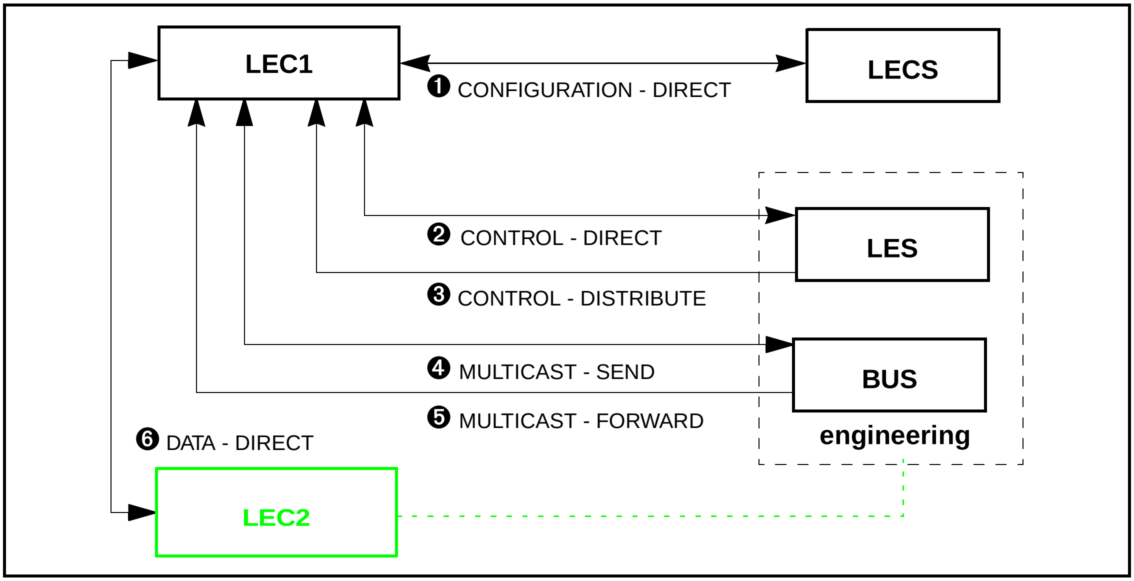

Figure 7.2 - ELAN Operation

7.3.1 Initialization

Upon initialization, LEC1 obtains its ATM address via ILMI address registration. LEC1 obtains the address of the LECS in one of four ways: by querying the switch to which LEC1 is connected via ILMI, by connecting to a “well-known” address defined by the ATM Forum’s LANE standards (**c5.0079.00.000000.0000.0000.0000.00a03e000001.00** or **47.0079.00.000000.0000.0000.0000.00a03e000001.00**), by using PVC (0,17), or by using an address that is locally configured on LEC1.

Once the location of the LECS is known, LEC1 establishes a configuration-direct connection ❶ to the LECS. When connected, the LECS provides LEC1 with the information necessary to connect to the ELAN it wishes to join. This information includes such parameters as: the ATM address of the ELAN’s LES, the type of LAN being emulated, the maximum packet size, and the name of the ELAN (**engineering**, for example). This configuration information is contained in a configuration file that must be built and maintained by the network administrator.

7.3.2 Registration and Address Resolution

After the address of the LES is obtained, LEC1 establishes a control-direct connection ❷ to the LES.

NOTE

When using DLE, this address is a single, anycast address which allows the LEC to reach one of the other DLE peer servers for its ELAN if its local server goes down. This address is routed via PNNI to the nearest active DLE peer server for this ELAN.

NOTE

If the LES is secure, upon receiving a request from a LEC to join the ELAN, the LES sends a message to the LECS to verify that the LEC is allowed to join. If verification is received from the LECS, the LES grants the LEC permission to join. If verification is not received from the LECS, the LES rejects the join request and the LEC is dropped.

The LES assigns LEC1 a unique identifier, and LEC1 registers its own MAC and ATM addresses with the LES. (The LES maintains a table containing the MAC addresses and corresponding ATM addresses of all members of the ELAN.) At this point, LEC1 has “joined” the ELAN.

The LES then establishes a control-distribute connection ❸ back to LEC1. Connections ❷ and ❸ can now be used by LEC1 to send LAN Emulation ARP (LE_ARP) requests to the LES, and receive replies.

LEC1 now sends an LE_ARP request to the LES to get the ATM address of the BUS corresponding to the broadcast MAC address (FFFFFFFFFFFF). The LEC then establishes a multicast-send connection ❹ to the BUS. The BUS responds by setting up a multicast-forward connection ❺ to the LEC.

At this point, the LEC is ready to transfer data.

7.3.3 Data Transfer

When LEC1 receives a network-layer packet from a higher layer protocol to transmit to some destination MAC address (for example, LEC2), LEC1 initially does not know the corresponding ATM address of the destination. Consequently, LEC1 sends an **LE_ARP** request to the LES.

NOTE

The example shown in Figure 7.2 assumes that LEC2 has already registered with the LES, and that connections similar to those described for LEC1 already exist.

While waiting for the LES to respond, LEC1 forwards the packet to the BUS. The BUS broadcasts the packet to all LECs on the ELAN. This is done to avoid data loss, and to circumvent connection setup latency (due to the **LE_ARP** process) that may not be acceptable to some network protocols.

If the **LE_ARP** response is received, LEC1 establishes a data-direct connection ❻ to the destination address of LEC2. It is this path that is used for subsequent data transfers. Before LEC1 begins to use this connection, it first sends a “flush” packet via the BUS to the destination, LEC2. When LEC2 acknowledges receipt of this packet, signifying that the BUS path is empty, only then does LEC1 begin to use the data-direct connection ❻ for data transfer. This process ensures that the network protocol’s frames arrive in the proper order.

If no response is received to the **LE_ARP**, LEC1 continues to send data via the BUS, while continuing to **LE_ARP** until a response is received and a data-direct connection to LEC2 established.

If LEC1 already has a data-direct connection to a MAC address it wishes to reach, it need not go through the **LE_ARP** process again. Instead, it continues to use the current connection. This is possible because each LEC maintains a cache of MAC address to ATM address mappings that it receives in response to the **LE_ARP**s it has sent. Entries in this cache are “aged” out over a period of time. Data-direct connections are also cleared if they remain inactive for a period of time.

7.4 Distributed LAN Emulation

Distributed LAN Emulation (DLE) allows the LES and BUS functions provided to each ELAN to be distributed among multiple, interconnected server platforms. In this way, DLE provides these ELANs with resiliency and scalability.

To understand DLE operation, it is useful to compare DLE to the current LANE service model, which uses a single LES and BUS for each ELAN. This section first describes a simple example of the single server model and then provides a detailed overview of the DLE model.

7.4.1 Single Server LANE Services Model

Figure 7.3 shows the topology of a single server supporting an ELAN. In this example, the LECs are hosts that are using IP, and the LES and BUS are running on the same switch. Three LANE LECs are all registered in the same ELAN, **Eng**, and each is therefore connected to a LES and to a BUS for that ELAN.

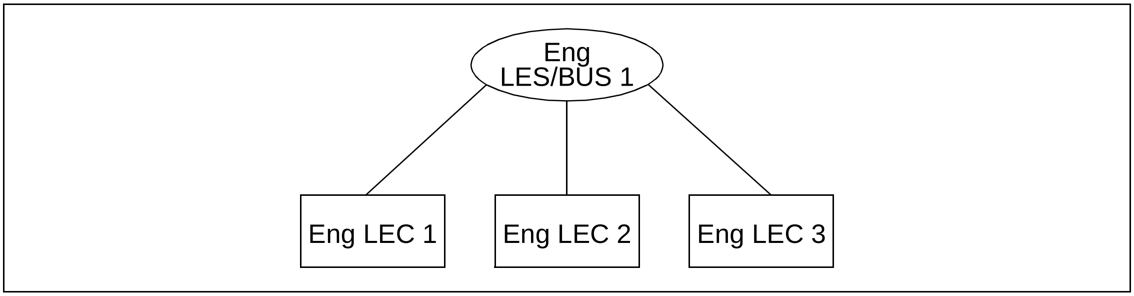

Figure 7.3 - Single Server LANE Services Model

7.4.1.1 Using a Single Server

When LEC 1 wants to contact LEC 3, several messages are exchanged. First, LEC 1 attempts to learn the MAC address of LEC 3 by broadcasting an IP-ARP request with LEC 3's IP address. As Figure 7.4 shows, this ARP request is sent in two steps: ❶ as a point-to-point message from LEC 1 to the LANE BUS, then ❷ as a point-to-multipoint message from the BUS to all of the LECs registered in the ELAN.

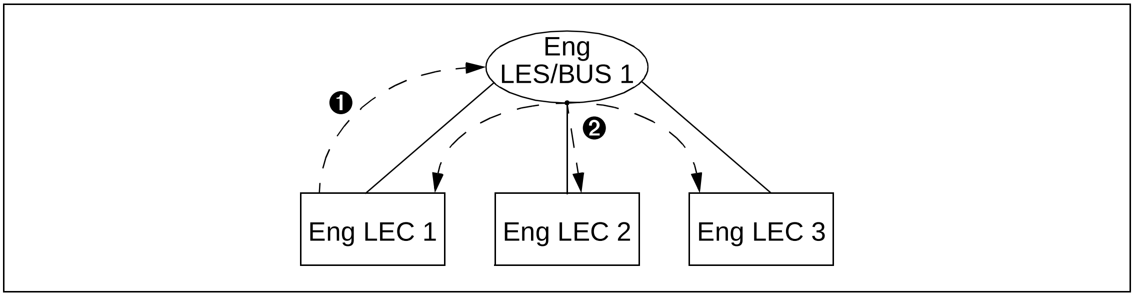

Figure 7.4 - Broadcast IP-ARP Request

When LEC 3 receives the IP ARP request, it recognizes that it is the intended destination, and, therefore, attempts to send an IP ARP response to LEC 1 (whose MAC address was supplied in the ARP request packet).

As shown in Figure 7.5, the delivery of the ARP response is a three-step process: ❸ LEC 3 sends an LE-ARP query to the LES, asking for the ATM address that corresponds to LEC 1's MAC address; ❹ the LES sends an LE-ARP response to LEC 3; and ❺ LEC 3 establishes a circuit to LEC 1's ATM address.

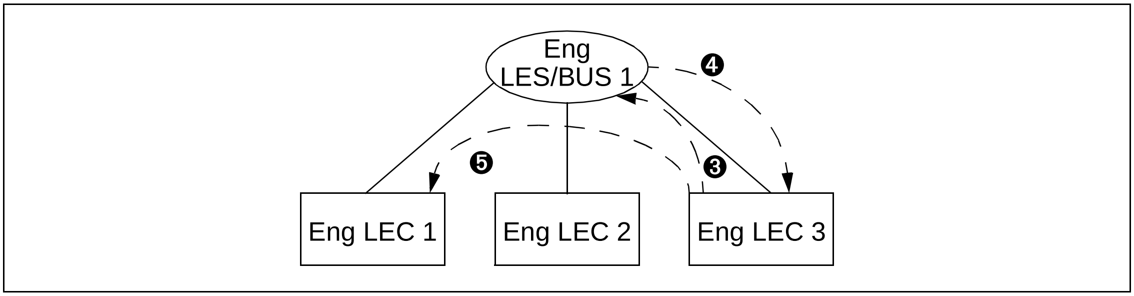

Figure 7.5 - IP ARP Response Handling

7.4.1.2 Limitations of a Single Server

Because there is only one LES/BUS supporting the ELAN, the following limitations exist:

- The number of LECs in a single ELAN is limited by the number of virtual circuits that the single LES/BUS can establish through the platform's ATM port. This usually limits the ELAN to about 500 LECs.
- Clusters of LECs that are geographically separated from the LES/BUS may have poor throughput, even when connecting to each other, because address queries and broadcasts may traverse slow wide-area links.
- A failure of the LES or BUS brings down the ELAN.

7.4.2 Distributed LAN Emulation Model

To address the limitations of the single server model, DLE distributes the LANE services load among a mesh of LES/BUS DLE peer servers, as shown in Figure 7.6.

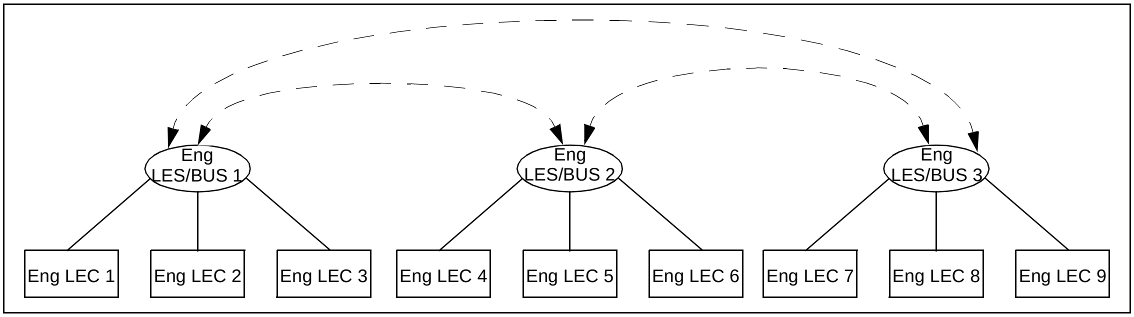

Figure 7.6 - Distributed LAN Emulation Model

Each DLE peer server actually maintains two sets of connections: one is a point-to-multipoint connection to each of its peers for broadcasting multicast data and flooding control information, and the other includes individual point-to-point connections to each peer for directed control traffic.

Each DLE peer server that supports the ELAN is responsible for registering and giving reports about the LECs that are attached to it directly. Each DLE peer server propagates this information to both its locally attached LECs and its peers.

NOTE Each device running a DLE peer server must use *ForeThought* 5.1; however, the DLE peer servers support clients and attached switches using *ForeThought* 4.0, 4.1, 5.0, and third-party devices that are ATM Forum LANE 1.0 compliant.

7.4.2.1 Using DLE

Figure 7.7 shows how a connection begins to be established through DLE peer servers. LEC 1 wants to communicate with LEC 9, which is in the same ELAN, but is locally attached to a different DLE peer server. First, ❶ LEC 1 sends an IP ARP broadcast request to its local DLE BUS. Then, ❷ the BUS broadcasts the packet to both its locally attached LECs and its DLE peer servers.

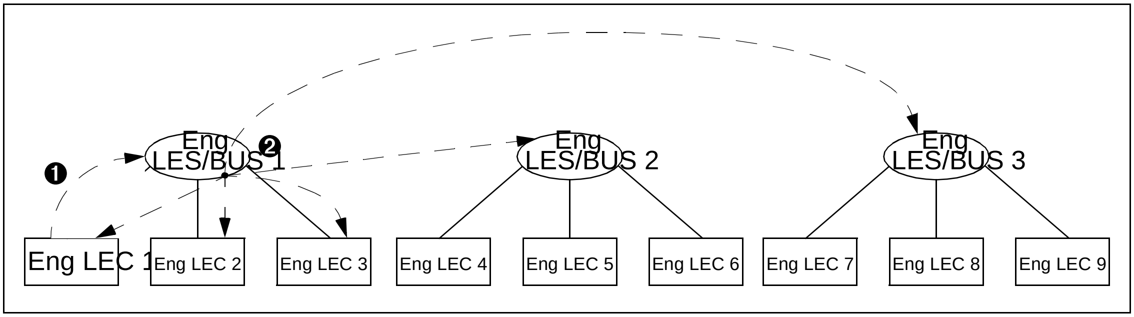

Figure 7.7 - IP ARP Broadcast from LEC 1 to LEC 9

Upon receiving the broadcast from the first DLE peer server, the peers re-distribute the packet to the locally attached LECs ❸, as shown in Figure 7.8, so the packet arrives at its actual destination at LEC 9.

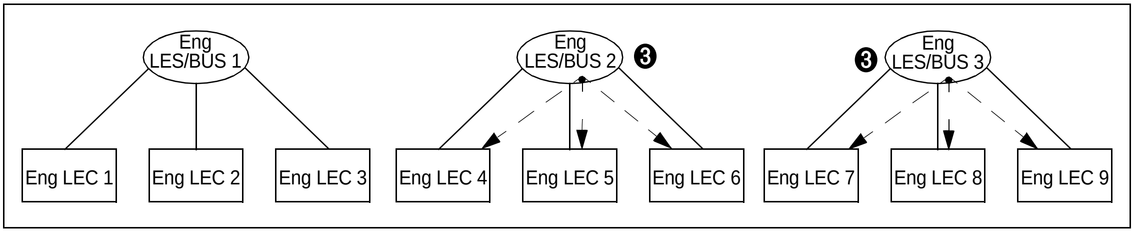

Figure 7.8 - Re-distributing the Broadcast across DLE Peer Servers

NOTE

The peers do not create a loop by re-distributing the packet to other peers.

LEC 9 recognizes its IP address, and prepares an IP ARP response. As shown in Figure 7.9, it then sends an LE-ARP request to its local LES ❹, asking for the ATM address that matches the LEC 1 MAC address. Since LEC 9's local LES does not have an entry for LEC 1, the local LES passes the query along to all of its locally-attached proxy LECs (none are shown in this figure) and all of its DLE peer servers ❺.

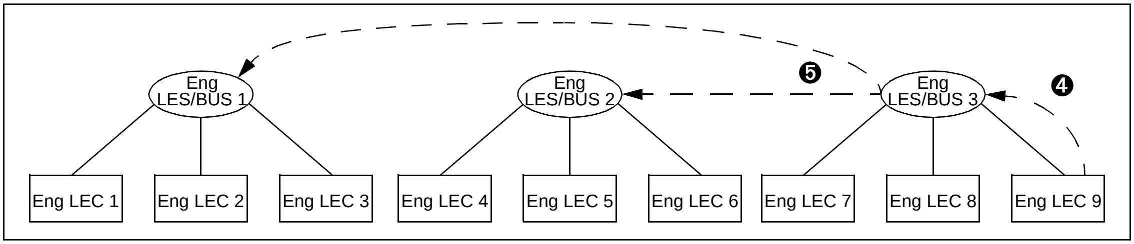

Figure 7.9 - LE-ARP for Unknown Host Sent to Proxies and DLE Peer Servers

In Figure 7.10, the second DLE peer server is attached to two proxy LECs (LEC 4 and LEC 5). When the DLE peer server receives the LE-ARP query, it cannot resolve the query, so the DLE peer server re-distributes the query to the proxy LECs ❻ (but not to the peer servers again, avoiding a loop). Meanwhile, the first peer server has been able to resolve the LE-ARP for the address of LEC 1 and has sent an LE-ARP response to the third server ❼.

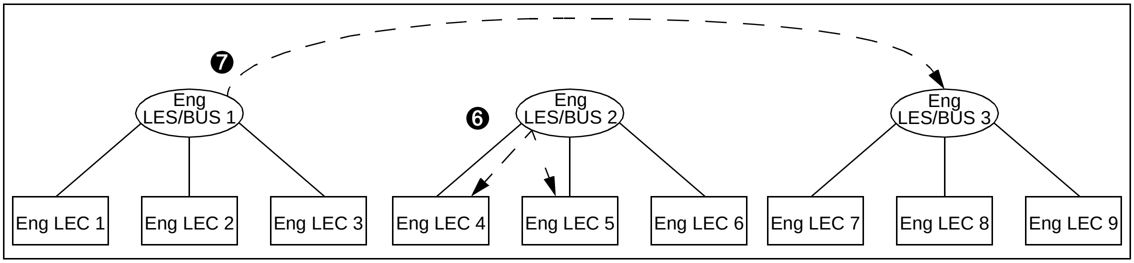

Figure 7.10 - LE-ARP Query Answered by One DLE Peer Server and Re-distributed

When the third DLE peer server receives the LE-ARP response, it passes it directly to LEC 9 ❽ (which sent the original query). The third DLE peer server also caches the registration information for LEC 1 so that other local LECs do not have to go through the entire process again. However, this cache ages out over time. LEC 9 can now open a connection to LEC 1, and send its IP ARP response ❾, as shown in Figure 7.11.

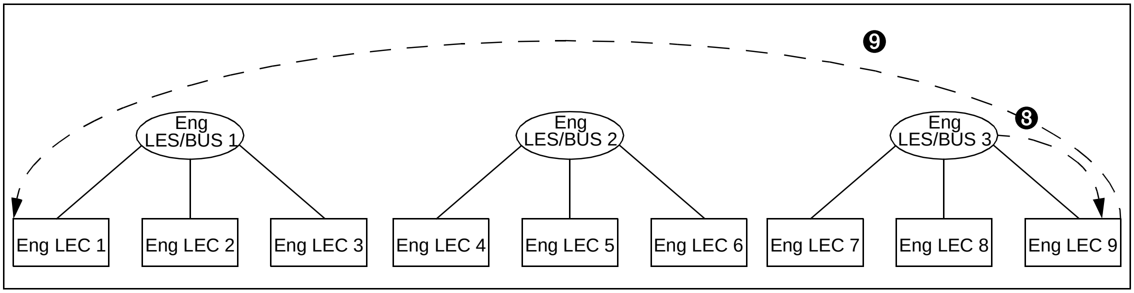

Figure 7.11 - LE-ARP Response Delivered and LEC 9 Contacts LEC 1

7.4.2.2 Advantages of DLE

As mentioned earlier, using DLE provides solutions to the problems of using a single server by providing load sharing, improved performance for remote LECs, and fault tolerance.

7.4.2.2.1 Load Sharing

DLE peer servers distribute the circuit and processing load. The number of LANE LECs is no longer limited by the number of circuits one LES/BUS platform can maintain, since many platforms can support a single ELAN. Also, more VCs are available for use by other applications.

7.4.2.2.2 Improved Performance for Remote LECs

With DLE, broadcast delivery and LE-ARP resolution across peer servers can take a little longer than if all LECs were connected to a single server, since extra processing steps and transmissions are needed. However, ELANs with groups of LECs in different locations can be designed for higher performance by providing a DLE peer server with each group. Broadcasts and address resolution within each group improves.

7.4.2.2.3 Fault Tolerance

Perhaps the most important advantage of DLE is fault tolerance. In a single server ELAN, the server can be a single point of failure. If the server fails, endstations in the ELAN are unable to discover each other through broadcast queries and unable to resolve MAC addresses into ATM addresses. Increased network reliability, therefore, requires that ELANs have backups for LES and BUS functions. To illustrate this point, the single server model is again discussed.

7.4.2.2.3.1 Single Server ELAN

Figure 7.12 shows a single server ELAN composed of nine LECs attached to three different switches. The LECS and the LES/BUS are attached to a host connected to a single switch. The process for LEC 1 to connect to the LANE services takes several steps:

1. LEC 1 asks the signalling software on its switch to open a connection to the "well-known" LECS address. (Other addressing methods could also be used).
2. The signalling software knows that this address is attached to port N (the port on which the host resides on the switch), and opens a circuit between LEC 1 and port N.
3. LEC 1 sends a message to the LECS, asking for the address of the LES for LEC 1's ELAN. The LECS responds with the ATM address of the LES, and LEC 1 establishes a circuit to the LES and then the BUS.

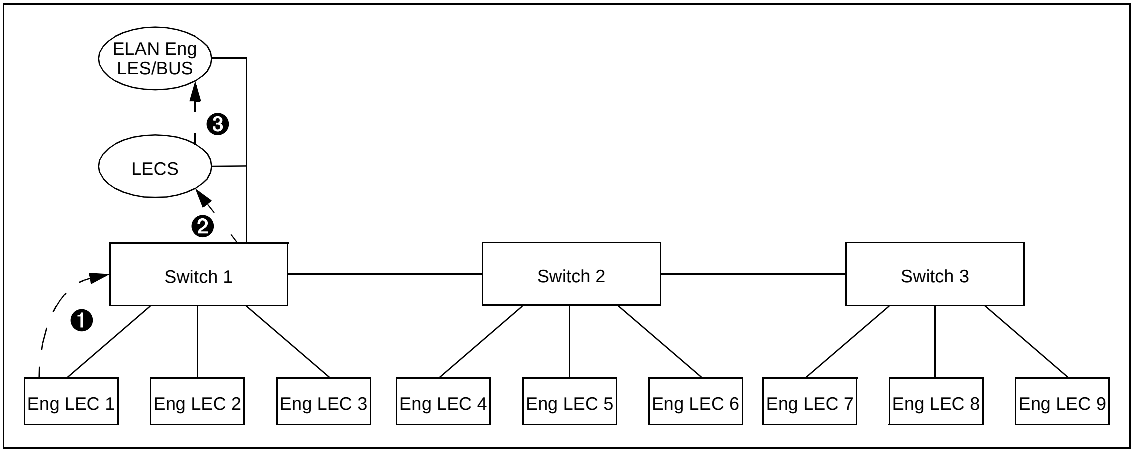

Figure 7.12 - ELAN with Single Server and Multiple Switches Connecting to Services

In Figure 7.13, when LEC 7 goes through the same process, it is slightly more complicated. When LEC 7 asks the local switch signalling software to establish a circuit to the LECS ❶, the local switch must use inter-switch link information (IISP or PNNI tables) to establish a cross-switch circuit to the LECS. Once this circuit is established, however, the process is identical.

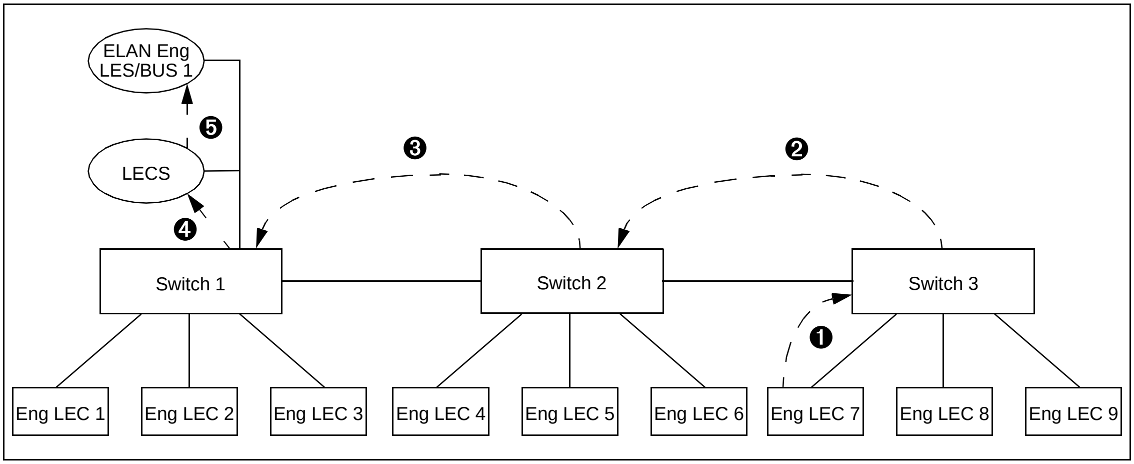

Figure 7.13 - ELAN with Single Server and Remote Connection to Server

Figure 7.14 shows the ELAN in operation after three LECs have gone through the registration process.

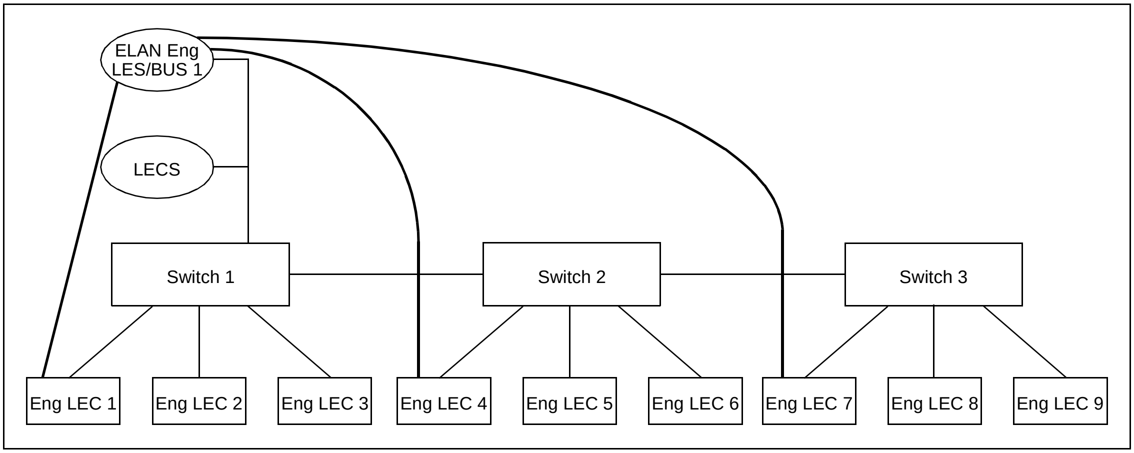

Figure 7.14 - ELAN with Single Server in Operation

If the single server in Figure 7.14 goes down, the entire ELAN goes down. At this point, the administrator must intervene and reconfigure the ELAN.

7.4.2.2.3.2 DLE ELAN

As noted previously, having a single server supporting an ELAN has a potential problem because the server can be a single point of failure. However, DLE can address this problem. By attaching the ELAN LECs to multiple DLE peer servers which communicate with each other as described earlier, the number of LECs affected by a server failure is reduced, and a backup server is provided for affected LECs to use. Figure 7.15 shows the configuration of such an ELAN as three stations register.

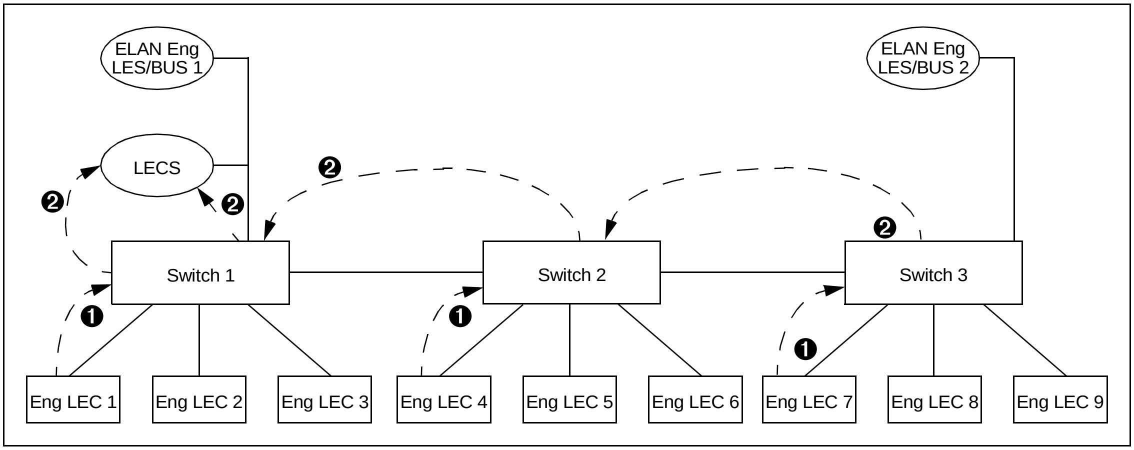

Figure 7.15 - Registrations on an ELAN with Multiple Servers

LECs 1, 4, and 7 are directed by the respective switches to the LECS. The result is shown in Figure 7.16.

NOTE The connection between the two servers carries broadcasts and LE-ARP traffic as described earlier.

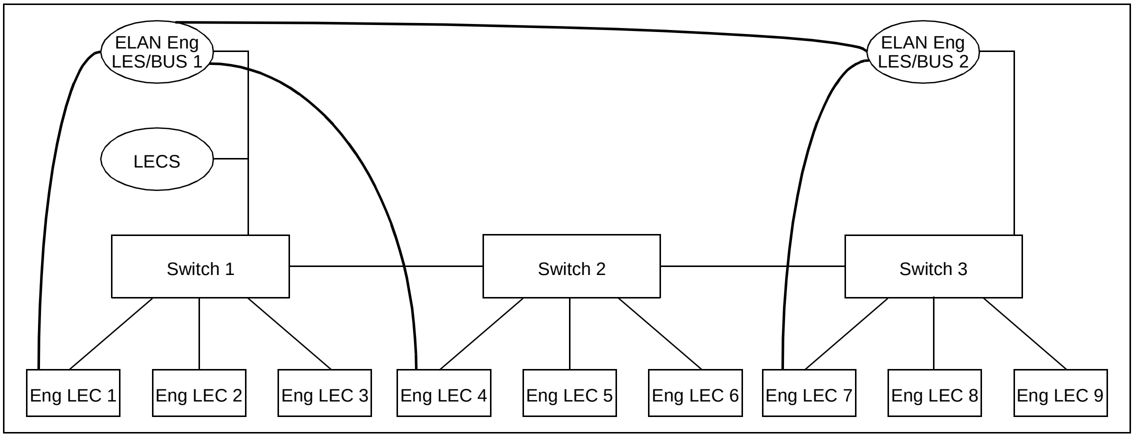

Figure 7.16 - ELAN with Multiple Servers in Operation

This ELAN may experience significant performance improvements for the reasons described earlier. Even if the actual performance is similar to using a single server in a particular network, a great advantage is gained through its fault-tolerance if one of the servers fails as depicted in Figure 7.17.

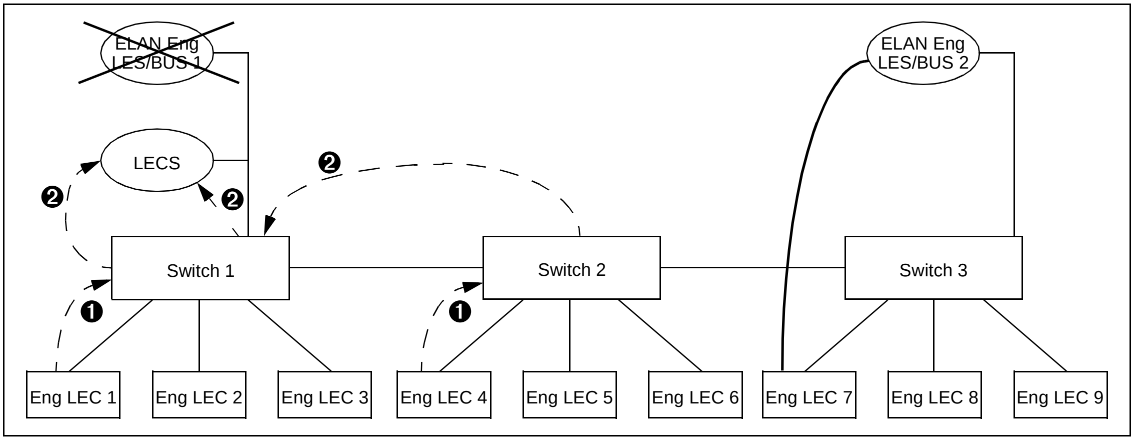

Figure 7.17 - Failure of One ELAN Server and the Recovery Process

Configuring an ELAN

The failure and recovery process occurs as follows:

1. Eng LES/BUS 1 has lost power. All circuits connected to it are torn down. Low-level signalling traffic (e.g., SSCOP messages) stop, and Switch 1 removes the address of Eng LES/BUS 1 from its link tables.
2. LECs 1 and 4 had been connected to Switch 1. They detect that their connections to Eng LES/BUS 1 have been torn down; user intervention is not necessary.
3. LECs 1 and 4 follow LANE 1.0 protocols to locate an LECS to find the address of their ELAN's LES. In this example, they again connect to the LECS.
4. The LECS reports to LECs 1 and 4 that their ELAN server is at ATM address N1. This address is used by every peer LES supporting the ELAN; both Eng LES and Eng LES in this example.
5. LEC 1 sends a request to Switch 1 to establish a connection to address N1. Switch 1 no longer believes it has a direct connection to N1, and instead uses PNNI to establish a circuit through Switches 2 and 3 to Eng LES.
6. LEC 4 sends a request to Switch 2 to establish a connection to N1. Switch 2 may have learned from Switch 1 that it no longer offers a connection to N1, or Switch 2 may attempt a route through Switch 1 and be "bounced back" through ATM Forum PNNI crankback. Either way, Switch 2 finally routes the connection through Switch 3 to Eng LES.

This recovery process occurs quickly -- clients typically recover at a rate of 100 clients per minute -- and the result is a re-configured ELAN as shown in Figure 7.18.

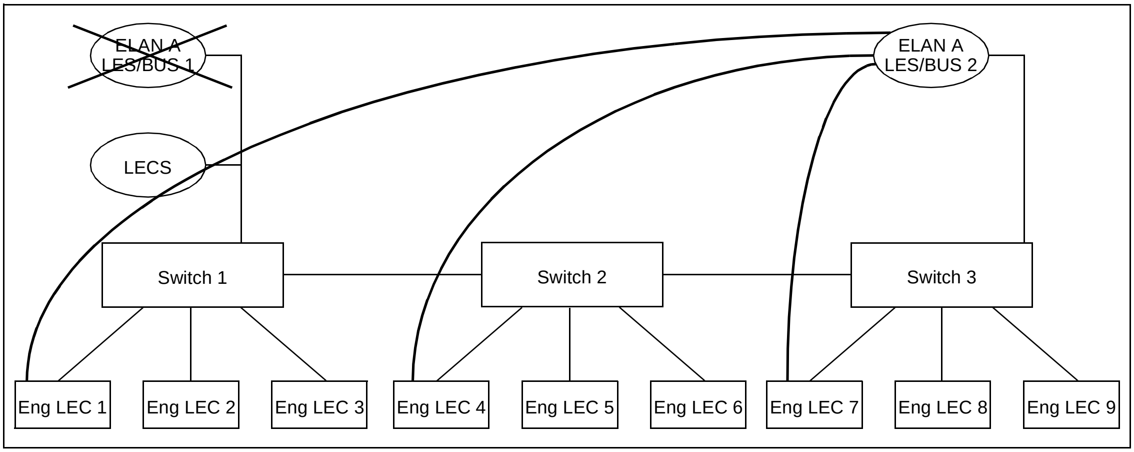

Figure 7.18 - ELAN Re-established Using the Second Server

7.5 Configuring an ELAN

7.5.1 Command-line ELAN Configuration and Administration

There are two methods for configuring an ELAN:

1. using the **configure_atm** script. This method is described in *Chapter 3, Software Installation and Configuration*.
2. at the command line, using the appropriate LAN emulation commands (**elconfig**, **elarp**, **leq**, **lestat**)

Command-line configuration and administration of ELANs is accomplished using the following commands provided with *ForeThought* 5.1: **elconfig, elarp, leq, and lestat**.

NOTE Detailed information about each of these commands may be found in *Chapter 8, Additional Administration Information*, or in the on-line man pages corresponding to each command.

The system administrator should configure the LECs using **elconfig** (Section 7.5.1.1).

Once an ELAN is configured and running, information about it can be obtained by using the **elarp**, **leq**, and **lestat** commands.

The remainder of this section gives a practical example of configuring and administering an ELAN manually using *ForeThought* 5.1.

7.5.1.1 Administering LECs

LECs are controlled from the command line with the **elconfig** command. A detailed explanation of the syntax and usage of **elconfig** is available on-line in the **elconfig** man page, or in this manual in *Chapter 8, Additional Administration Information*.

NOTE LECs configured with **elconfig** require a functioning network interface (for example, **el0**). Refer to *Chapter 4, Network Interface Administration* for information on configuring the appropriate network interface(s).

7.5.1.1.1 Starting a LEC

To start a LEC/MPC that attempts to join ELAN **`engineering`**, enter the following:

`elconfig add engineering`

By default, the above command starts a LEC/MPC (on the local host) that attempts to contact the LECS on a "well-known" address as defined by the ATM Forum's LAN Emulation standards (**`c5.0079.00.000000.0000.0000.0000.00a03e000001.00`** or **`47.0079.00.000000.0000.0000.0000.00a03e000001.00`**). This LEC/MPC, by default, has an ATM address based on the host adapter card's ATM address (an unused selector byte is chosen to make the resulting ATM address unique). Consequently, each LEC/MPC "looks" like just another adapter card to other users on the network. An ATM address can also be assigned to the LEC/MPC. When assigning LEC/MPC ATM addresses manually, be careful to assign each LEC/MPC a unique address.

Similarly, to start a LEC that attempts to join an ELAN already specified for that LEC in the LECS configuration file and that does not act as an MPC, enter the following:

`elconfig add -auto -nompoa`

If a LEC is to use an LECS running at an address other than the well-known address, enter the following:

`elconfig set -lecs` *`<address>`*

where *`<address>`* is the ATM address of the LECS the LEC is to use.

If the LEC is not to use an LECS, enter the following:

`elconfig set -lecs -manual`

In this case, the ATM address of the LES the LEC is to use when starting the LEC must be specified. For example:

`elconfig add engineering -les` *`<address>`*

where *`<address>`* is the ATM address of the LES the LEC is to use.

7.5.1.1.2 Deleting a LEC

ELANs cannot be deleted on platforms running the IRIX operating system.

7.5.1.2 Using elarp

The **elarp** command is used to display and (optionally) delete MAC-to-ATM ARP table entries used in conjunction with ELANs. (ARP table entries that are not related to ELANs may be displayed and controlled with the **arp** command as described in *Chapter 4, Network Interface Administration*.)

7.5.1.2.1 Displaying ARP Table Information

To display all of the current ARP table ELAN-related entries, enter the following:

elarp show -all

Similarly, to display all of the ARP table entries for the **engineering** ELAN, enter:

elarp show -elan engineering

Finally, to display the ARP table entry for a particular host, enter:

elarp show -mac *<MAC_address>*

The following is the format of a typical ARP table entry displayed in response to an **elarp show** command:

```
0:20:48:10:d:65 at 0x45.000580ffe1000000.f215149c002048100d65.02
ELAN=FORE_elan state=valid addrTTL=300 vcTTL=1200 unit=1 vpi/vci=0/49
```

The first line gives the MAC-to-ATM address mapping. The second line gives the name of the ELAN, flag status, the address mapping time-to-live and connection time-to-live (in seconds), and the virtual path and channel identifiers used by the host at the mapped address.

7.5.1.2.2 Deleting ARP Table Information

All ELAN-related ARP table entries may be deleted by entering:

elarp delete -all

This command deletes all ELAN-related dynamic address mappings and closes the corresponding SVCs to all hosts in the table.

Likewise, to delete all ARP table entries associated with the **engineering** ELAN, enter:

elarp delete -elan engineering

Similarly, to delete the ARP table entry for a given MAC address, enter:

elarp delete -mac *<MAC address>*

7.5.1.3 Using leq

Each LES maintains a table containing the MAC addresses registered on the ELAN, together with their corresponding ATM addresses. This table is known as the **LE.ARP** table (similar to a telephone directory). It is this table that provides address information (via the LES) to a LEC when a LEC wishes to communicate with another host whose address it does not know. The **leq** command is a tool used to display ELAN information obtained from the **LE.ARP** table.

An ELAN is identified either by name, or by the address of its LES. If a name is used, the LES address is discovered by **leq** querying the LECS either at the well-known address (default), or at a user-specified LECS address.

If a LES address is used, address arguments to **leq** may be given:

- by specifying the SEL octet of a local address in decimal (e.g., **42**) or hexadecimal (e.g., **0xfa**), or
- by specifying the full 20-octet ATM address of a non-local address with 40 hexadecimal digits and optional period separators where desired (e.g., **47.0005.80.ffe100.0000.f215.0f5b.002048102aef.00**)

Thus, to query and list the MAC to ATM address mappings of all clients registered in the ELAN named **engineering**, enter:

leq engineering

The resulting display would be similar to the following:

```
ELAN Name: "engineering"
00-20-48-10-2a-ef -> 47.0005.80.ffe100.0000.f215.0f5b.002048102aef.00
00-20-48-11-28-9b -> 47.0005.80.ffe100.0000.f21a.01cd.00204811289b.00
00-20-48-11-27-eb -> 47.0005.80.ffe100.0000.f21a.01cd.0020481127eb.00
```

More detailed information about the ELAN may be obtained using the **-l** (long output format) option:

leq -l engineering

NOTE

If DLE has been configured for a given ELAN, the information shown by the **leq** command is that for the LES/BUS peer reached via the anycast address - not those for the entire ELAN.

The resulting display would be similar to the following:

```
% leq -l adapsw
       ELAN Name: "engineering"
              LES:     c5.0005.00.000000.000000007773002048706164.61 (anycast)
              BUS:     47.0005.80.ffe100.0000.f21a.2e71.0020480637ae.e0
              Peer #0: 47.0005.80.ffe100.0000.f21a.2e71.0020480637ae.e0
                     Point-to-Multipoint VCC to Peers: 0.280 (unit 2)
              Peer #1: 47.0005.80.ffe100.0000.f51a.22a9.002048061248.e0
                     Point-to-Point VCC to Peer: 0.213 (unit 1)
                     Point-to-Multipoint VCC from Peer: 0.214 (unit 1)

              LAN Type: Ethernet/IEEE 802.3     Maximum Data Frame Size: 1516
              Non-proxy Control Distribute VCC: 0.240 (unit 2)
                     Proxy Control Distribute VCC: -.- (unit -)
                     Multicast Forward VCC: 0.241 (unit 2)

              Number of local clients: 3

       LEC #1 at 47.0005.80.ffe100.0000.f21a.2e71.0020480637ae.05 (non-proxy)
              02-20-48-06-37-ae -> 47.0005.80.ffe100.0000.f21a.2e71.0020480637ae.05
              Name: mushroom
              MPC Control Address: 47.0005.80.ffe100.0000.f21a.2e71.0020480637ae.02
              Control Direct VCC: 0.351 (unit 0)

       LEC #2 at 47.0005.80.ffe100.0000.f21a.2e71.0020480637ba.01 (non-proxy)
              02-20-48-06-37-ba -> 47.0005.80.ffe100.0000.f21a.2e71.0020480637ba.01
              Control Direct VCC: 0.357 (unit 0)

       LEC #3 at 47.0005.80.ffe100.0000.f21a.2733.002048084001.00 (non-proxy)
              00-20-48-08-40-01 -> 47.0005.80.ffe100.0000.f21a.2733.002048084001.00
              Control Direct VCC: 0.355 (unit 0)
```

This format includes:

- the ATM addresses of the LES and BUS for the ELAN named **engineering.**
- the virtual path and channel identifiers of the Control Distribute VCC. (Recall from the discussion in Section 7.3 that this is the connection that the LES sets up with each LEC in its ELAN.)
- the MAC to ATM address mapping for each LEC in the **engineering** ELAN, together with the virtual path and channel identifiers of the associated Control Direct VCC. (This is the connection that each LEC sets up with the LES.)

7.5.1.4 Using lestat

NOTE If DLE has been configured for a given ELAN, the information shown by the **lestat** command is that for the LES/BUS peer reached via the anycast address - not those for the entire ELAN.

The **lestat** command allows statistics about the LES and BUS for a given ELAN to be displayed. The statistical types are contained in each line of output:

JoinReq Number of LE_JOIN requests handled by the LES.

ARPReq Number of LE_ARP requests handled or forwarded by the LES.

Unknown Number of unexpected LE control frames received (and dropped) by the LES.

UniPkts Number of unicast packets forwarded by the BUS.

UniBytes Number of unicast bytes forwarded by the BUS.

MulPkts Number of multicast packets forwarded by the BUS.

MulBytes Number of multicast bytes forwarded by the BUS.

FlshRq Number of LE_FLUSH requests handled by the BUS.

Unknown Number of other LE control frames received (and dropped) by the BUS.

For example, entering:

```
lestat engineering
```

results in the display of the LES and BUS statistics (i.e., the absolute values of the counters) for the *engineering* ELAN up to the point in time at which the **lestat** command was issued.

Similarly, statistics for a specified ELAN can be updated and displayed at regular intervals. For example, entering:

```
lestat engineering 30
```

displays the absolute values of the LES and BUS counters for the *engineering* ELAN at the point in time at which the **lestat** command was issued, followed every 30 seconds by display of the *differences* in value between successive readings.

CHAPTER 8 Additional Administration Information

8.1 Additional Software and Manual Pages

The *ForeThought* 5.1 release contains administrative and example programs, along with on-line manual pages.

NOTE

The installation locations of the *ForeThought* 5.1 utilities and **man** pages differ from previous releases. Be sure to remove older versions of these and/or set paths to reference the *ForeThought* 5.1 utilities and **man** pages before attempting to access the new versions.

8.2 Administrative Programs

Table 8.1 lists the administrative programs and man pages included with this release. The man pages are reproduced on the following pages.

Table 8.1 - *ForeThought* 5.1 Administrative Programs and Manual Pages

Module	Man Page	Description	Device
FOREDrv	adconfig(8)	Provides a tool to display and modify the current configuration of an ATM device.	fatm*x*
	adinfo(8)	Provides a tool to display information about ATM devices. The information displayed includes the device driver version, the device type, the media type, the hardware version, the firmware version (if applicable), the serial number, the slot number, and the MAC address.	
	adstat(8)	Displays physical layer (TAXI, OC3), ATM layer, ATM Adaptation Layer (AAL), and device specific counters gathered by the ATM device driver.	
FOREip	atmarp(8)	Shows and manipulates FORE IP Address Resolution Protocol (ARP) entries maintained by the adapter's device driver. This is also used to establish PVC connections.	fa*x*
	atmconfig(8)	Used to enable or disable SPANS signalling, MTU size and various other parameters.	
FOREcore	atm_snmpd(8)	SNMP agent for FORE Systems devices which implements MIB-II and FORE Systems' MIBs for ATM computer interfaces and switches.	
FOREclip	cliparp(8)	A tool for viewing and modifying Classical IP (CLIP) ARP and connection caches. It also may be used to create and delete PVCs.	ci*x*
	clipconfig(8)	A tool for displaying and modifying FORE Systems' CLIP configuration. It may also be used to create, delete, and display CLIP interfaces and ARP server addresses.	
FOREmpoa	elarp(8)	Shows and manipulates MAC and ATM address mappings for LAN Emulation Clients (LECs).	el*x*

Table 8.1 - *ForeThought* 5.1 Administrative Programs and Manual Pages *(Continued)*

Module	Man Page	Description	Device
	elconfig(8)	Shows and modifies LEC configuration. Allows the user to set the ATM address of the LAN Emulation Configuration Server (LECS), display the list of Emulated LANs (ELANs) configured in the LECS for this host, display a list of ELANs locally configured along with the membership state of each, and locally administer ELAN membership.	
	lappqos(8)	Provides a tool for associating legacy application flows with VCs. This allows the user to specify such parameters as QoS and VC sharing. The tool can be used to enter flow descriptors or display flow descriptors and their currently associated VCs. **lappqos** can also be used to specify default parameters for MPOA shortcut setup and teardown thresholds.	
	leq(8)	Provides information about ELANs. This information is obtained from the LES, and includes MAC addresses registered on the ELAN together with their corresponding ATM addresses.	
	lestat(8)	Provides statistical information about the LES/BUS.	
FOREuni	uniconfig(8)	Provides a tool to display/modify the current UNI configuration of an ATM device.	

8.2.1 adconfig(8)

```
NAME
     adconfig - Configuration tool for FORE ATM devices

SYNOPSIS
     adconfig device

     adconfig -p vpi-bits device

     adconfig -f sonet | sdh device

     adconfig -c internal | external device

     adconfig -s on | off device

     adconfig -i idle | unassigned device

     adconfig -l on | off device

DESCRIPTION
     adconfig is a tool to display and modify the current  confi-
     guration  of  an  ATM device.  If no action is indicated for
     the specified device, the configuration information for  the
     device is displayed.

     The physical  media  device  (PMD)  configuration  displayed
     includes  the current framing used, the device clock source,
     the state of scrambling, the cell insertion  type,  and  the
     loopback state.

OPTIONS
     -p    Specifies the  number  of  least-significant  bits  to
          match  in  the  VPI  field of the ATM cell header.  The
          number of VCI bits is computed automatically based upon
          the  number  of VPI bits specified and the total number
          of VPI/VCI bits supported by the adapter.

     -f    Set PMD framing type to  SONET  or  SDH.   Default  is
          SONET.

     -c    Set PMD clock source to internal or external.  Default
          is internal.
```

```
     -s    Enable or disable PMD scrambling.  Default is enabled.

     -i    Set PMD to insert idle cells (ITU-T standard) or unas-
          signed cells (ATM Forum and ANSI standard).  Default is
          unassigned.

     -l    Enable or disable PMD internal loopback mode.  Default
          is disabled.

RESTRICTIONS
     It is not possible to set the number of VPI  bits  on  200E-
     series adapters.

NOTES
     Modifying PMD 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
     ForeThought_5.1
```

8.2.2 adinfo(8)

```
NAME
     adinfo - show FORE Systems’ ATM device information

SYNOPSIS
     adinfo [ device ]
     adinfo -c

DESCRIPTION
     adinfo is a tool to display information about  ATM  devices,
     or  the  copyright notice if the -c option is specified.  If
     device is given, then information about the specified device
     is  displayed.   Otherwise, information is displayed for all
     ATM devices.

     The information displayed includes the  device  driver  ver-
     sion, the device type, the media type, the hardware version,
     the firmware version (if applicable), the serial number, the
     slot number, and the MAC address.

OPTIONS
     -c    Display the FORE copyright notice.

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

RELEASE
     ForeThought_5.1
```

8.2.3 adstat(8)

NAME

adstat - show FORE Systems' ATM device driver statistics

SYNOPSIS

adstat [-poa045d] device [interval]

DESCRIPTION

The adstat program displays Physical layer, ATM layer, ATM Adaptation Layer (AAL), and device specific counters gathered by the ATM device driver.

The device argument is the name of the ATM device, for example fatm1. If interval is specified, adstat summarizes activity during each interval- second period. Only a single layer may be selected when specifying an interval. The fields of adstat's display are as follows:

Output Cells	Number of cells transmitted by the ATM device driver.
Input Cells	Number of cells received by the ATM device driver.
Framing	Numbers of cells received with bad framing.
Hdr-CRC	Number of cells received with bad header CRC.
VPI-OOR	Number of cells received with out of range VPI.
VPI-NoC	Number of cells received for a disconnected VP.
VCI-OOR	Number of cells received with out of range VCI.
VCI-NoC	Number of cells received for a disconnected VC.
Drops	Number of cells dropped due to lack of buffer space or queue overflow.

Congestn	Number of AAL 5 CS-PDUs dropped due to cells lost or gained as a result of network congestion.
CS-PDUs	Number of PDU’s to (input) or from (output) CS-sublayer.
CSProto	Number of CS-PDU’s received with protocol errors.
Pay-CRC	Number of cells (AAL 4) or CS-PDUs (AAL 5) received with bad payload CRC.
SARProto	Number of cells received with SAR protocol errors.
Section BIP	Number of PMD section layer BIP errors detected in STS stream.
Path BIP	Number of PMD path layer BIP errors detected in STS stream.
Line BIP	Number of PMD line layer BIP errors detected in STS stream.
Line FEBE	Number of PMD line layer FEBE errors detected in STS stream.
Path FEBE	Number of PMD path layer FEBE errors detected in STS stream.
Corr HCS	Number of cells received with correctable HCS.
Uncorr HCS	Number of cells received with uncorrectable HCS.
Buffer Allocation Failures	Number of times a buffer of the required size and type was unavailable. The type and size of small and large buffers is adapter and platform dependent.

```
     Receive Queue Full
                    Number of cells dropped due to a full receive
                    queue.

     Carrier        Indicates that a carrier has been detected on
                    the receive line.

OPTIONS
     -p              Display physical layer statistics.

     -o              Display physical media  device  (PMD)  error
                    statistics.

     -a              Display ATM layer statistics.

     -0              Display  statistics  about  ''null''   AAL
                     traffic.

     -4              Display statistics about AAL 4 traffic.

     -5              Display statistics about AAL 5 traffic.

     -d              Display device specific statistics.

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

RELEASE
     ForeThought_5.1
```

8.2.4 atmarp(8)

```
NAME
     atmarp - manipulate FORE IP Internet to ATM address mappings

SYNOPSIS
     atmarp [ -N ] hostname

     atmarp [ -N ] -a

     atmarp -s hostname if vpi vci aal [encapsulation] [peak]

     atmarp -l if vpi vci aal [decapsulation]

     atmarp -d hostname

     atmarp -x if vpi vci

     atmarp -f

     atmarp -m if vpi vci aal [encapsulation] [peak]

     atmarp -u

DESCRIPTION
     The atmarp program displays and deletes  FORE  IP  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 spe-
     cial  applications  which may require the use of PVCs for IP
     traffic.  This program does not actually control  the  crea-
     tion 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  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.

-s	Set ARP entry for outgoing Permanent Virtual Channel (PVC). All traffic to hostname will be encapsulated based on encapsulation and sent via the FORE IP interface if on VPI vpi, VCI vci, using AAL type aal. The interface if must be a FORE IP interface, typically faX. Specifying peak will limit all traffic to hostname to peak kilobits per second. If peak is not specified, no traffic shaping is applied.
-l	Attach IP to an incoming PVC. All traffic received on the FORE IP interface if with VPI vpi, VCI vci, and AAL type aal will be decapsulated based upon decapsulation and handed up to IP. The interface if must be a FORE IP interface, typically faX.
-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.
-x	Detach IP from an incoming SVC or PVC. IP traffic will no longer be accepted on the specified VPI and VCI.
-f	Delete all dynamic address mappings from the ATM ARP table and close all Switched Virtual Circuits (SVCs) to all hosts in the table.
-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 FORE IP interface if 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 speci-
                    fied, no traffic shaping 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.

NOTES
     The allowed values for vpi, vci, aal, and peak  will  depend
     on  the  capabilities  of  the ATM adapter used by the given
     interface if In addition, certain adapters may only  support
     discrete  peak  cell  rates.  If so, the rate will be set to
     the closest supported rate which is less than the  specified
     rate.

     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).

RELEASE
     ForeThought_5.1

SEE ALSO
     arp(1M),
```

8.2.5 atmconfig(8)

```
NAME
     atmconfig - FORE IP configuration tool

SYNOPSIS
     atmconfig device

     atmconfig -m mtu device

     atmconfig -q peak | off device

     atmconfig -b on | off

     atmconfig -g seconds

     atmconfig -h seconds

     atmconfig -c vpi vci aal [ peak ] device

     atmconfig -s vpi vci aal [ peak ] device

DESCRIPTION
     atmconfig is a tool to display and modify the  current  FORE
     IP  configuration.  If no action is indicated for the speci-
     fied device, the configuration information for the device is
     displayed.  Configuration information includes the interface
     MTU, the peak rate used by SVCs, the VC parameters  for  the
     FORE IP connectionless and SPANS signalling VCs, and FORE IP
     load balancing/failover information.

     The load balancing information includes the state of FORE IP
     load  balancing,  automatic  failover  parameters,  and  the
     dynamically determined failover groups.  All units within  a
     set  of parentheses belong to the same failover group.  If a
     unit number is followed by an asterisk  then  that  unit  is
     current inoperational.

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

     -q    Set/disable SVC rate shaping on the specified  device.
```

```
     The peak rate is specified in kilobits per second.

-b    Enable/disable IP load balancing.  When load balancing
     is enabled, all IP traffic traveling over SVCs and des-
     tined 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.

-g    Set the automatic failover validation interval,  which
     is the frequency at which the network interface is ver-
     ified to be operational.  The default is 5 seconds.

-h    Set the automatic failover duration, which is the max-
     imum  time  spent  verifying  an interface before it is
     declared down.  The default is 10 seconds.

-c    Set FORE IP connectionless VC parameters for the given
     device.   The  connectionless  VC will use VPI vpi, VCI
     vci, and AAL type aal. If peak  is  specified,  traffic
     sent  on  the  VC  will  be shaped to peak kilobits per
     second.

-s    Set SPANS signalling VC parameters for the given  dev-
     ice.   The signalling VC will use VPI vpi, VCI vci, and
     AAL type aal. If peak is specified, traffic sent on the
     VC will be shaped to peak kilobits per second.

NOTES
     The allowed values for vpi, vci, aal, and peak  will  depend
     on  the  capabilities  of  the ATM adapter used by the given
     interface.  In addition, certain adapters may  only  support
     discrete  peak  cell  rates.  If so, the rate will be set to
     the closest supported rate which is less than the  specified
     rate.

     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.
```

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

Using a shorter failover validation interval allows failure conditions to be detected more quickly, but more host and network resources are consumed due to frequent revalidation.

Using a shorter failover retry duration allows failure conditions to be detected more quickly, but there is a higher probability of “false” failure conditions on busy hosts. Setting a longer duration allows hosts to endure heavier traffic without indicating a failure condition, but takes longer to detect real failure conditions.

RELEASE

ForeThought_5.1

SEE ALSO

atmarp(8)

8.2.6 atm_snmpd(8)

```
NAME
     atm_snmpd - SNMP agent for FORE Systems’ ATM devices

SYNOPSIS
     snmpd [ -c cdb_file ] [ -d ] [ -f ] [ -h ] [ -i ]
           [ -l unit_list ] [ -m comm_file ] [ -n ] [ -p port ]
           [ -s ]

DESCRIPTION
     snmpd is an SNMP agent for FORE Systems’  ATM  devices.   It
     implements  MIB-II, plus FORE Systems’ MIBs for ATM computer
     interfaces and switches.

     On a workstation equipped with FORE Systems  ATM  interface,
     it also performs ATM Address Registration using ILMI.

     On a Solaris workstation  with  Solstice  Enterprise  Master
     SNMP agent, it also can run as a subagent.

     On a workstation equipped with a FORE Systems ATM interface,
     snmpd should be started at system initialization time.

     FORE Systems’ ATM switches are configured to  run  snmpd  as
     shipped; no additional installation is required.

OPTIONS
     -c cdb_file
          Use cdb_file as the cdb configuration file.
     -d    Display a hexadecimal dump of  the  contents  of  each
          SNMP packet on the standard output.
     -f    Run the agent in the foreground rather than forking  a
          background process and exiting.
     -h    Display the usage line for the snmpd and exit.
     -i    Run only as ILMI agent for performing  Address  Regis-
          tration.
     -l    Specify a space seperated list of units that use  ILMI
          for address registration.
     -m    Use comm_file as the SNMP community string  configura-
          tion file.
     -n    Run only as SNMP agent and do not perform ILMI Address
          Registration.
```

-p port

Use port as the UDP port to listen on, instead of the standard SNMP port.

-s Run the agent as a subagent of Solstice Enterprise Master Agent. This option is only available on SunOS platforms.

FILE

Community string configuration file defines the community strings for SNMP “get” and “set” queries and the hosts that have permission for the queries. The configuration file consists of a sequence of lines. Each line is in one of the following formats:

get: <community_string>

set: <community_string>

set-ip: <ip_address> [, address_mask]

get-ip: <ip_address> [, address_mask]

<community_string> is a character string up to 32 characters; <ip_address> is either a host or a subnet ip address in dot decimal format. <address_mask> determines if <ip_address> is a host or a subnet IP address; if it is a host IP address, <address_mask> is either 0xffffff or 255.255.255.255; otherwise it is the corresponding subnet mask. By default, <address_mask> is 0xffffff. All the IP addresses of set-ip also have the “get” permission as those addresses of get-ip.
There can be only one line for the community string and multiple lines of IP addresses. Any text after a ‘#’ is treated as comment and ignored.

ERRORS

bind: Address already in use

This indicates that another SNMP agent is already running. snmpd cannot coexist with other vendors’ SNMP agents.

RELEASE

ForeThought_5.1

8.2.7 cliparp(8)

```
NAME
     cliparp - display or manipulate Classical  IP  address  map-
     pings and PVCs

SYNOPSIS
     cliparp show [ interface ] [ -n ]

     cliparp add -pvc vpi vci llc_encap interface [ host ]
                      [ -reval revalidation_time ]
                      [[-qos ubr -pcr PCR ] |
                       [-qos cbr -pcr PCR ] |
                       [-qos abr -pcr PCR [-mcr MCR] [-icr ICR]]]

     cliparp add -address host atm_addr interface

     cliparp delete -all | interface |
                    -address host interface |
                    -pvc vpi vci interface

     where llc_encap is ( llc_bridged dst_mac_addr | llc_routed )

DESCRIPTION
     cliparp is a tool for viewing  and  modifying  Classical  IP
     (CLIP)  ARP  and  connection caches.  It also can be used to
     create and delete PVCs.

COMMANDS
     show           The show command allows the user  to  display
                    any CLIP ARP or connection cache entries.  If
                    interface is provided, only cache entries  on
                    that network interface are displayed.  Other-
                    wise, all CLIP cache entries on  all  network
                    interfaces on the host are displayed.  The -n
                    flag will  prevent  attempts  to  print  host
                    names  symbolically  and  only  display  them
                    numerically.

     add -pvc        Allows the user to create a CLIP  PVC.   The
                    PVC  is  created on the adapter of the speci-
                    fied   network   interface    using    either
                    llc_routed  or llc_bridged encapsulation.  If
```

```
                    bridged, the destination MAC address must  be
                    provided.   If the address of the peer, host,
                    is not specified, an attempt will be made  to
                    inverse  ARP  for it.  Use the -reval flag to
                    enable revalidation.  revalidation_time is in
                    minutes.   The  optional -qos flag allows the
                    user to specify QoS parameters. See below for
                    a  discussion  of QoS parameters. Please note
                    that a PVC will only be deleted with the cli-
                    parp  delete  -pvc  option,  and not with any
                    other cliparp delete options.

     add -address    Allows the user to manually specify  a  host
                    to ATM address mapping.

     delete         The delete command allows the user to  delete
                    CLIP  ARP and connection cache entries.  If -
                    all is specified then all of the  CLIP  cache
                    entries  on  every  configured  interface are
                    deleted except for PVCs  and  manually  added
                    ARP  entries.  If interface is specified, all
                    of the non-static SVC cache entries  on  that
                    network  interface are deleted.  If a host is
                    given, then any non-static SVC cache  entries
                    associated with that host on the given inter-
                    face are deleted.

QOS PARAMETERS
     A user may optionally specify QoS parameters  when  creating
     PVCs  by using the -qos flag.  The supported values for -qos
     are the classes ubr (Unspecified Bit  Rate),  cbr  (Constant
     Bit  Rate)  and  abr  (Available Bit Rate). However, all the
     adapters may not support all the classes  of  service.   The
     allowed  values  for  QoS will depend on the capabilities of
     the ATM adapter used by the given interface.   In  addition,
     certain  adapters may only support discrete peak cell rates.
     If so, the rate will be set to the  closest  supported  rate
     which is less than the specified rate.

     All the classes require a mandatory  pcr  (peak  cell  rate)
     value, which is the peak rate in kilobits per second for the
     connection.  A ubr connection with a pcr differs from a  cbr
     connection with a pcr in that there is no reserved bandwidth
```

for the ubr connection.

In addition to the pcr, an abr connection can optionally take a mcr (minimum cell rate) and icr (initial cell rate) which are rates expressed in kilobits per second. The default value for mcr is 0 and the default value for icr is pcr.

Any attempt to over allocate the bandwidth or supply inappropriate parameters will be rejected. Not specifying any QoS Parameters will result in the PVC being treated as an ubr connection with unlimited rate.

RELEASE

ForeThought_5.1

SEE ALSO

arp(1M),clipconfig(8),cliparpd(8)

8.2.8 clipconfig(8)

```
NAME
     clipconfig - Classical IP configuration tool

SYNOPSIS
     clipconfig show [ interface ]

     clipconfig add [ -if interface ] [ -unit unit ] [ -mtu mtu ]
                    [ -arpserver wellknown | atm_addr ]

     clipconfig set interface [ -mtu mtu ]
                    [ -arpserver wellknown | atm_addr ] |
                    [ -pvcsonly ]

     clipconfig delete interface

DESCRIPTION
     clipconfig is a tool to display  and  modify  FORE  Systems'
     Classical  IP  (CLIP)  configuration.   It  can  be  used to
     create, delete, or display CLIP interfaces  and  ARP  Server
     addresses.

COMMANDS
     show           The  show  command  displays   all   of   the
                    currently  configured  CLIP interfaces.  This
                    information includes the local  ATM  address,
                    the  ARP  Server's ATM address and connection
                    information, and the interface name.  If  the
                    interface name is specified, only information
                    about that particular interface is shown.

     add            The add  command  allows  the  super-user  to
                    create a CLIP interface.  The -arpserver flag
                    can be used to specify the ARP  Server's  ATM
                    address.   Specifying  the  keyword wellknown
                    will use the well-known ARP  server  address.
                    If  an ARP Server is not given, it is assumed
                    that the interface will  be  used  with  PVCs
                    only.   The -if and -mtu flags can be used to
                    set the network interface name and  its  MTU.
                    The default MTU is 9180.
```

Additional Administration Information

```
set            The set  command  allows  the  super-user  to
               modify  an  existing  CLIP  interface.  The -
               arpserver flag can be used to specify  a  new
               ARP Server, or the -pvcsonly flag can be used
               to specify that no ARP server will be used on
               the  interface.  Specifying the keyword well-
               known with -arpserver will use the well-known
               ARP  server  address.   The  -mtu flag can be
               used to set a new MTU.

delete         The delete command allows the  super-user  to
               delete a CLIP network interface.  Only inter-
               face must be provided.
```

NOTES

The -unit flag is mandatory when adding a new interface if there is more than one adapter installed.
The well-known ARP server address as used in add/set commands is 47.0079.00.010200.0000.0000.0000.00a03e000002.00.

RESTRICTIONS

On Solaris systems a CLIP interface can be deleted only when there are no longer users attached through DLPI. For attached protocols, the associated interface must first be configured “down” through ifconfig(1M). If the user attempts to delete a CLIP interface which has any DLPI user, the message ‘clipconfig: CLIP interface in use’ will be displayed.

On SGI IRIX systems, deletion of a CLIP interface is not supported.

On all other systems, the CLIP interface must first be configured “down” through ifconfig(1M) before deletion. If the user attempts to delete a CLIP interface which is “up”, the message ‘clipconfig: CLIP interface in use’ will be displayed.

RELEASE

ForeThought_5.1

SEE ALSO

ifconfig(1M),cliparp(8),cliparpd(8)

8.2.9 elarp(8)

```
NAME
     elarp - display or manipulate MAC to ATM address mappings

SYNOPSIS
     elarp show [ -elan elan | -mac mac | -mpc | -mps ]
                [ -layer3 ] [ -unit unit ]

     elarp delete -all | -elan elan | -mac mac
                  [ -unit unit ]

DESCRIPTION
     elarp is a tool to display and delete MAC-to-ATM address ARP
     cache entries and associated Switch Virtual Circuits (SVCs).
     Used in conjunction with the ATM Forum LAN Emulation  Client
     (LEC).   If  the LEC is configured with MPOA enabled, it can
     also display IP-to-ATM  ingress  and  egress  address  cache
     entries  as  well  as  the ATM addresses of other known MPOA
     Clients (MPC) and Servers (MPS).
COMMANDS
     show           The -elan flag will display all LANE and MPOA
                    ARP  entries  for elan elan. If the -mac flag
                    is used, the ARP entry for MAC address MAC is
                    displayed.  The time to live (TTL) in seconds
                    for both the connections and address mappings
                    are displayed.  If the -mpc flag is used, all
                    MPCs discovered  are  displayed.   Similarly,
                    the   -mps flag displays all MPSs discovered.
                    If no flags are given, all current  LANE  and
                    MPOA  ARP  entries  are  displayed.  If the -
                    layer3 option is specified, the layer 3  (IP)
                    address  to  MAC address ARP entries are also
                    displayed.  If more than one MAC  address  is
                    associated  with an ATM address, then all the
                    MAC-to-ATM address mappings are  shown  in  a
                    single entry.
     delete         The -all and - elan  flags  will  delete  all
                    dynamic  address  mappings from the ARP cache
                    and close all SVCs to all hosts in the cache,
                    or all hosts on elan elan, respectively.  The
                    -mac flag  will  delete  the  single  dynamic
                    address mapping and SVC for MAC.
```

```
EXAMPLE
     The following examples display an address mapping for a host
     on elan FORE_elan.

     % elarp show -elan FORE_elan
     0:20:48:10:d:65 at 0x45.000580ffe1000000.f215149c002048100d65.02
          ELAN=FORE_elan state=valid addrTTL=300 vcTTL=1200 unit=1 vpi/vci=0/49

     % elarp show -elan FORE_elan -layer3
     FORE_host (11.3.1.69) at 0:20:48:10:d:65
          at 0x45.000580ffe1000000.f215149c002048100d65.02
          ELAN=FORE_elan state=valid addrTTL=300 vcTTL=1200 unit=1 vpi/vci=0/49

     % elarp show -all
     8:0:9:e3:44:d0
     8:0:20:7a:c2:8d
     8:0:20:78:ef:9a at 0x47.0005.80.ffe100.0000.f21a.264c.00a0360081da.00
            ELAN=FORE_elan state=valid addrTTL=176 vcTTL=922 unit=1 vpi/vci=0/291

     The following examples display MPOA information for a host with
     MPOA enabled.

     % elarp show -elan FORE_elan
     169.200.20.50/0xffffffff -> 169.200.10.39
          at 0x47.0005.80.ffe100.0000.f21a.35fa.002048081a47.01
          ELAN=test1 vcState=open unit=1 vpi/vci=0/150
          IngressState=valid TTL=444
          EgressState=valid

     % elarp show -mpc
     test1: 00:20:48:1C:12:1D at
               0x47.0005.80.ffe100.0000.f21c.121d.0020481c121d.10
     test1: 00:20:48:06:12:AC at
               0x47.0005.80.ffe100.0000.f51a.2260.0020480612ac.01

     % elarp show -mps -layer3
     test1: host1 (169.144.233.1) at 00:20:48:1C:12:1D at
               0x47.0005.80.ffe100.0000.f21c.121d.0020481c121d.10

RELEASE
     ForeThought_5.1
SEE ALSO
     arp(1M)
```

8.2.10 elconfig(8)

```
NAME
     elconfig - ATM Forum LAN Emulation configuration tool

SYNOPSIS
     elconfig show [ elan | -auto | -configured | -lecs ]
                  [ -unit unit ]

     elconfig add elan | -auto [ -unit unit ] [ -if interface ]
                 [ -les ATMaddress ] [ -nompoa ]
                 [ -type token-ring | ethernet ]

     elconfig delete elan | -auto | -lecs [ -unit unit ]

     elconfig set -lecs ATMaddress | -wellknown | -manual
                       [ -unit unit ]
DESCRIPTION
     elconfig is a tool to display and modify FORE  Systems'  ATM
     Forum  LAN Emulation Client (LEC) and MPOA Client (MPC) con-
     figurations.  elconfig allows the super-user to set the  ATM
     address  of  the  LAN Emulation Configuration Server (LECS),
     display the list of Emulated LANs (ELANs) configured in  the
     LECS  for  this host, display the list of ELANs locally con-
     figured along with the membership state of each, and locally
     administer ELAN membership.

COMMANDS
     show           The -configured flag is used to  display  the
                    name,  the  ATM addresses of the LE Services,
                    local ATM  addresses  of  the  LEC  and  MPC,
                    specific ELAN information, and the local net-
                    work interface name of  each  ELAN  currently
                    configured  in the system.  Since the LE Ser-
                    vices' ATM addresses may be acquired  dynami-
                    cally,  only  those  addresses that have been
                    learned will be displayed.  In  addition,  if
                    connections  exist  to  the  LE Services, the
                    VPI/VCI  pairs  for   each   connection   are
                    displayed.   Alternatively,  a  single ELAN's
                    configuration information may be displayed by
                    specifying   the  single  argument  elan.  To
                    retrieve the ATM address of the current LECS,
```

Additional Administration Information

	the - lecs flag is used. If no options are given, the name and ATM address of the LES for each ELAN returned by the LECS are displayed.
add	The add command enables the user to join a particular ELAN and specify certain configuration parameters. The -auto flag is used to instruct the LEC to join the ELAN that is returned by the LECS. The -if flag maps elan to the network interface (e.g. el0), providing a mapping between ELAN name and network interface name. The -les flag allows the specification of the LES's ATM address as ATMaddress for joining ELANs whose configuration information is not returned by an LECS. The -type option is used to specify the ELAN type: ethernet or token-ring. By default, the ELAN interface will present itself as an MPOA client with the ability to set up inter-ELAN shortcut VCs. The -nompoa flag disables MPOA, and the interface will run as a regular LANE client with no shortcut ability.
delete	Used with elan, unjoin the specified ELAN, terminating connections to both its LES and BUS and removing the network interface associated with this ELAN. The -auto flag is used to delete an Automatic ELAN that was specified by -auto flag during the add operation. Used with the -lecs flag, remove the current LECS from the configuration. An LECS may be deleted only if no ELANs are currently configured from that LECS.
set -lecs	If the single argument, ATMaddress is used, set the ATM address of the LECS to ATMaddress and mark this LECS as current. If another set command is invoked with a different LECS address, this LECS is now marked as current. The add and delete commands may only be applied to ELANs returned by the current LECS. The -manual flag places the host in a manual configuration mode; configuration information will not be retrieved from the

```
                 LECS and the addition of ELANs  will  require
                 the user to set the LES address.
     set -mtu     (Solaris only)  Sets the  interface  MTU  to
                 match  that of the associated ELAN.  elconfig
                 handles the initial interface MTU  configura-
                 tion,  subsequent MTU reconfigurations may be
                 handled with -mtu.

NOTES
     The -unit flag is  mandatory  if  there  is  more  than  one
     adapter installed.

     (Solaris only)  Although the interface MTU may  be  modified
     through ifconfig(1M), elconfig is the recommended method for
     modifying the interface MTU of LECs.   For  compliance  with
     the ATM Forum LAN Emulation 1.0 specification, the interface
     MTU must not exceed the MAXIMUM-FRAME-SIZE of  the  Emulated
     LAN  of which it is a member.  elconfig ensures this compli-
     ance.

     Token-ring ELANs are not supported on Solaris or IRIX.

RESTRICTIONS
     On Solaris systems, an ELAN can be deleted only  when  there
     are  no  longer  users  attached through DLPI.  For attached
     protocols, the associated interface must first be configured
     “down” through ifconfig(1M) to detach them from the ELAN. If
     the user attempts to delete an ELAN which has any DLPI user,
     the message ‘elconfig: ELAN in use’ will be displayed.

     On SGI IRIX systems, deletion of an ELAN is not supported.

     On all other systems, the interface associated with an  ELAN
     must  first be configured “down” through ifconfig(1M) before
     deleting the ELAN.  If the user attempts to delete  an  ELAN
     which  is  “up”, the message ‘elconfig: ELAN in use’ will be
     displayed.

RELEASE
      ForeThought_5.1

SEE ALSO
     ifconfig(1M)
```

8.2.11 lappqos(8)

```
NAME
     lappqos - Configure Quality-of-Service parameters.

SYNOPSIS
     lappqos show [ -dest dst-host[/dst-mask] ]
                  [ -elan elan ] [ -n ]
     lappqos show -default [ -elan elan ]
     lappqos add elan [ -noshortcut ] [ -unit unit ]
                 dst-host[/dst-mask][:dst-port]
                 [ src-host[/src-mask][:src-port] ]
                 [ tcp | udp | icmp | igmp | proto:proto# ]
                 [ -scest packets/seconds ]
                 [ -ddest packets/seconds ]
                 [ -minbpeak ]
                 [ ubr[:PR] | cbr:PR | vbr:PR:SR:MBS |
                   shared ]
     lappqos set -default elan [ -unit unit ]
                           [ -scest packets/seconds ]
     lappqos delete elan [ -unit unit ]
                    dst-host[/dst-mask][:dst-port]
                    [ src-host[/src-mask][:src-port] ]
                    [ tcp | udp | icmp | igmp | proto:proto# ]

DESCRIPTION
     lappqos is a tool for associating legacy  application  flows
     with  VCs.   This allows the user to specify parameters such
     as QoS and VC sharing.  The tool can be  used  to  enter  or
     display flow descriptors and their currently associated VCs.
     lappqos can also be used to specify default  parameters  for
     MPOA shortcut setup thresholds.

COMMANDS
     show      The show command  is  used  to  display  currently
               active  flow  descriptors.   By  default, all flow
               descriptors across  all  ELANs  and  adapters  are
               displayed,   whether   entered  using  lappqos  or
               retrieved from the LECS.  - dest  shows  any  flow
               descriptors  based  on  the  specified IP host and
               mask, while -n prevents attempts  to  print  host,
               protocol,  and  port names symbolically.  -default
               is used to display the default MPOA shortcut setup
```

threshold for each ELAN. This default can be set on a per-ELAN basis using set -default, or set on a per-flow descriptor basis (which takes precedence). -elan may be specified with either of these show forms.

add The add command is used to add flow descriptors to an ELAN interface. At least a destination host must be specified. The optional mask allows the user to specify a destination subnet. If a mask is given, insignificant bits in the IP address are ignored. If a port for TCP or UDP is not specified, any port is matched. The same rules apply when specifying the optional source information. The protocol, TCP, UDP, ICMP, IGMP, or a numeric form, may also be specified. If absent, all protocols are assumed. Finally, some QoS must be specified: UBR with or without a peak rate (PR) in kbps, CBR with a PR (kbps), VBR with a PR (kbps), sustained rate (SR) in kbps, and maximum burst size (MBS) in cells, or shared. For each flow, the thresholds at which MPOA shortcuts are setup, -scest, may also be specified in packets per second. If this value is not provided, the default for that ELAN are used. The - noshortcut option disables the ability to set up MPOA shortcuts for this flow. The - ddest value, in packets per second, specifies when a LANE Data-Direct should be established for this flow. Until this threshold is exceeded, packets sent to this destination are forwarded through the BUS. When the -minbpeak flag is used, only a minimal amount of bandwidth is reserved on the backwards channel of QoS VCs. This option should only be used when the behaviors of the other clients on your ELAN with regard to their use of the backwards channel are fully understood.

set -default
The set -default command is used to specify the default MPOA shortcut thresholds for this ELAN.

delete The delete command is used to remove flow descriptors. To uniquely identify the flow descriptor to be deleted, the destination IP information, source IP information, and protocol are needed. If any of these are wildcard values, they do not need to be specified, just as done in the corresponding add.

NOTES

There will always be one default flow descriptor on each ELAN interface. This entry cannot be deleted, and merely specifies that, by default, all traffic should be shared UBR using the default MPOA and Data-Direct thresholds.

The allowed values for QoS will depend on the capabilities of the ATM adapter used by the given interface. In addition, certain adapters may only support discrete peak cell rates. If so, the rate will be set to the closest supported rate which is less than the specified rate.

RELEASE

ForeThought_5.1

SEE ALSO

elconfig(8), elarp(8)

8.2.12 leq(8)

```
NAME
     leq - Query the state of a LAN Emulation Server (LES)

SYNOPSIS
     leq [ -lm ] [ -u unit ] [ -c lecs-addr ] elan-name

     leq [ -lm ] [ -u unit ] les-addr

DESCRIPTION
     leq provides information about an Emulated LAN (ELAN).  This
     information  is  obtained  from  the  LES,  and includes MAC
     addresses  registered  on  the  ELAN  together  with   their
     corresponding ATM addresses.

     An ELAN is identified either by name, or by the  address  of
     its  LES.   If a name is used, the LES address is discovered
     by querying the LAN Emulation Configuration Server (LECS).

     Address arguments to leq are given  by  specifying  the  SEL
     octet  of  a  local address in decimal (e.g., 42) or hexade-
     cimal (e.g., 0xfa), or by specifying the full  20-octet  ATM
     address  of  a  non-local address with 40 hexadecimal digits
     (and optional period separators where desired).   For  exam-
     ple,

          47.0005.80.ffe100.0000.f215.0f5b.002048102aef.00

OPTIONS
     -l    Use the long output format, where all available infor-
          mation is printed.

     -m    Use the machine-oriented output format, intended to be
          more easily parsed by administrative scripts.

     -u unit
          Use the given adapter unit number.  Otherwise the first
          adapter with an assigned ATM address is used.

     -c lecs-addr
          Use the given address to contact the LECS (to  map  the
          ELAN  name  to an LES address) instead of the ATM-Forum
```

Additional Administration Information

```
          specified LECS address.

SEE ALSO
     lnni(8)

     ATM Forum LAN Emulation SWG, LAN Emulation Over ATM Specifi-
     cation - Version 1.0, December, 1994

RELEASE
     ForeThought_5.1
```

8.2.13 lestat(8)

```
NAME
     lestat - Show LAN Emulation Server statistics

SYNOPSIS
     lestat [ -u unit ] [ -c lecs-addr ] elan-name
            [ interval [ rows ] ]

     lestat [ -u unit ] les-addr [ interval [ rows ] ]

DESCRIPTION
     lestat displays the frame and byte counters gathered by  the
     LAN  Emulation Server (LES) and Broadcast and Unknown Server
     (BUS) on the ELAN named elan-name.  If  interval  is  speci-
     fied, lestat summarizes activity during each interval-second
     period.

     The first section of each output line contains  LES  Statis-
     tics:

     JoinReq     Number of LE_JOIN requests handled by the LES.

     ARPReq      Number of LE_ARP requests handled  or  forwarded
                 by the LES.

     Unknown     Number of unexpected LE control frames  received
                 (and dropped) by the LES.

     The second section contains BUS Statistics:

     UniPkts     Number of unicast packets forwarded by the BUS.

     UniBytes    Number of unicast bytes forwarded by the BUS.

     MulPkts     Number of multicast  packets  forwarded  by  the
                 BUS.

     MulBytes    Number of multicast bytes forwarded by the BUS.

     FlshRq      Number of LE_FLUSH requests handled by the BUS.

     Unknown     Number of other LE control frames received  (and
```

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```
                 dropped) by the BUS.

OPTIONS
     -u unit         Use the given adapter unit number.  Otherwise
                    the first adapter with an assigned ATM address
                    is used.

     -c lecs-addr    Use the given address to contact the LECS (to
                    map  the  ELAN name to an LES address) instead
                    of the ATM-Forum specified LECS address.

ARGUMENTS
     elan-name   Specify the  name  of  the  emulated  LAN  whose
                 counters are to be displayed.

     les-addr    Specify  the  ATM  address  of  the  LES   whose
                 counters are to be displayed.

     interval    Specifies that lestat should loop,  redisplaying
                 the  counters every interval seconds.  The first
                 row of output  gives  absolute  values  for  the
                 counters,  while  subsequent  rows  give differ-
                 ences.

     rows        lestat attempts to automatically  determine  the
                 number  of  rows on the output device so that it
                 can redisplay the  column  headers  before  they
                 scroll  off  the  screen.  A rows argument over-
                 rides this automatic determination.

SEE ALSO
     leq(8), adstat(8)

RELEASE
     ForeThought_5.1
```

8.2.14 uniconfig(8)

```
NAME
     uniconfig - UNI configuration tool for FORE ATM devices

SYNOPSIS
     uniconfig show [ -unit unit ]
     uniconfig set vc [ -unit unit ] [ -aal aal_type ]
                      [ -vpi vpi_value ] [ -vci vci_value ]
                      [ -peakrate peak_cell_rate ]
     uniconfig set properties [ -unit unit ]
                              [ -version 3.0|3.1|auto ]
                              [ -address atm_addr ]
     uniconfig set failover [ -state off|static|dynamic ]
                            [ -group unit ... ]

DESCRIPTION
     uniconfig is a tool to display/modify the current UNI confi-
     guration of an ATM device.

COMMANDS
     show      The show command displays the current  UNI  confi-
               guration, including the signalling channel parame-
               ters, the configured and operational UNI versions,
               the  primary  ATM  address, and the failover state
               and groups.

               If a -unit option is specified,  only  information
               about  that unit is given.  Otherwise, information
               about all available units is displayed.

     set vc    The set vc command is used to modify  the  various
               configuration  parameters  for  the UNI signalling
               channel.

               The -aal option sets the AAL type (default 5),   -
               vpi  sets  the  VPI (default 0), -vci sets the VCI
               (default 5), and   - peakrate  sets  the  CBR  PCR
               (default  UBR)  for  the  connection, expressed in
               kilobits per second.

               A -unit option must be specified unless  the  host
               has exactly one adapter.
```

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```
     set properties
               The set properties command is used to set the pro-
               perties of the UNI.

               The UNI version may be set to 3.0, 3.1,  or  auto-
               configuration  mode  via the -version option.  The
               primary ATM address may be set via the   - address
               option.

               A -unit option must be specified unless  the  host
               has exactly one adapter.

     set failover
               The set failover command sets the UNI load balanc-
               ing and failover state and groups.

               The state may be  either:   dynamic,  where  group
               membership is learned automatically, static, where
               the -groups option is used to  set  group  member-
               ship, or off, where the feature is disabled.

               The arguments to  the   - group  option  are  unit
               numbers  to  be  removed  from existing groups and
               placed together in the same group.  So, specifying
               a  single  unit  effectively removes the unit from
               any existing group.

RELEASE
     ForeThought_5.1

SEE ALSO
     adconfig(8), elconfig(8)
```

CHAPTER 9 Software Interfaces

9.1 XTI Application Programming Interface Support

ForeThought 5.1 contains support for ATM extensions to the XTI programming interface, as described in X/Open's XNS Specification, Issue 5.

This release differs from the XNS Issue 5 specification in the following ways:

- PVC extensions to the XTI interface are provided (the XNS specification makes no mention of PVC support). Refer to the PVC example code for samples of how to utilize these extensions.
- X/Socket feature of the XTI API is not supported.
- SSCOP reliable transport feature is not implemented.
- AAL0 is supported for PVCs and SVCs.
- ABR support is provided for PVCs.

9.1.1 XTI Contents

Sample code, header files, and a library that provides simplistic ATM name resolution is provided with this release. There is no separate library for XTI support. Rather, this is integrated in the ATM driver.

For additional software documentation, refer to `/opt/FOREatm/examples/xti/readme.txt` and `/opt/FOREatm/include/fore_xti/_atm_common.h`.

9.1.1.1 Header Files

Header files follow the naming convention specified in the XNS spec and are installed in:

`/opt/FOREatm/include/fore_xti`

The reason for the additional level of indirection (the **`fore_xti`** directory) is to avoid confusion with vendor-supplied versions of these files, as they become available. FORE recommends using the include path:

`/opt/FOREatm/include`

Using this path, programs then include files such as:

```
#include <fore_xti/xti.h>
```

which helps avoid confusion with OS-supplied files of the same name.

9.1.1.2 Device Names

Two new devices are created with this installation, **/dev/xtisvc**<*n*> and **/dev/xtipvc**<n>, where <n> is the adapter unit number, i.e., **/dev/xtisvc2**. Use these device names to create ATM XTI endpoints (see the sample code for examples).

9.1.1.3 ANS Library

An ANS library is included with this release. The ANS library is contained in

/opt/FOREatm/lib/libans.a

which provides simple file-based name resolution for XTI applications. This library reads a file, **/etc/xti_hosts**, which contains pairs of ATM addresses and host names, e.g.,

```
47.0005.80.ffe100.0000.f21a.2a2a.002048062fc2.00 thurston
```

NOTE The separating periods are optional.

Refer to the SVC sample code, and to the file:

/opt/FOREatm/include/fore_xti/ans.h

for more details on using this feature.

CHAPTER 10 Troubleshooting

The troubleshooting tests detailed in this chapter indicate and identify some of the most common problems in establishing ATM networks. Therefore, before contacting your service provider, perform these tests to correct, or at least pinpoint, the problem.

If contacting your service provider, the results of these tests, and the information requested in Section 10.5, should be available when reporting problems.

10.1 Installation Conflicts

Installation conflicts may occur if a device or module being installed attempts to assign a major number that is already in use by the IRIX kernel. These numbers are assigned by SGI based on the following, which can be found in `/usr/include/sys/major.h`:

```
---

#define GFX_MAJOR             57      /* graphics driver */
#define CONSOLE_MAJOR         58      /* console driver */
#define IPFILT_MAJOR          59      /* IP packet filtering */

               /* 60-79 Are reserved for Customer Use */

#define STRLOG_MAJOR          80      /* STREAMS log device */

---
```

If, during the installation proces,s the following message appears during the installation process (assuming that the conflicting number is 79, which is used by the FOREip module):

```
Warning: major number collision -- 79
```

perform the following procedure:

1. Exit `inst` by entering **q**, **quit**, or **14**.
2. Resolve the conflict and rebuild the IRIX kernel as described in *Section 10.1.1, Resolving Installation Conflicts.*
3. Reboot.

10.1.1 Resolving Installation Conflicts

Fortunately, it is possible to change the master number assignments before booting the system. To correct the situation, perform the following procedure:

1. Using device `/dev/fa0` as the example.

```
:~#grep '^sn' /var/sysgen/master.d/fore*
/var/sysgen/master.d/fore_clip:snf  clip_   77  1 fore_core, fore_sdapi, bsd
/var/sysgen/master.d/fore_core:snc  fore_   70  1 bsd
/var/sysgen/master.d/fore_ilmi:snc  ilmi_   71  1 fore_core
/var/sysgen/master.d/fore_ip:snf    foreip_ 79  1 fore_spans, bsd
/var/sysgen/master.d/fore_mpoa:snf  lane_   76  1 fore_core, fore_sdapi, bsd
/var/sysgen/master.d/fore_sdapi:snf sdapi_  73  1 fore_core, fore_ilmi, fore_uni, stream
/var/sysgen/master.d/fore_spans:snc spans_  78  1 fore_core
/var/sysgen/master.d/fore_uni:snc   uni_    72  1 fore_core, fore_ilmi
/var/sysgen/master.d/fore_xtipvc:snfxtipvc_74  1 fore_core, stream
/var/sysgen/master.d/fore_xtisvc:snfxtisvc_75  1 fore_core, fore_ilmi, fore_uni, stream
```

2. In this example, `foreip` is using major number 79. It is necessary to determine how many places that major number 79 is being used. These entries then need to be changed.

```
:~#grep mknod /etc/init.d/fore*
/etc/init.d/fore_drv:      /sbin/mknod /dev/$device c /hw/fore/$device
/etc/init.d/fore_spans:    /sbin/mknod /dev/$FOREIP_DEV_NAME$i c 79 $i
/etc/init.d/fore_xti:      /sbin/mknod /dev/xtipvc$i c 74 $i
/etc/init.d/fore_xti:      /sbin/mknod /dev/xtisvc$i c 75 $i
```

3. Edit `/var/sysgen/master.d/fore_ip` to assign an available major number for the FOREip module.
4. Edit `/etc/init.d/fore_spans` to reflect the same available major number.
5. `Run autoconfig`

10.2 Adapter Hardware Troubleshooting

Figure 10.1 illustrates the tests used to check the basic hardware functionality of a FORE Systems adapter with the adapter card isolated from the network. The tools used to perform the tests are provided by FORE Systems and the computer hardware vendor. Each of the tests in Figure 10.1 is described in the following subsections.

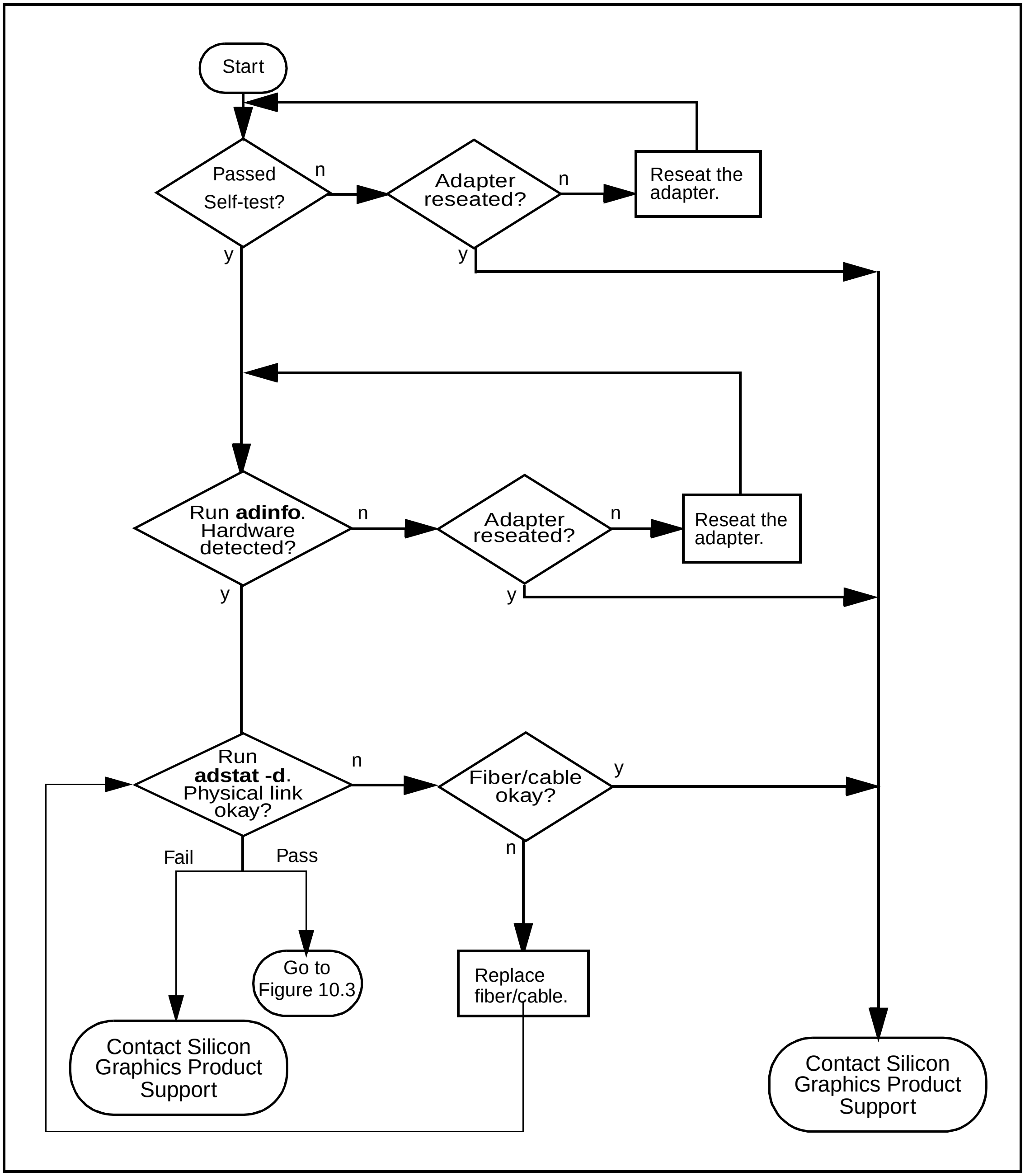

Figure 10.1 - Adapter Troubleshooting Flowchart

10.2.1 Check Self-Test (Automatically Performed)

During a system boot, the ATM adapter automatically performs a hardware self-test, running a low-level diagnostic which checks memory read / write capability. Upon completion of the self-test, a message is printed to the console of the workstation indicating whether or not the hardware failed.

If the self-test is successful, proceed to the instructions regarding the firmware download as described in Section 10.2.2.

If the self-test fails, reseat the board by performing the following steps to ensure that failure was not due to improper insertion of the board:

1. Halt the system following the procedures outlined in *Chapter 2, Hardware Installation*.
2. Open the computer as shown in *Chapter 2, Hardware Installation* and reseat the board.
3. Reboot the system.

If the board still fails after a reseat, then it should be returned for repair. Contact your service provider for further assistance.

10.2.2 Firmware Download (Automatically Performed)

NOTE Firmware download problems are not applicable to the *ForeRunnerHE* adapters.

Before operating as an ATM interface, the firmware is automatically downloaded from the system RAM to the onboard i960 processor during host system boot. A message similar to: **`INITIALIZING FORE ATM ADAPTERS...`** is displayed on the console, indicating that the board is being initialized. When the initialization is complete, success is indicated with the message "`done`", is displayed. Failure is indicated if the message "`failed`" is displayed.

If the download is successful, check to see if the hardware has been detected by the driver as described in Section 10.2.3.

If the firmware failed to download, then there is most likely a hardware problem. Contact your service provider for further assistance.

10.2.3 Hardware Detected by Driver

Once the host system has come up completely, to determine if the driver software on the host has detected the presence of an ATM adapter, issue the following commands:

adinfo

Output similar to the following should be displayed for the **adinfo** command:

```
root@O2000# /opt/FOREatm/bin/adinfo
ForeThought_5.1-1999022419(Beta1.2) derived from FORE Systems ForeThought_5.1(35430)
fatm0:  HE622 Media=OC12-MM-SC HW=0.0.0 Serial=2949194
        Module_ID=1 XIO_Slot=11 PCI_Slot=0x1
        MAC=00:20:48:2d:00:4a
```

If the driver located the ATM board, the screen output shows **fatm0** (or the interface name supplied during installation). If there is more than one adapter card, the next board is named **fatm1**, and so on.

Output similar to the following is displayed when the hardware inventory (**hinv**) command is executed:

hinv | grep ATM

```
root@O200# hinv | grep ATM
ATM HE155 OC-3: module 1, xio-slot 2, pci_slot 0, unit 0
ATM HE622 OC-12: module 1, xio_slot 5, pci_slot 1, unit 2
```

If the driver does not see the ATM board, no response is given. Reseat the board by performing the following steps to ensure that failure was not due to improper insertion of the board:

1. Halt the system following the procedures outlined in *Chapter 2, Hardware Installation*.
2. Open the computer as shown in *Chapter 2, Hardware Installation* and reseat the board.
3. Reboot the system.

If the board still fails after a reseat, it should be returned for repair. Contact your service provider for further assistance.

10.2.4 Checking the Physical Link

To display the carrier state of the adapter, issue the following command:

`adstat -d fatm0`

The **`-d`** option displays device statistics in the following format:

```
Device statistics:
       Buffer Allocation Failures
          Type 1           Type 2
      Small    Large    Small    Large    Receive Queue Full    Carrier
        0        0        0        0                    0          ON
```

If **`ON`** is displayed in the `Carrier` field, then the physical link is okay. If **`OFF`** is displayed in the `Carrier` field, then there is either a problem with the loopback fiber or there is a hardware problem with the optical drivers on the board. Check the fiber. If the fiber is bad, replace the fiber. If the fiber is not bad, contact your service provider for further assistance.

Alternatively, if access is available to the back of the host and the LED displays on the adapter backplate can be viewed, a red LED on the R (Receive port) also indicates carrier failure.

10.3 Testing Network Connectivity Using PVCs

Network connectivity tests require that two ATM adapters are connected to an ATM switch with PVCs (as shown in Figure 10.2). The carrier lights should be unlit on the boards and on the switch, indicating that the fibers are OK.

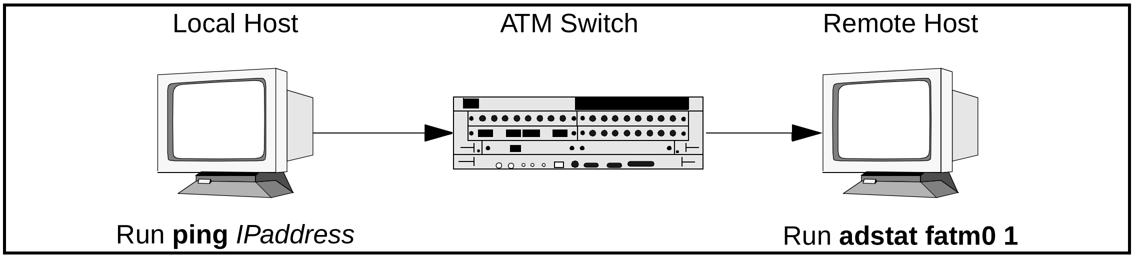

Figure 10.2 - Hardware Configuration for Checking PVCs

The network connectivity test suite, shown in Figure 10.3 and Figure 10.4, examines higher level functionality after basic adapter board performance has been verified by passing all the tests and checks in Figure 10.1.

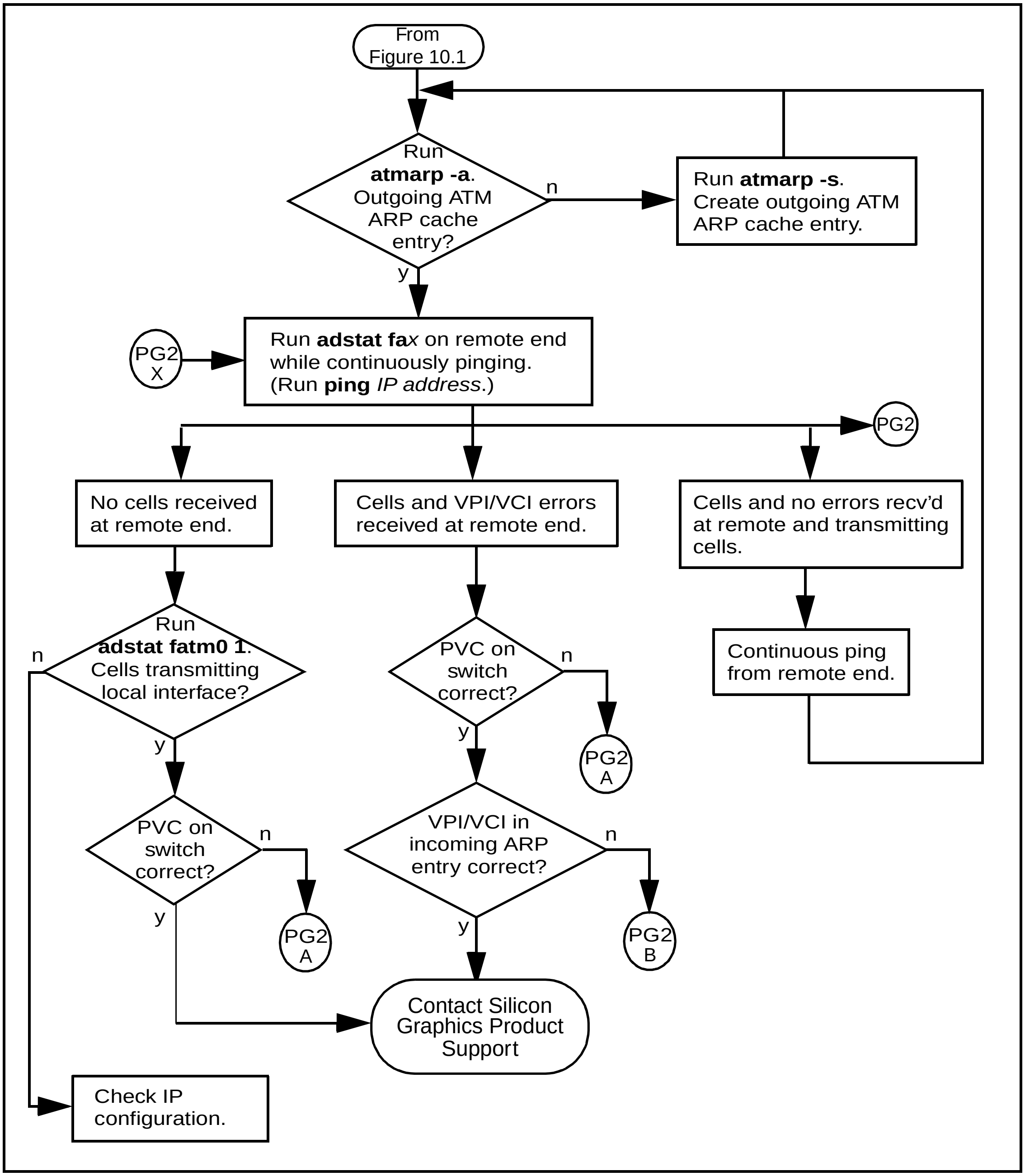

Figure 10.3 - Networking Connectivity Using PVCs (Page 1)

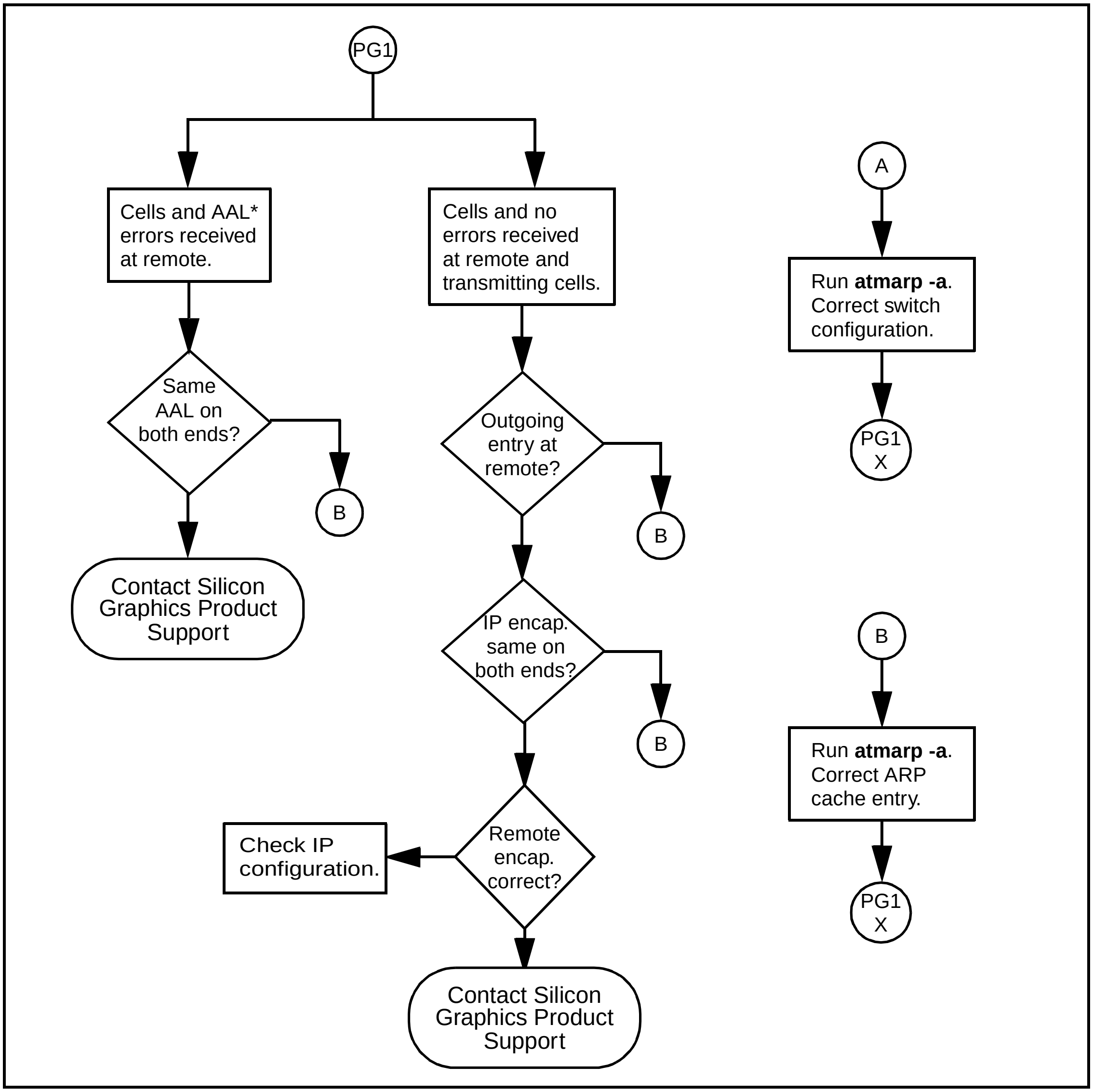

Figure 10.4 - Networking Connectivity Using PVCs (Page 2)

These tests require that the switch be configured with a valid PVC and the end stations have the proper IP configuration and ATM ARP cache entries. See the **atmarp(8)** man page and Chapter 1 of the *ForeRunner ATM Switch Network Configuration Manual* to determine if the PVCs are correctly configured. The tests in Figure 10.3 assume that a **ping** was tried and there was no response (**ping** failed).

The tests in Figure 10.3 also require that if a switch is used, it is a FORE Systems switch on which SPANS has been disabled on both ports of the switch and the ATM endstations. SPANS must be disabled because it automatically creates ATM connections, which may alter the test results.

All of the test conditions are checked by running a continuous **ping** with the following command:

ping *<IP_address_of_remote_workstation>*

10.3.1 Verifying the Outgoing ATM ARP Entry

To verify the outgoing ATM ARP cache entry for the endstation originating the ping, enter the following command on the host:

atmarp -a

The following is an example of a typical ATM ARP cache display:

```
Outgoing connections:
fa0: ws2-atm (198.29.21.74): vpi.vci=0.100 aal=5
        switch.port=-.-
        flags=(PVC) encapsulation=NULL peak rate=(unlimited)
fa0: ws3-atm (198.29.21.94): vpi.vci=0.200 aal=5
        switch.port=-.-
        flags=(PVC) encapsulation=NULL peak rate=(unlimited)
Incoming connections:
fa0:switch.port=f21a2e71.18 vpi.vci=0.404 aal=5
    flags=() decapsulation=NULL
fa0:switch.port=f21a22a9.19 vpi.vci=0.383 aal=5
    flags=() decapsulation=NULL
```

Make sure the ARP cache entry matches the IP address of the remote endstation and is using the PVC configured on the switch.

If a prompt is returned with no information, this indicates that the ATM ARP cache is empty.

Use the following commands to create a PVC on the host:

atmarp -s *<hostname> <device> <vpi> <vci> <aal>*
atmarp -l *<device> <vpi> <vci> <aal>*

If the ATM ARP cache entry is valid, perform the **adstat** instructions in Section 10.3.2.

10.3.2 adstat

To determine a particular failure state, enter the following command on the remote workstation while continuously pinging:

adstat fatm0 1

```
PHY/ATM/AAL statistics:
         Output                Input                            Errors
       ATM     AAL*         ATM      AAL*      PMD      ATM      ATM     AAL*     AAL*
     Cells  CS-PDUs       Cells  CS-PDUs Framing Hdr-CRC VPI/VCI Pay-CRC   Proto
         5        5          26       26       0        0 33218626       0       0
```

Failure states are determined by examining the output from the **adstat fatm0 1** command string. Failures are classified by whether or not cells are sent (or received) and whether or not errors are received. The output shown above is typical of the first response from the **adstat fatm0 1** command string. Succeeding lines of data continue in the same format. Refer to Section 10.3.2.1 through Section 10.3.2.5 for a description of each type of failure.

10.3.2.1 No Cells Received by Remote End

If no cells are received by the remote end (the Input ATM Cells field displays zero), run the following command on the local machine to verify that cells are going out the ATM interface:

adstat fatm0 1

If there are no cells going out (the ATM Output Cells field shows zero), there is most likely a problem on the local machine rather than the remote host or the network. Ask the network administrator to check the IP configuration.

If cells are going out (the ATM Output Cells field shows a value other than zero), the PVC on the switch may be configured incorrectly. Check the PVC configuration. If it is not set up properly, correct the PVC and rerun the test. If the PVC is configured correctly and the error persists, contact your service provider for further assistance.

10.3.2.2 Cells and VPI/VCI Errors Received by Remote

If the remote workstation is receiving cells and is receiving VPI/VCI errors, this indicates that cells are coming into the workstation, but are on a VPI/VCI that may not be configured correctly.

Check the PVC configuration. Correct the PVC configuration if necessary and rerun the test. If the PVC is configured correctly and the error persists, the incoming ARP entry on the remote workstation is most likely the problem. List the ATM ARP cache using **`atmarp -a`** and check the incoming ARP entry for that connection.

If the incoming ARP entry is not configured properly, correct the configuration and rerun the test. If the incoming ARP entry is configured properly and the error persists, contact your service provider for further assistance.

10.3.2.3 Cells and AAL* Errors Received by Remote

If the remote workstation is receiving cells and AAL* errors, the AAL types of the outgoing entry on the local workstation and the incoming entry on the remote workstation probably do not match. Check both ATM AAL types using **`atmarp`** to see if they match. If they are different, set the AAL parameter to the same type and rerun the test. If they match and the error persists, contact your service provider for further assistance.

10.3.2.4 Cells and No Errors Received by Remote/Transmitting No Cells

If the remote workstation is receiving cells with no errors, but is not transmitting any cells, either the outgoing IP address on the remote end is incorrect or the IP encapsulation does not match on both ends. (A FORE IP PVC uses AAL5 based Multiplexing (NULL) encapsulation.)

First, check the outgoing IP address on the remote end using **`atmarp -a`**. If it is not configured properly, correct the configuration and rerun the test. If the outgoing ARP entry is configured properly, check to see if the IP encapsulation matches on both ends using **`atmarp -a`**.

If the IP encapsulation does not match on both ends, correct the configuration and rerun the test. If the IP encapsulation matches on both ends and the error persists, there may be an IP routing problem on the remote host.

The network administrator should verify the IP routing. If there is still a problem, contact your service provider for further assistance.

10.3.2.5 Cells and No Errors Received by Remote/Transmitting Cells

If the remote end is receiving cells with no errors and is transmitting cells in response, the remote end is OK. Looking at Figure 10.2, reverse the direction. From the remote host, start a continuous **`ping`** and then run these same tests starting again with Section 10.3.1. Observe the results of these tests on the local host.

10.4 LAN Emulation Troubleshooting

The following procedures provide a top-down series of troubleshooting procedures for LAN emulation from the point of view of the host in which the adapter resides. Troubleshooting procedures for the host system, as well as for equipment to which the adapter may be connected, are referenced as necessary. If there are any questions about troubleshooting LAN emulation as employed with this adapter, contact your service provider for further assistance.

10.4.1 Troubleshooting Procedures

If the host system is unable to communicate with other members of the ELAN, review the following questions and procedures for possible solutions.

10.4.1.1 Before Beginning

Before attempting to troubleshoot suspected LAN emulation problems, perform the following:

- Ensure that the host hardware (switches, workstations, adapters, etc.) that is running the various LAN emulation software processes (LECS, LES, BUS, LEC) is correctly connected, powered up, and functional.
- Perform the appropriate hardware troubleshooting.

NOTE Section 10.2 provides adapter hardware troubleshooting procedures. Refer to the documentation supplied with the host system, as well as any hardware involved in running LAN emulation processes, for appropriate hardware troubleshooting.

- Obtain the appropriate network parameters from the system administrator that define how the host should be configured for the ELAN that is being troubleshot. This information should include:
  - the ELAN name
  - the name assigned the interface
  - the IP address assigned the interface
  - the ATM address of the system on which the ELAN's services is running

10.4.1.2 Is the ELAN state "Operational?"

***How to check* -**

Enter **`elconfig show -configured`** and check if the ELAN state is "**`Operational`**." Also note the "**`Last Error`**" from the output.

***Possible Solutions* -**

If the state is **"`Suspended`**":

1. Ensure that the interface is assigned the correct IP address and is UP.

If the state is "**`Operational`**":

1. Check routing entries. Make sure that the destination and gateway addresses are correct. Make sure that the default route is correct (i.e., default gateway address is correct). Refer to *Chapter 4, Network Interface Administration* for IP interface configuration.
2. Follow IP troubleshooting procedures in Chapter 3 of the *IRIX Admin Networking and Mail manual #007-2860-005*.
3. Contact your service provider.

If the state is **NOT** "**`Operational`**" or "**`Suspended`**," proceed to Section 10.4.1.3.

10.4.1.3 Is the ATM address assigned?

***How to check* -**

Enter **`uniconfig show`** and check if the ATM address is assigned.

***Possible Solutions* -**

If the ATM address is **NOT** assigned.

1. Ensure that FORE **`ilmid`** is running. (Check the **`/var/adm/SYSLOG`** file to see if ILMI has registered the ATM address with the switch)
   - If not running, reinstall the software OR contact your service provider.
2. Enter **`adstat fatm0`** and observe the response.
   - If **`adstat`** does not respond, contact your service provider.
   - If **`adstat`** responds with cell counts, **and** if using a non-FORE switch, make sure that address registration in the switch is working properly.

     If using a FORE switch, contact FORE Systems Technical Assistance Center.

If the ATM address **is** assigned, proceed to the next question.

10.4.1.4 Last Error in the `elconfig show -configured` command?

***How to check* -**

Enter **`elconfig show -configured`** and note the last error message in the output.

***Possible Solutions* -**

Last error messages and corrective actions are mentioned with each case below.

- LES address is zero (only in autoconfig mode) or VCI not assigned for LES (only in manual configuration).

1. **“LECS failed to find ELAN”**

   Ensure that the ELAN name is correct and is registered with the LECS (in case of auto-configuration only).

2. **“LECS failed to respond”**

   If in auto-configuration mode, make sure that the LECS is started and is running.

3. **“failed to connect to LES”** or
   “Could not connect to the BUS”

   Make sure that services (LES,BUS) are up, and that the services machine is connected to the switch. Make sure that the ATM address of the services machine is correct in the LECS database.

4. If services are UP, check the **`/var/adm/SYSLOG`** file (if enabled) for any ERROR conditions and make corrections as appropriate. If services are UP but **`/var/adm/SYSLOG`** is not enabled, contact your service provider.

5. Enter **`adstat fatm0 1`** and observe the response.

   a. If **`adstat`** does not respond, contact your service provider.

   b. If **`adstat`** responds, check troubleshoot the switch. Otherwise, contact your service provider.

- LES address is assigned (in auto-configuration mode only) **and** BUS address is not assigned.

1. **“LE_ARP for BUS failed”** or
   “BUS connection dropped” or
   “LES connection dropped”

   Check for '`direct vpi.vci`' to LES in the **`elconfig`** output. Make sure that the LES is running if vpi.vci is not assigned.

   Check the LES log (if enabled) and contact your service provider for any error conditions.

- All addresses are assigned but VCIs are not assigned.

1. **“LES connection dropped”** or
   “BUS connection dropped”

   Make sure that the services are running.

2. Enter **`adstat fatm0 1`** and observe the response.
   a. If **`adstat`** does not respond, contact your service provider.
   b. If **`adstat`** responds, troubleshoot the switch. Otherwise, contact your service provider.

10.5 Collecting Additional Information

Once basic adapter installation and network connectivity have been tested, this section explains how to obtain the additional information needed before contacting your service provider. This information should exist either on-line (by redirecting the output to a file) or in hard copy form.

10.5.1 Adapter Information

At a command line prompt on the host, perform the following command(s) and note the responses:

• **uname -aR**	Displays the machine hardware name, (CPU board), hostname or nodename, operating system release, system name, and operating system version.
• **ifconfig fa*x***	Displays adapter interface configuration. May also be used to show the Classical IP (**ci*x***), and ELAN (**el*x***) interface configurations.
• **ifconfig -va**	Displays interface statistics for all interfaces.
• **netstat -nr**	Displays routing table with destinations, gateways, and flags.
• **netstat -in**	Displays device names and addresses, and usage information.
• **netstat -m**	Displays statistics for memory management.
• **/var/adm/SYSLOG info**	Displays system messages related to ATM.
• **adinfo**	Displays adapter device name and version information.
• **adstat -d fatm0**	Displays carrier state and a variety of error counters.
• **hinv**	Displays the contents of the system hardware inventory table.
• **versions -b | grep patch**	Displays a list of installed OS patches.

If a system crash occurs, the **/var/adm/crash/analysis.*x*** file contains information relative to the crash.

Typical responses are shown below following each command. The responses from these commands enable support to gather sufficient information to resolve a majority of problems.

NOTE

The assumed adapter name in the examples is **fax**. On the particular system, the adapter may have a different designation. To check the name of the adapter, issue the **netstat -in** command.

uname -aR

```
IRIX64 quinn 6.5 02121744 IP27
```

ifconfig fa0

```
fa0: flags=863<UP,BROADCAST,NOTRAILERS,RUNNING,MULTICAST>
        inet 192.168.51.67 netmask 0xffffff00 broadcast 192.168.51.255
```

netstat -nr

```
Routing tables

Internet:
Destination      Gateway            Netmask    Flags    Refs     Use  Interface
default          169.144.120.1                 UGS         7      118  ef0
127.0.0.1        127.0.0.1                     UH          7        2  lo0
169.144.120      169.144.120.67     0xffffff00 U          13       19  ef0
169.144.120.67   127.0.0.1                     UGHS        1        6  lo0
192.168.51       192.168.51.67      0xffffff00 U           1      616  fa0
192.168.52       192.168.52.67      0xffffff00 U           0       58  ci0
192.168.53       192.168.53.67      0xffffff00 U           0       10  el0
224              169.144.120.67     0xf0000000 US          2   104448  ef0
```

netstat -in

```
Name Mtu   Network         Address            Ipkts Ierrs    Opkts Oerrs  Coll
ef0  1500  169.144.120     169.144.120.67    399612     0   253886     0     0
fa0  65511 192.168.51      192.168.51.67    1196337     0    70325     0     0
el0  9218  192.168.53      192.168.53.67         61     0       51     1     0
ci0  9180  192.168.52      192.168.52.67      18706     0     3966     0     0
lo0  8304  127             127.0.0.1           4639     0     4639     0     0
```

adinfo

```
root@O2000# /opt/FOREatm/bin/adinfo
ForeThought_5.1-1999022419(Beta1.2) derived from FORE Systems ForeThought_5.1(35430)
fatm0:  HE622 Media=OC12-MM-SC HW=0.0.0 Serial=2949194
        Module_ID=1 XIO_Slot=11 PCI_Slot=0x1
        MAC=00:20:48:2d:00:4a
```

adstat -d fatm0

```
Device statistics:
      Buffer Allocation Failures
        Type 1           Type 2
    Small    Large    Small    Large    Receive Queue Full    Carrier
        0        0        0        0                     0         ON
```

hinv

```
root@O200# hinv
4 180 MHZ IP27 Processors
CPU: MIPS R10000 Processor Chip Revision: 2.6
FPU: MIPS R10010 Floating Point Chip Revision: 0.0
Main memory size: 4352 Mbytes
Instruction cache size: 32 Kbytes
Data cache size: 32 Kbytes
Secondary unified instruction/data cache size: 1 Mbyte
Integral SCSI controller 0: Version QL1040B (rev. 2), single ended
  Disk drive: unit 1 on SCSI controller 0
  Disk drive: unit 2 on SCSI controller 0
  Disk drive: unit 3 on SCSI controller 0
  Disk drive: unit 4 on SCSI controller 0
CDROM: unit 6 on SCSI controller 0
Integral SCSI controller 1: Version QL1040B (rev. 2), single ended
IOC3 serial port: tty1
IOC3 serial port: tty2
Integral Fast Ethernet: ef0, version 1, module 1, slot io1, pci 2
ATM HE622 OC-12: module 1, xio_slot 11, pci_slot 1, unit 0
Origin BASEIO board, module 1 slot 1: Revision 3
Origin PCI XIO board, module 1 slot 2: Revision 3
IOC3 external interrupts: 1
```

10.5.2 Switch Information

NOTE The information in this section assumes that the connected switch is a FORE Systems' switch.

Enter the following commands at a command prompt and note the responses:

- **`adstat fatm0`**
- **`netstat -ai`**

Log in to the ATM Management Interface (AMI) on the switch and check the following:

- **`configuration spans show`**
- **`configuration port show`**
- **`configuration signalling show`**
- **`configuration module traffic d show`**
  (this command displays the configuration of a Series D Netmod, refer to the AMI Configuration Commands Reference Manual for specific modules)

Typical responses are shown under each command. The responses from these commands can enable support to gather sufficient information to resolve a majority of problems.

`adstat fatm0`

```
PHY/ATM/AAL statistics:
         Output                  Input                           Errors
       ATM     AAL*        ATM     AAL*     PMD     ATM     ATM    AAL*    AAL*
     Cells  CS-PDUs      Cells  CS-PDUs Framing Hdr-CRC VPI/VCI Pay-CRC   Proto
         5        5         26       26       0       0 33218626       0       0
```

The following commands display SPANS, port, and signalling configuration and status and are executed from the AMI interface on a FORE Systems switch.

```
::configuration spans> show
 Port  VPI  State Type   CDVT  Action RemoteAddress
 1A1     0  down  uni    1000  tag
 1A2     0  down  uni    1000  tag
 1A3     0  down  uni    1000  tag
 1A4     0  down  uni    1000  tag
 1A5     0  down  uni    1000  tag
 1A6     0  down  uni    1000  tag
 1C1     0  down  uni    1000  tag
 1C2     0  down  uni    1000  tag
 1C3     0  down  uni    1000  tag
 1C4     0  down  uni    1000  tag
 1CTL    0  down  uni       0  tag

::configuration spans> show advanced
 Port  VPI SigVCI CLSVCI AAL MinVCI MaxVCI SigBW CLSUPC OpenT/O CloseT/O OutServ
 1A1     0     15     14 4       32    511     0      0     300      500     vbr
 1A2     0     15     14 4       32    511     0      0     300      500     vbr
 1A3     0     15     14 4       32    511     0      0     300      500     vbr
 1A4     0     15     14 4       32    511     0      0     300      500     vbr
 1A5     0     15     14 4       32    511     0      0     300      500     vbr
 1A6     0     15     14 4       32    511     0      0     300      500     vbr
 1C1     0     15     14 4       32    511     0      0     300      500     vbr
 1C2     0     15     14 4       32    511     0      0     300      500     vbr
 1C3     0     15     14 4       32    511     0      0     300      500     vbr
 1C4     0     15     14 4       32    511     0      0     300      500     vbr
 1CTL    0     15     14 4       32   1023     0      0     300      500     vbr

::configuration port> show
 Port Carrier Admin  Mbps ATM-Rate   CDVT Policing VBROB BuffOB AIS/RDI  Model
 1D1  no      up    155.0    149.8    250 enabled    100    100 disabled OC3
 1D2  no      up    155.0    149.8    250 enabled    100    100 disabled OC3
 1D3  no      up    155.0    149.8    250 enabled    100    100 disabled OC3
 1D4  yes     up    155.0    149.8    250 enabled    100    100 disabled OC3
 1CTL yes     up     80.0     80.0   5000 enabled    N/A    N/A disabled ASX-CTL
Note: ATM/OAM processing is disabled

::configuration port> show advanced
              Input                 Output
 Port   CDV        maxCTD    CDV        maxCTD
 1B1    1          21        computed   computed
 1B2    1          21        computed   computed
 1B3    1          21        computed   computed
 1B4    1          21        computed   computed
 1D1    1          21        computed   computed
 1D2    1          21        computed   computed
 1CTL   0          0         computed   computed
```

```
myswitch::configuration signalling> show
 Port VPI Interface      SigVersion State ILMI Side    RemoteAddress
 1A1    0 privateUNI(a)  uni30(a)   down  down network
*1A2    0 privateUNI(a)  uni31(a)   up    up   network 172.19.12.141
 1A3    0 privateUNI(a)  uni31(a)   down  down network
 1A4    0 privateUNI(a)  uni30(a)   down  down network
 1B1    0 FT-PNNI(a)     uni31(a)   up    up   user    169.144.64.59
 1B2    0 privateUNI(a)  uni30(a)   down  down network
 1B3    0 FT-PNNI(a)     uni31(a)   up    up   network 172.19.12.58
 1B4    0 privateUNI     uni30      up    down network 172.19.12.139
 1C1    0 privateUNI(a)  uni30(a)   down  down network
 1C2    0 privateUNI     uni31      up    up   network 172.19.12.140
 1C3    0 PNNI(a)        pnni10(a)  up    up   network 172.19.12.57
 1C4    0 PNNI           pnni10     up    up   network 169.144.64.58
 1CTL   0 privateUNI(a)  uni30(a)   up    down network
```

The following commands display specific network module (NETMOD) configuration and status and are executed from the AMI interface on a FORE Systems switch.

```
::configuration port taxi> show
 Port       Carrier    State      Loopback
 2A1        yes        up         none
 2A2        no         down       none
 2A3        no         down       none
 2A4        no         down       none
 2A5        no         down       none
 2A6        no         down       none

::configuration port ds3> show
 Port Carrier Status Mode Framing  Loopback Timing   Scrambling EmptyCells Length
 1A1  yes     0x1    plcp cbit     none     internal off        unassigned Gt225
 1A2  yes     0x1    plcp cbit     none     internal off        unassigned Gt225

::configuration port ds1> show
 Port Carrier Status Mode Framing Loopback Timing   PRBS Scram Length  EmptyCells
 1A1  no      0x81a0 hcs  ESF     none     internal N/A  off   Lt110   unassigned
 1A2  no      0x81a0 hcs  ESF     none     internal N/A  off   Lt110   unassigned

::configuration port e1> show
 Port Carrier Status Mode   LineType Loopback Timing    Scram Length   EmptyCells
 3B1  no      0x8064 hcs    CRC      none     internal  on    Lt110    idle
 3B2  no      0x8064 hcs    CRC      none     internal  on    Lt110    idle

::configuration port e3> show
 Port Carrier Status Mode Loopback Timing    Scrambling EmptyCells
 1D1  no      0x58   hcs  none     internal  on         unassigned
 1D2  no      0x58   hcs  none     internal  on         unassigned
 1D3  no      0x58   hcs  none     internal  on         unassigned
 1D4  no      0x58   hcs  none     internal  on         unassigned
```

```
::configuration port sonet> show
 Port Width  Line Mode  Loopback Timing   Scrambling EmptyCells
 1C1  sts3c  MM   sonet none     internal on         unassigned
 1C2  sts3c  MM   sonet none     internal on         unassigned
 1C3  sts3c  MM   sonet none     internal on         unassigned
 1C4  sts3c  MM   sonet none     internal on         unassigned
 1D1  sts12c MM   sonet none     N/A      on         unassigned

::configuration port tp25> show
 Port Carrier Media Loopback RxTiming
 1A1  no      UTP   none     Yes
 1A2  no      UTP   none     Yes
 1A3  no      UTP   none     Yes
 1A4  no      UTP   none     Yes
 1A5  no      UTP   none     Yes
 1A6  no      UTP   none     Yes
 1B1  yes     UTP   none     Yes
 1B2  yes     UTP   none     Yes
 1B3  no      UTP   none     Yes
 1B4  yes     UTP   none     Yes
 1B5  no      UTP   none     Yes
 1B6  yes     UTP   none     Yes

::configuration port j2> show
 Port Carrier Status LineLength   Loopback     Timing       EmptyCells
 1C1  no      0xc0   short        none         internal     idle
 1C2  no      0xc0   short        none         internal     unassigned
 1C3  no      0xc0   short        none         internal     unassigned
 1C4  no      0xc0   short        none         internal     unassigned
```

APPENDIX A PMD LED Indicators

This appendix shows the location of and gives a description of the PMD module LED indicators.

A.1 LED Location

Figure A.1 shows the faceplate of the HE adapters.

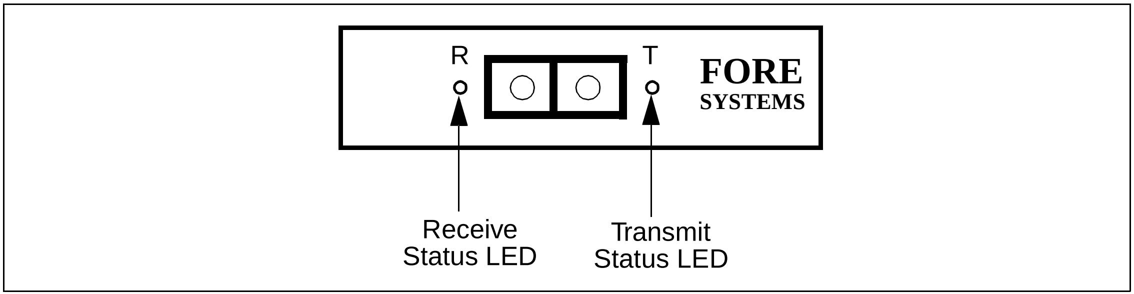

Figure A.1 - SC Connector Face Plate Configuration

A.2 LED Descriptions

The LEDs have the following meanings:

Table A.1 - Transmit LED

LED Color	Meaning
green	Transmitting data
off	Idle
yellow	SONET alarm condition declared (indicates trouble with the receiving device) (OC-3 only)

Table A.2 - Receive LED

LED Color	Meaning
green	Receiving data
off	Idle
yellow	No carrier

APPENDIX B ATM Network Configurations

After installing a FORE Systems ATM adapter, there are several physical configurations (network topologies) that may exist. The most likely configurations are:

- FORE adapters in a back-to-back configuration, in which they are directly connected to one another
- FORE adapters connected to a *ForeRunner* ATM Switch
- FORE adapters connected to an ATM product from a different manufacturer

This chapter describes methods for ensuring communications in the above network configurations.

B.1 Adapter-to-FORE ATM Switch

ForeRunner ATM switches support the SPANS signalling protocol. If an ATM adapter is connected to a *ForeRunner* ATM switch, connections can be automatically created between the adapter and other SPANS-capable devices, such as other *ForeRunner* ATM adapters and the switch itself. In this topology, the only requirements are the physical connection between the adapter and assignment of IP addresses to ensure proper communication (for more information on assigning IP addresses, see *Chapter 4, Network Interface Administration*).

When UNI 3.0 or 3.1 signalling is used, it is no longer possible to connect adapters directly in a back-to-back mode because the signalling protocols UNI 3.0 and UNI 3.1 do not support a direct adapter to adapter connection. Instead, a UNI 3.0 or 3.1 compliant switch, such as a *ForeRunner* ASX series ATM switch must be used between the two adapters. This configuration is shown in Figure B.1.

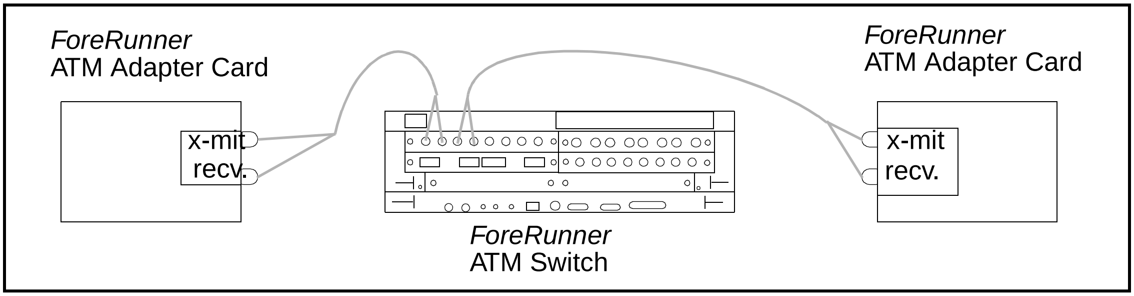

Figure B.1 - Minimum Configuration with UNI 3.0 or UNI 3.1 Signalling

B.2 Adapter-to-Other Vendor's Equipment

If an ATM adapter is connected to ATM equipment that does not support the SPANS signalling, UNI 3.0 signalling, or UNI 3.1 signalling, PVCs must be used for ATM connections. In this case, the devices must be properly cabled and IP addresses assigned to the various devices. To make any connections, PVCs must be established on the ATM adapter. For additional information on connecting an adapter card to other vendor's equipment, see *Chapter 4, Network Interface Administration* and *Chapter 8, Additional Administration Information*.

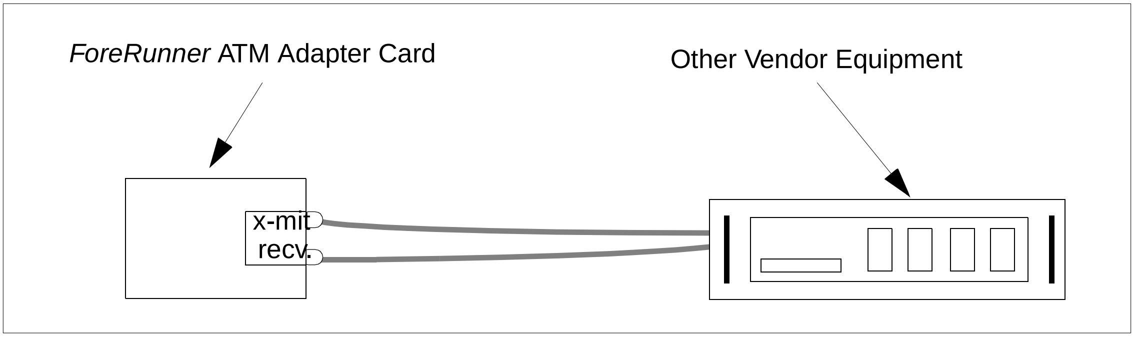

Figure B.2 - Adapter-to-Other Vendor Configuration

APPENDIX C Tunable Parameters

This appendix describes additional tunable parameters. If any of these modifications are made, a kernel reconfiguration is required for the change to take effect.

NOTE There is generally no need to make any of these modifications. Verify the symptoms carefully before making any modifications.

The following listed files can be changed, if symptoms warrant, to better tune the adapter software:

- HE adapter /var/sysgen/master.d/fore_he
- FORE-IP device name change /var/sysgen/master.d/fore_ip

C.1 CPU to ATM Adapter Mapping

HE adapters have the ability to generate a good deal of packets per second. If statistics indicate that the default CPU (CPU 0 for example) is being overloaded with interrupts, it is possible to administratively configure interrupts from a particular board to go to a particular CPU. This is done using `DEVICE_ADMIN` statements in `/var/sysgen/system/irix.sm`. Refer to IRIX `system(4)` man page for more information.

Following is an example on an Origin2000 with the ATM adapter installed in XIO slot 6. It may be necessary to change the following to adapt to the specific environment.

```
#find /hw -name fore -prune -o -name 'fatm*' -print
/hw/module/1/slot/io6/xtalk_pci/pci/1/fore_1601/fatm
```

Add the following line to the file **`/var/sysgen/system/irix.sm`**.

```
DEVICE_ADMIN: /hw/module/1/slot/io6/xtalk_pci/pci/1 INTR_TARGET=/hw/cpunum/1
```

This line causes interrupts from the adapter in XIO slot 6 to be redirected to CPU number 1.

Use **`autoconfig`** to reconfigure the kernel and then reboot the system to start the new kernel.

```
% autoconfig -vf
```

C.2 TCP Performance

The default tcp_sendspace and tcp_recvspace may not provide the best TCP performance, especially for the HE-622 adapter.

```
/* TCP window sizes/socket space reservation */
systune tcp_sendspace = 61440 (0xf000);
systune tcp_recvspace = 61440 (0xf000);
```

can be changed to

```
systune tcp_sendspace = 262144 (0x40000);
systune tcp_recvspace = 262144 (0x40000);
```

or any other value that is supported by the operating system.

These variables are dynamically changeable through systune(1M). Also, on a per interface level using ifconfig interface rspace value sspace value. Refer to ifconfig(1M) man page for more details.

C.3 UDP Socket Buffer Overflows

If User Datagram Packet (UDP) socket buffer overflows occur, data is being discarded at the UDP layer due to a lack of buffer space. Performance may be improved by increasing udp_sendspace and/or udp_recvgrams. The udp_sendspace parameter defines the default maximum size of UDP datagrams that can be sent. The udp_recvgrams parameter determines the number of maximally sized UDP datagrams that can be buffered in a UDP socket. The total receive buffer size in bytes for each UDP socket is the product of udp_sendspace and udp_recvgrams. For example;

```
/* UDP window sizes/socket space reservation */
systune udp_sendspace
    udp_sendspace = 61440 (0xf000);
systune udp_recvgrams
    udp_recvgrams = 2 (0x2);
```

This loss at the UDP layer can be seen by running the **netstat -C** and observing the UDP statistics.

C.4 Tuning the HE622

The HE622 can perform interrupt coalescing (i.e., the HE622 can receive several packets *before* interrupting the host and indicating that packets are ready to be processed). Interrupt coalescing *reduces* the interrupt load on the host by *not* generating an interrupt for each packet received.

NOTE When interrupt coalescing is enabled, a small amount of latency is introduced since some packets stay in the receive queue longer before they are processed by the host.

By default, interrupt coalescing is disabled.

C.4.1 Enabling Interrupt Coalescing

To enable interrupt coalescing, perform the following:

1. Add the following command to the end of the **/var/sysgen/master.d/fore_he** file:

```
set fore_he:he_intr_coalesce=1
```

NOTE To maximize HE622 performance and to avoid potential problems due to the increased packet latency, it is recommended that interrupt coalescing be enabled; *and* the TCP buffer spaces be set to 512 kbytes, *and* UDP buffer spaces to 64 kbytes as explained in Section *C.2, TCP Performance* and Section *C.3, UDP Socket Buffer Overflows.*

APPENDIX D Two-Node Origin200 and 2GB Octane Support

ForeThought 5.1 software supports FORE Systems PCI ATM adapters in Origin200 two-node configurations running IRIX 6.5. Support is available for the HE155 and HE622 adapters.

The maximum configuration of an Origin200QC system can consist of two towers connected together using the CrayLink™ interconnection fabric. Two Origin200QC systems connected in this way enable the independent machines to function as one. From a user's perspective, they become one machine with pooled resources. For example, each Origin200QC contains three PCI slots, so a two-node Origin200QC has a total of six PCI slots. In this configuration, one Origin200QC is designated as Master (Module=1, NodeID=0) and the other as Slave (Module=2, NodeID=1).

The remainder of this appendix discusses problems that could be encountered when using FORE Systems PCI ATM adapters in Origin200QC two-node systems or Octanes with greater than 1.5 GB of main memory followed by possible solutions. Performance tuning options are also discussed.

NOTE

This problem does not apply to cards placed in the Gigachannel expansion box. However, due to an address translation limitation on the Octane; Octanes with more than 1.5 GB of main memory are subject to this problem as well.

D.1 The Problem

The configuration problem arises with the 40-bit physical addresses used by IRIX 6.5 to access memory. The 40-bit physical address space is divided as follows:

- NodeID [39:32] - Maximum of 256 nodes
- Address [31:0] - Maximum of 4GB of memory on each node

  NodeID identifies the node on which Address is present.

FORE Systems adapters use 32-bit PCI addresses (i.e., when the card does Direct Memory Addressing (DMA), it can use only 32-bit addresses). Therefore some form of mapping from 40-bit physical addresses to 32-bit PCI addresses is required. To support 32-bit PCI cards, Silicon Graphics, Inc. supports “Mapping Registers” in its PCI bridge.

Whereas, Origin200QC systems are available with only 128 such mapping registers, the Origin 2000s have 16384 mapping registers. Because of the limited number of mapping registers in the Origin200, it is difficult to sustain OC12 rates.

NOTE

This problem does not apply to cards placed in the Gigachannel box. However, due to an address translation limitation, Octanes with more than 1.5 GB of main memory are also subject to this problem.

D.1.1 Single Origin200 Systems

When there is only one Origin200, it is assigned a NodeID of zero. Silicon Graphics hardware provides a bypass to avoid using mapping registers when the buffer being used for DMA is present on NodeID zero (i.e., the upper 8-bits (NodeID) of a 40-bit physical address are zero). So the hardware uses the lower 32-bits provided by the adapter and constructs the 40-bit physical address by padding zeroes in the upper 8 bits.

On a two-node Origin200 the DMA engine has to distinguish by some means if the adapter is accessing by means of DMA to or from memory present on node zero or one. Therefore, PCI drivers are forced to use the mapping registers to perform DMA.

D.2 The Solution

One solution to avoid using mapping registers is by using 64-bit PCI adapters (40-bit physical addresses can be completely specified by 64-bit PCI addresses). This solution can not be used because the current adapters use 32-bit PCI addresses.

Another solution is by ensuring that buffers used for DMA are always allocated on node zero, so that the driver can use the bypass described above.

The solution is implemented in *ForeThought* 5.1 as follows:

- Receive loaned buffers are by default allocated on node zero.
- At initialization, the driver detects if it is running on a two-node Origin200 configuration and sets aside a fixed number of buffers from node zero (node zero buffers). During transmit, the driver first attempts to map the buffer (either by using the bypass if the buffer is from node zero or by using DMA map registers). If that fails (because the system is out of mapping registers), data is copied into one of the pre-allocated node zero buffers and the transmission is completed. Copying is necessary in the transmit path since the driver does not have control on which node the buffer to be transmitted is allocated. (Transmit buffers are typically allocated by socket / TCP / UDP / NFS / IP layers.)

D.3 Tunable Parameters

The following variables, declared in **/var/sysgen/master.d/fore_he**, control the number and size of the transmit buffers set aside from node zero (i.e., Master Origin200) during initialization. These buffers are used in the transmit path for copying when the system runs out of mapping registers.

- **he_node0_buf_pool_size** The number of node zero buffers to be pre-allocated. The driver uses 128 transmit entries to queue transmit buffers to the firmware. So the maximum value this variable can take is 128. By default this variable is set to 128 during installation. The default value is appropriate for most installations.

- **he_node0_buf_size** — The size of each node zero buffer to be pre-allocated. This should at least be equal to the maximum MTU size of FORE IP, Classical IP or LAN Emulation of the network interface being used. In addition, if XTI is being used, it should at least be equal to the maximum PDU transmitted by any XTI application. In other words, **he_node0_buf_size** should at least be equal to the maximum packet transmitted by the adapter. A default value of (10 * 1024) i.e., 18K bytes (works for most installations that use FOREIP, CLIP or LANE/MPOA) is assigned during installation.

Remember that (**he_node0_buf_pool_size * he_node0_buf_size**) bytes of memory from node zero (Master Origin200) are reserved per adapter during initialization. If memory is at a premium, these values need to be fine tuned for specific machine and network configurations.

If repeated "**node0_buf_pool EMPTY**" messages are displayed in the SYSLOG, it is an indication the **he_node0_bug_pool_size** is not large enough to sustain network traffic. If "**pdu length(xx) is greater than he_node0_buf_size(xx)**" messages appear in the SYSLOG, increase **he_node0_buf_size** appropriately.

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