COMPAQ

SCO UNIX Connectivity to SNA Environments Over X.25 Networks

Compaq TechNote

Includes information on:

- SNA Gateway Platform
- Installation and configuration procedures
- Operational characteristics

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SCO UNIX Connectivity to SNA Environments Over X.25 Networks

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Chapter 1
Introduction

This TechNote describes a COMPAQ ProSignia PC Server running SCO UNIX and providing simultaneous multiuser and TCP/IP network access to remote SNA sites over X.25 packet-switched networks. This system is implemented in the SNA network as a PU2.1 Cluster Controller with LU6.2/APPC support. Throughout this TechNote, we refer to this configuration as the "SNA Gateway Platform." This TechNote provides the installation and configuration procedures and operational characteristics to build and configure the SNA Gateway Platform.

Use the following table to help you locate the information you want.

Table 1-1
TechNote Chapter Summary

Chapter 1 INTRODUCTION	Contains a brief explanation of the TechNote purpose and presumptions.
Chapter 2 TECHNICAL OVERVIEW	Discusses functional subsystems that were integrated to form the SNA Gateway Platform and details on X.25 packet-switched networks and SNA networks.
Chapter 3 COMMUNICATION PRODUCTS	Discusses the products used in the SNA Gateway Platform. Presents a technical product overview and product highlights.
Chapter 4 SNA GATEWAY PLATFORM	Provides detailed, step-by-step instructions for installing, configuring, verifying status, starting, stopping, and removing components.
Appendix A ACRONYMS	Lists acronyms used in this TechNote and their meanings.
Appendix B VENDOR CONTACT INFORMATION	Lists mailing address and telephone information for the vendors referred to in this TechNote.

In this SNA Gateway Platform, we configured a COMPAQ ProSignia as a UNIX multiuser host system with TCP/IP network support. We incorporated multiport serial I/O capability using the DigiCHANNEL C/X EISA host adapter and concentrators configured to support 64 concurrent users. This TechNote presumes that you have installed the following on the COMPAQ ProSignia:

- SCO UNIX System V/386 Release 3.2.4 Operating System
- SCO TCP/IP Runtime System 1.2
- DigiCHANNEL C/X EISA Multiport Serial I/O System

You can easily implement the SNA Gateway Platform into an X.25 packet-switched Wide Area Network (WAN) that interconnects remote SNA sites, as the following figure illustrates.

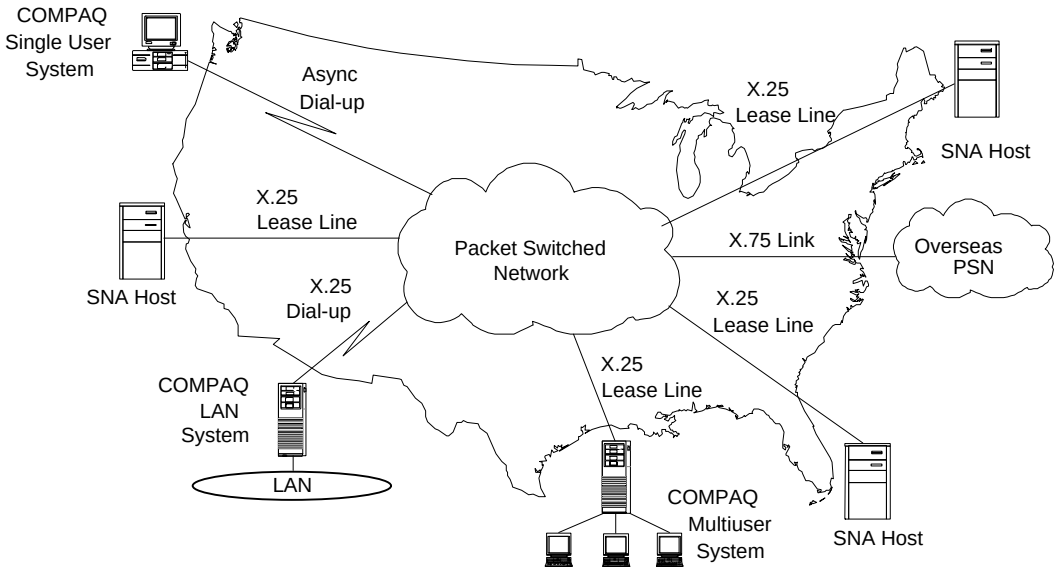


Figure 1-1. X.25 WANs Interconnecting Remote Sites

Chapter 2
Technical Overview

This chapter provides an overview of the functional subsystems that are integrated to form the SNA Gateway Platform. Specifically, this chapter discusses the following topics:

- X.25 packet-switched networks
- SNA networks

X.25 Packet-Switched Networks

X.25 networks and dedicated point-to-point links (leased lines) are the most commonly used means to establish wide-area links. These X.25 packet-switched networks are best suited for light-to-moderate network traffic requirements such as multiuser host interfaces and many transaction processing applications. Leased lines are best suited for continuous moderate-to-heavy network traffic requirements such as bridging of remote file server to file server connections. Leased lines might or might not use X.25.

In X.25 packet-switched networks, the X.25 protocol standard provides the interface. Worldwide, there are many suppliers of publicly accessible X.25 networks. These suppliers are commonly referred to as Public Data Network (PDN) providers. Many private X.25 networks also exist. These networks use leased lines, satellite links, microwave, and so on, and are referred to as private data networks.

Your decision to use PDNs or to create your own private network depends upon your requirements. You must consider such issues as cost and up-time. PDNs typically base their costs on line use. This results in cost fluctuations. Leased lines charge a fixed fee regardless of the traffic volume. As a result, the leased line resource is wasted during idle times. PDNs also perform dynamic routing which permits packet rerouting if a network node fails. The lack of alternate routing capability in leased lines might or might not be acceptable to your requirements.

The X.25 protocol is an interface to a wide-area, packet-switched network. The internal workings of the network are not important to end-nodes. When a source node sends packets via X.25 to the network, the network delivers the packets to network location closest to the destination node that interfaces with the network via X.25. This chapter provides an overview of this packet delivery process.

X.25 Standard

The X.25 standard specifies a Data Terminal Equipment (DTE) to Data Circuit-Terminating Equipment (DCE) interface. The DCE provides access to the packet-switched network. A COMPAQ ProSignia that is running the Eicon SNA Gateway products functions as a DTE. The X.25 standard defines three levels, as shown in the following figure.

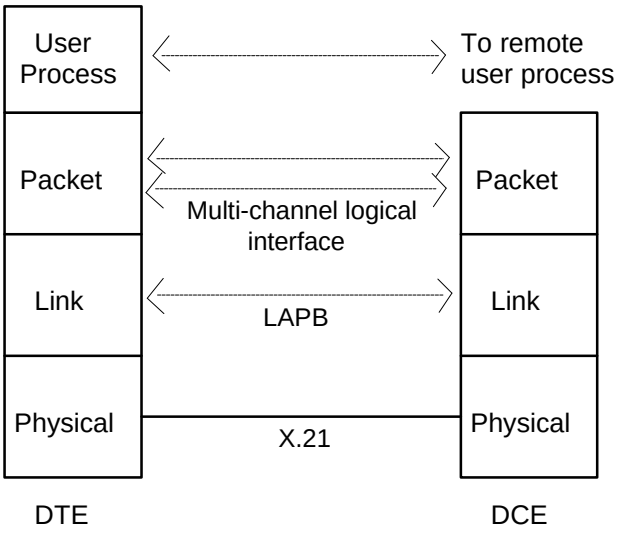


Figure 2-1. X.25 Interface

Physical Level

The X.21 standard is specified. However, the RS-232-C or V.35 standard is commonly used.

Link Level

X.25 defines both a Single Link Procedure (SLP) and a Multi-Link procedure (MLP) that allows the interface to operate over multiple lines. The SLP is defined to be Link Access Procedure Balanced (LAPB). When multiple links exist, each link utilizes SLP LAPB.

Packet Level

X.25 specifies a virtual circuit service. Two types of virtual circuits exist: virtual call and permanent virtual circuit. A virtual call is dynamically established. A permanent virtual circuit is a network-assigned virtual circuit. A DCE can establish up to 4095 simultaneous virtual circuits with DTEs over a single DTE-DCE link. Individual virtual circuits could correspond to applications, processes, terminals, and so on. The DTE-DCE link provides full duplex multiplexing.

Packet-Switched Network Internals

Packet-switched networks are complex in their internal workings and employ routing services using one of two techniques. However, the key functional elements found in each technique include:

- Routing
  Because source and destination nodes are not directly connected, the network must route each packet from node-to-node through the network.
- Traffic Control
  Network traffic must be regulated for proper flow and congestion control to provide efficient, stable, and predictable performance.
- Error Control
  Measures must be taken to handle lost packets as well as link node and station failures.

The approach used to provide this functionality varies between packet-switched networks. Internally, and sometimes externally, the network provides either a virtual circuit or datagram routing service.

With a virtual circuit service, the network delivers the packets in the sequence they were received. With a datagram service, the network handles packets independently and does not guarantee the delivery sequence. The following paragraphs describe virtual circuits and datagram services.

Virtual Circuit Service

A virtual circuit is a bi-directional logical connection between two nodes over which packets are transmitted. There are two types of virtual circuit services, permanent and switched. With a switched virtual circuit, the node and station must exchange call-setup and call-clearing information to create and remove the virtual circuit.

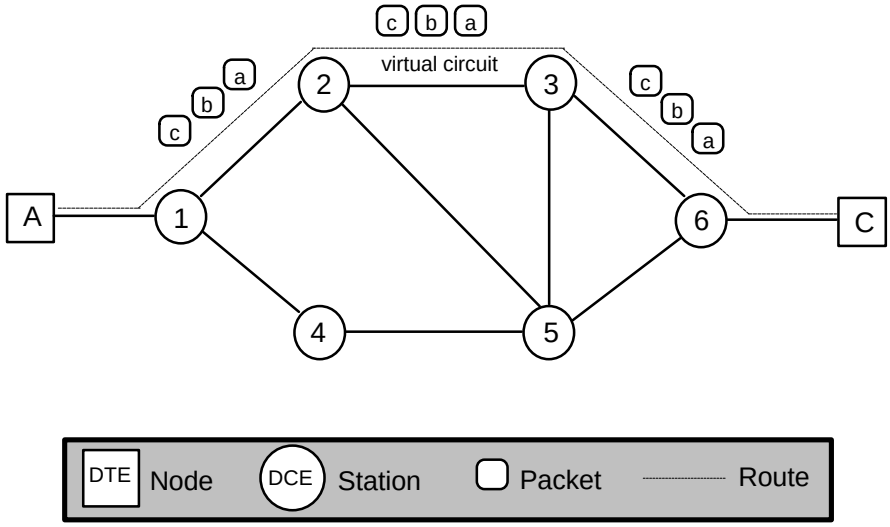


Figure 2-2. Virtual Circuit Service

When a node requests a station to send packets to another node, the station determines a routing sequence. The station considers current network traffic, the number of hops, and so on, and establishes a virtual circuit. All subsequent packet transmissions between the two nodes occurs over this virtual circuit until all packets for this transmission group are transmitted. Therefore, routing decisions are made only at setup time.

This approach minimizes per-packet overhead because routing decisions are made only once per virtual circuit. It also guarantees that the packets arrive at the station closest to the destination node and in the proper sequence.

Datagram Service

When a node requests a station to send packets to another node, the station treats each packet independently and determines the routing sequence on a per-packet basis. As a result, the packets can travel different routes even though they are part of the same transmission group. This technique does not ensure that the packets are received by the station closest to the destination node in the original sequence. The receiving station usually performs buffering and sorting of the packets prior to transmitting them to the destination node. Popular networks utilizing this approach are SNA and DECNet.

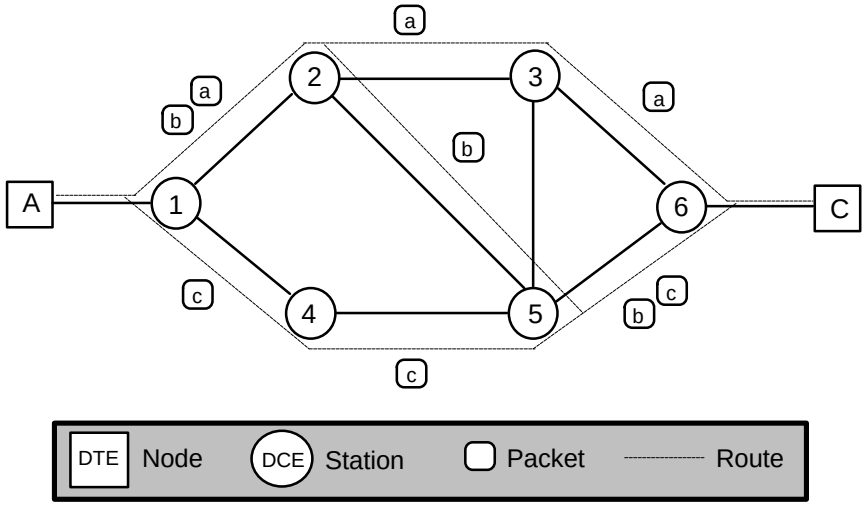


Figure 2-3. Datagram Service

Many packet-switched networks provide the best of both approaches. They employ an internal datagram service because of its robustness and dynamic routing flexibility. These networks also provide an external virtual circuit service by performing buffering and sorting of the packets at the receiving station.

Connecting to Public Packet-Switched Networks

There are many suppliers of PDNs available today. The most popular PDNs focusing primarily on transport services are Telenet, Tymnet, and Infonet. These PDNs provide global connections to over 70 countries. You can access these networks using any of the following:

- Asynchronous dial up: Uses standard asynchronous modems with connections at 300, 1200, 2400, and 9600 Kb/s using V.32.
- Leased lines: Uses either asynchronous or synchronous protocols.

  Asynchronous: Analog lines operate at 1.2 to 19.2 Kb/s and digital at 9.6 to 56 Kb/s. Depending on the line type, a modem or Digital Service Unit (DSU) is required.

  Synchronous: This is the most popular means for high-volume, multi-session support. The major advantage of synchronous over asynchronous lines is the ability to allow many users to share the same physical link. Line speeds of 1.2, 2.4, 4.8, 9.6, 14.4, 19.2 and 56 Kb/s are available. Depending on the line type, a modem or DSU is required. Tymnet advises that a single 4.8 Kb/s line can typically support 16 simultaneous users while a 14.4 Kb/s line can handle 48. This is the connection method we used in the SNA Gateway Platform.
- X.25 dial up (X.32): X.32 provides basically the same functionality as synchronous leased lines without the cost of a leased line. Using V.32 synchronous modems operating at 9.6 Kb/s, throughput is essentially the same as low-to-medium range synchronous leased lines.

Summary

The X.25 is a relatively old technology; the standards were originally developed in 1976 and last updated in 1988. However, X.25 packet-switched networks enjoy worldwide acceptance today. There are many public and private X.25 networks in place that provide highly flexible, reliable, and cost-effective connectivity solutions.

X.25 networks guarantee the reliable delivery of data by detecting and correcting packet errors at every hop across the network. In addition, they provide the ability to establish up to 4095 simultaneous virtual circuits over a single physical link. As a result, you can easily perform global internetting of remote sites.

Internally, X.25 networks are slower than traditional 10-Mb/s Ethernet networks. Internal network speeds are typically between 64 Kb/s and 2 Mb/s. External connections operate even more slowly. Modem connections between X.25 DTE-DCEs typically operate at 2400 byte/s to 19.2 Kb/s. Leased lines can operate at 56 Kb/s to 1.544 Mb/s (T1 service).

X.25 networks provide a means to connect geographically dispersed sites in a cost-effective manner. Worldwide, there are many suppliers of commercial X.25 PDNs who also provide a range of value-added services such as email, store-and-forward, dial-out, and network management.

SNA Networks

The SNA protocol provides a framework for communications between IBM and non-IBM devices. SNA is a communication protocol model comprised of seven distinct functional layers similar to those of the Open Systems Interconnection (OSI) model. The following figure depicts a typical SNA network configuration.

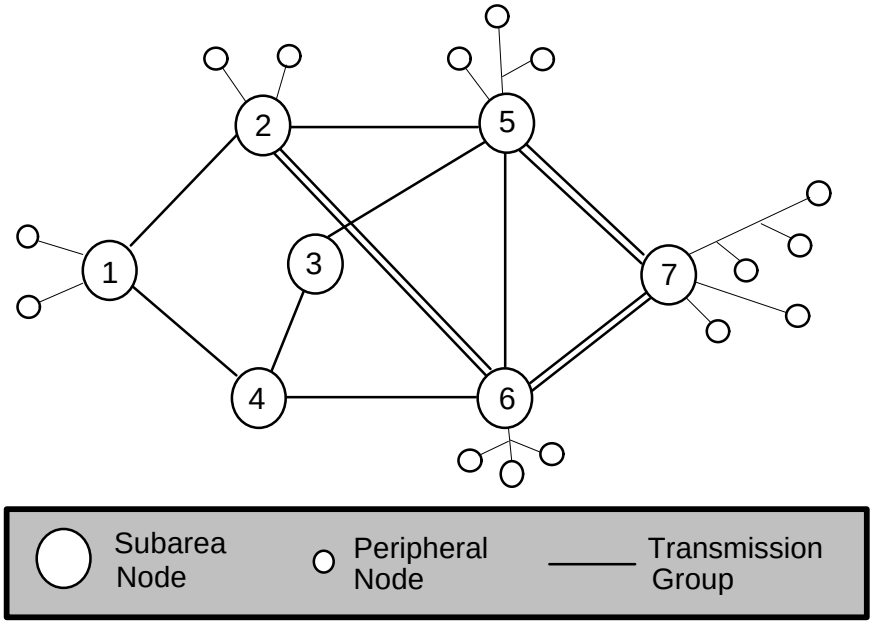


Figure 2-4. SNA Network Configuration

Network Node Types (PUs)

First introduced in 1974, the SNA standards specified a terminal-to-host communications network (hierarchical network) where a single mainframe host controlled all communications between network nodes, peripheral devices, and end-users (terminals and printers). Each network node only needed to understand and implement a subset of the SNA architecture required to perform its function.

SNA defines three types of nodes: host subarea nodes, communications controller subarea nodes, and peripheral nodes. Terminals and printers are classified as SNA end-users. Node types are classified as Physical Units (PU):

- PU type 5 (host subarea node)
  A mainframe computer that implements the Virtual Telecommunications Access Method (VTAM) software. VTAM implements the SNA System Services Control Point (SSCP) software that controls and manages a predefined portion of an SNA network. SSCP tracks which network nodes are running and which nodes must be activated. SSCP also manages which SNA terminals can access which operating environments (for example, Customer Information Control System - CICS) on the host.
- PU type 4 (communications controller subarea node)
  A front-end processor that implements the Network Control Program (NCP). NCP provides the SNA functions necessary for controlling communication lines and routing. It also manages the flow of data in the network.

- PU types 1, 2, and 2.1 (peripheral nodes)
  These PU types describe all other SNA nodes, such as cluster controllers, that control SNA end users, terminals, and printers. PU1 type nodes are old technology and are rarely used. PU2 nodes are widely used and can communicate only with PU5 nodes.

  As technology improved, mini- and micro-computers were introduced. To incorporate these systems intelligently into an SNA network, PU2.1 was defined. PU2.1 provides for distributed processing by providing any-to-any connectivity without mainframe host intervention. PU2.1 is the blueprint used within SNA to provide Advanced Peer-to-Peer Networking (APPN).

  The following figure illustrates a typical SNA network topology.

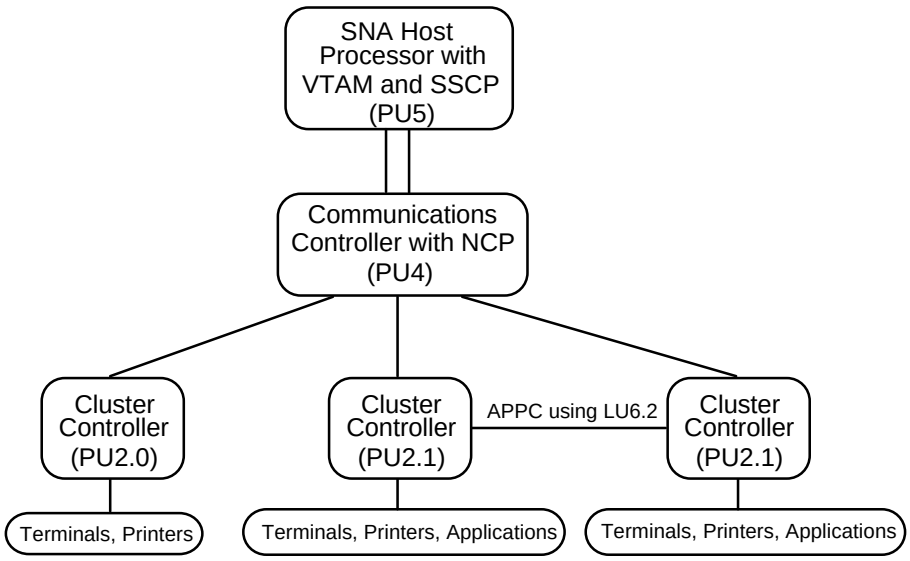


Figure 2-5. SNA Network Topology

Network Session Types (LUs)

An SNA node contains one PU and one-to-many Logical Units (LUs). LUs are defined by SNA as an interface in which an end-user obtains access to an SNA Network. It is most easily thought of as a communications port. Connections between LUs are defined as "sessions." Within these sessions, one LU is designated as the Primary LU (PLU) and the other as the Secondary LU (SLU). Before the introduction of PU2.1, the PLU always resided on PU5 and the SLU on PU2.

The PLU handles error recovery and establishes session rules during session creation. SLUs must only have the intelligence to control terminals and printers. PU2 nodes implement one LU per end user. PU2.1 nodes allow many end users per LU. LUs can be configured into a pool of LUs. This approach provides for a dynamic allocation of LUs based on end-user session request.

SNA defines eight different types of LUs:

- LU type 0 - Provides generalized program-to-program communications
- LU type 1 - Used for Remote Job Entry (RJE) workstations
- LU type 2 - Used for interactive 327X terminals attached to cluster controllers
- LU type 3 - Used for printers attached to cluster controllers
- LU type 4 - Used for program-to-terminal word processing
- LU type 6.0 and 6.1 - Used for host program-to-program communications
- LU type 6.2 - Used for any-to-any program communications (PU2.1 and PU5)
- LU type 7 - Used for program-to-5250-terminals communications (AS/400 and S/36 minicomputers)

With the exception of LU 6.0, 6.1, and 6.2, all communications are with applications residing on the mainframe host. LU6.2 is the most recent addition to the standards. It is the vehicle used within SNA to provide for peer-to-peer distributed network functionality.

Routing

Communications within an SNA network is a complex subject. In general, the SSCP, PU, and LU communicate with one another and are called Network Addressable Units (NAU). Messages flowing within the network carry a unique address of the destination SSCP, PU, or LU. The communication controllers (PU4) are responsible for routing messages throughout the network.

SNA networks are divided into subareas that consist of a host subarea node (PU5) or a communications controller subarea node (PU4) and its attached peripheral nodes (PU1, 2, 2.1). Each network message contains a subarea address (destination subarea node) and an element address (resource within the subarea, such as a terminal).

Routing within an SNA network occurs by using an end-to-end static routing mechanism that supports multiple routes between subarea nodes if multiple physical paths exist. There are two types of SNA routes: explicit and virtual.

Explicit Route

A physical route between two subarea nodes. An explicit route defines a sequence of nodes and a Transmission Group (TG) from one subarea to another. A TG is a group of one or more links connecting subarea nodes.

Messages for a specific SNA session are queued for transmission over any available link within the same transmission group. The receiving end of the TG must reorder the messages received on different links belonging to the same transmission group. This is a datagram service which provides for robust communications by providing dynamic routing and load balancing across TGs.

Virtual route

A logical connection between two subarea nodes. Virtual routes provide routing without regard to explicit (physical) routes. Virtual routes consist of a virtual route number and a Transmission Priority (TP) of low, medium, or high.

During activation of an SNA session, a virtual route is mapped to an explicit route with a TP. Multiple virtual routes can be mapped to a single explicit route. This allows multiple communication paths to exist and increases network load distribution and network performance.

Connecting SNA Nodes Over X.25

There are several methods of connecting SNA nodes. The most common and widely used methods are SDLC, X.25, and Token-Ring Interface Card (TIC). An X.25 link is the most flexible connection for linking remote nodes. This is because X.25 communications can support multiple logical connections over a single physical link. A node connected to an X.25 network can simultaneously communicate with all nodes on the network. The access method in the SNA Gateway Platform is X.25 using the Qualified Logical Link Control (QLLC) system. QLLC is the IBM standard for SNA data packaged for transmission over an X.25 network.

The IBM SNA-to-X.25 product that implements QLLC is called NCP Packet Switching Interface (NPSI). NPSI is a software package that runs on a PU4 communications controller and converts the PU4 into an X.25 DTE. It also allows the ports on the PU4 to be configured to run X.25 instead of SDLC. Using NPSI, SNA PU5 host nodes may communicate using X.25 with PU 1, 2, 2.1, 5, and non-SNA X.25 DTEs.

Summary

With the recent addition of PU2.1 and LU6.2, distributed processing using peer-to-peer networking and program-to-program communications is possible under SNA. The standard which defines this capability is referred to as the System Application Architecture (SAA) and supports a dual network protocol stack of SNA and OSI. SAA defines a collection of interfaces, protocols, and products that facilitates the implementation of this functionality (for example, SNA/LU6.2 and APPC).

Advanced Program to Program Communications (APPC) is an interface standard. This standard defines a set of Application Program Interfaces (API) which permits application programs to communicate with one another across an SNA LU6.2 session. Eicon Technology provides a product called *APPC Developer Toolkit for UNIX* which provides these APIs. You can use this product to provide a development environment for distributed applications within an SNA network.

You can achieve SNA connectivity to industry standard X.25 networks by using NPSI. NPSI is the IBM vehicle for providing SNA networks with global interconnecting capability over X.25 PDNs.

Chapter 3
Communication Products

This chapter discusses the Eicon Technology and the DigiBoard products that we used in the SNA Gateway Platform. We present a technical overview for each product, along with a list of product highlights.

EiconCard HSI/PC Communications Adapter

The EiconCard HSI/PC from Eicon Technology is a 1-Megabyte communications adapter that we used in the SNA Gateway Platform to enable the COMPAQ ProSignia to interface to the X.25 packet-switched network. The adapter features a 32-bit, 16-MHz Motorola 68000 microprocessor with 1 megabyte of memory. It has a single communications port which is a High Speed Interface (HSI), supporting speeds of up to 384 Kb/s and is configured to interface with V.24, X.35, or X.21 synchronous modems.

The V.24 interface is compatible with CCITT V.24, V.28, X.21*bis*, and EIA RS-232-C, which is used in this TechNote. Optionally, you may use a null-modem cable to create a direct connection between two systems containing EiconCards.

The EiconCard adapter is an intelligent communications card which performs all protocol processing on-board. The protocol software is loaded onto the EiconCard at boot time. For this TechNote, HDLC, X.25, SNA, and APPC protocols are downloaded at boot-time by the Eicon Technology SNA PC Gateway for UNIX software. Once downloaded, the protocol software runs under its own real-time OS, thereby providing the functionality required for simultaneous access to multiple hosts.

SNA PC Gateway for SCO UNIX Software

This is the Eicon Technology software product that we used in the SNA Gateway Platform to enable the COMPAQ ProSignia to function as Cluster Controller in an SNA environment. In this configuration, the software provides simultaneous access to multiple SNA hosts over an X.25 packet-switched network.

In the SNA architecture, LUs provide access to an SNA host or network. PUs manage LUs. Each PU can manage one or more LUs and is generally implemented in a piece of hardware called a Cluster Controller (CC). The SNA PC Gateway software for SCO UNIX can simultaneously emulate multiple (maximum of 32) PUs on each EiconCard adapter. Other highlights of the product are:

- Communications Protocols - X.25/QLLC and SDLC (Synchronous Data Link Control) at speeds up to 384 Kb/s
- PU types - 1 (RJE - 5294, 5394), 2.0 (CC - 3274) and 2.1 (CC - 3174)
- EiconCards supported - 4 maximum per SNA PC Gateway for UNIX package
- LU types - 0, 1, 2, 3, 4, 6.2, and 7
- Concurrent LU sessions - 254 maximum per EiconCard adapter

Eicon Technology Certification Compliance

The Eicon Technology product is certified as compliant in the following countries:

Argentina	Australia	Austria	Bahamas	United Kingdom
Bahrain	Belgium	Brazil	Canada	United States
Chile	Colombia	Costa Rica	Denmark	Venezuela
Egypt	Finland	France	Germany	
Greece	Honduras	Hong Kong	Iceland	
India	Indonesia	Ireland	Israel	
Italy	Korea	Kuwait	Luxembourg	
Malaysia	Mexico	Netherlands	New Zealand	
Norway	Peru	Portugal	Puerto Rico	
Saudi Arabia	Singapore	Spain	Sweden	
Switzerland	Taiwan	Thailand	Turkey	

Access for SCO UNIX 3270 Emulation Software

This is the Eicon Technology software product that we used in the SNA Gateway Platform to enable the COMPAQ ProSignia to provide 3270 terminal and 3287 printer emulation. Highlights of the product are:

- Terminal emulation - 3278 (models 2, 3, 4 and 5), 3279 (models 2A, 2B, 3A, 3B and S3G)
- Printer emulation - 3287-1 (PU1 SNA Character Stream), 3287-3 (PU3 3270 Data Stream)
- File transfer - IND$FILE
- Concurrent host sessions - 254
- Keyboard remapping facility

EiconAPPC Developers Toolkit Software

This is the Eicon Technology software product that we used in the SNA Gateway Platform to provide Application Program to Program Communications between SNA PU2.1 nodes over LU6.2 sessions. The package consists of a 'C' library containing the Application Program Interfaces (API) which closely adhere to the IBM APPC/PC verb set. It features a full implementation of LU6.2 protocol (except for option set numbers 1, 5, 10, 15, 22, 23, and 40). The package includes Basic and Mapped Conversation verbs, Control Operator Functions, and Security Functions. You can use this package to configure a PU2.0 or PU2.1 to support LU1, LU2, LU3, and LU6.2 sessions. You can also configure a PU1 to support LU4 and LU7 sessions.

Eicon Technology also produces an *SNA Function Management Developers Toolkit* which provides full support for LU0, LU1, LU2, LU3, LU4, and LU7 sessions. This product is not addressed in this TechNote.

DigiCHANNEL C/X EISA Intelligent I/O Subsystem

The DigiCHANNEL C/X EISA system provides a convenient, high-performance, and cost-effective method of multiport serial I/O with a capacity of 16 to 128 concurrent users per adapter. You can install a maximum of four adapters for a total capacity of 512 ports. The system is comprised of a microprocessor-controlled host adapter board with one to eight external intelligent concentrators. A single-host adapter can support 64 concurrent users at data rates up to 38.4 Kb/s or 128 concurrent users at lower data rates.

Each external concentrator provides 16 serial port connections and uses its own microprocessor to reduce demand on the host system processor dramatically. To aid system administration and monitoring, each concentrator contains a diagnostic and activity display for each port.

Putting It All Together

Organizations that have existing SNA environments can integrate high performance and cost-effective SNA solutions using the COMPAQ ProSignia and the Eicon Technology SNA and X.25 products. Industry standard X.25 packet-switched network services are available worldwide and provide a reliable and flexible communications vehicle for interconnecting geographically dispersed sites. SNA is the IBM master plan for communications between IBM devices and other industry-standard networks such as X.25. In this TechNote, industry standards such as COMPAQ, UNIX, and X.25 are integrated together to form a powerful and flexible base solution for many current wide-area connectivity requirements. Most major network protocols, including TCP/IP, OSI, and SNA, are supported by this base platform.

We configured the SNA Gateway Platform presented in this TechNote to provide simultaneous multiuser and TCP/IP network access to remote SNA sites over an X.25 packet-switched network. We connected the platform to the X.25 DCE using the High-level Data Link Control (HDLC) synchronous protocol over a 56 Kb/s leased line via a Digital Signaling Unit (DSU). We then implemented it in the SNA network as a PU2.1 Cluster Controller. The platform provides LU0, 1, 2, 3, 4, 6.2, and 7 session support to the remote 9370 PU5 node and LU6.2/APPC session support to the remote COMPAQ system PU2.1 node.

Components

The base platform consists of a COMPAQ ProSignia running SCO UNIX. This TechNote assumes that the base platform already has the SCO UNIX operating system installed and running. To provide network access to the platform, we used the COMPAQ NetFlex network controller (a standard component on the COMPAQ ProSignia) and SCO TCP/IP Runtime System and configured the platform as a network node. To provide multiuser access to the platform, we added the DigiCHANNEL C/X EISA multiport I/O subsystem and configured the platform as a multiuser host system capable of supporting 64 concurrent users. To provide X.25 and SNA connectivity, we added the Eicon Technology products and configured them as described in this TechNote.

The following table lists the SNA Gateway Platform components. For the minimum system configuration required for the Eicon Technology SNA PC Gateway for UNIX product, refer to the *SNA PC Gateway for UNIX Users and Administrators Guide*.

Table 3-1
SNA Gateway Platform Components

COMPAQ Hardware
COMPAQ ProSignia PC Server Model 486DX2/66-550 with:
2 additional 4-Megabyte Single Inline Memory Modules (SIMMs), for a total of 16 Megabytes
COMPAQ 5 1/4-Inch 1.2-Megabyte Diskette Drive
COMPAQ 320-/525-Megabyte Tape Drive
COMPAQ NetFlex Controller
Operating System Software
SCO UNIX System V/386 Release 3.2.4 Operating System
SCO TCP/IP Runtime System 1.2
SCO UNIX Maintenance Supplement 4.1
COMPAQ Supplement 1.5 for SCO UNIX Systems V/386 Release 3.2.4
SNA Gateway Communications Hardware and Software
Eicon Technology EiconCard HSI/PC Communications Adapter hardware
Eicon Technology SNA PC Gateway for SCO UNIX software
Eicon Technology Access for SCO UNIX 3270 Emulation software (unrestricted user version)
Eicon Technology Eicon APPC Developers Toolkit software
Multiport I/O Hardware
DigiCHANNEL C/X EISA communication adapter
4 C/CON-16 Concentrators for a total of 64 asynchronous ports
Miscellaneous Hardware
Liberty 120 Terminals
NEC Pinwriter P5300 132-Column Printer

Topology

The tested topology for the SNA Gateway Platform includes various terminal and printer sessions attachments. Each of these attachments access an IBM 9370 mainframe running a Virtual Machine (VM) Operating System connected by X.25 over a 56-Kb/s leased line connected to a private packet-switched network. It also includes APPC/LU6.2 program-to-program communications to another SNA PU2.1 node application.

We used the following connection schemes to emulate 3270 series (3278 model 2) terminal sessions with the mainframe:

- COMPAQ ProSignia system console emulating an ANSI terminal
- Liberty terminal emulating a Wyse-60 asynchronously-connected to the COMPAQ ProSignia COM 1 serial port
- Liberty terminal emulating a Wyse-60 asynchronously-connected to the DigiCHANNEL C/X EISA multiport I/O communications system
- COMPAQ personal computer emulating a Wyse-60 asynchronously-connected to the DigiCHANNEL C/X EISA multiport I/O communications system
- Network-connected COMPAQ personal computer utilizing Telenet emulating a VT-100 terminal

To emulate 3287 printer sessions with the mainframe, we routed the IBM 3287-3 print stream data by the SNA PC Gateway software to the UNIX system print spooler.

To perform file transfers to and from the mainframe, we used IND$FILE.

To perform APPC/LU6.2 sessions, we used APPC between the SNA Gateway Platform and another COMPAQ system configured as a PU2.1 node with APPC/LU6.2 support. This SNA node used the same Eicon Technology products as the SNA Gateway Platform.

The following figure illustrates the topology we used to validate the functionality of the SNA Gateway Platform:

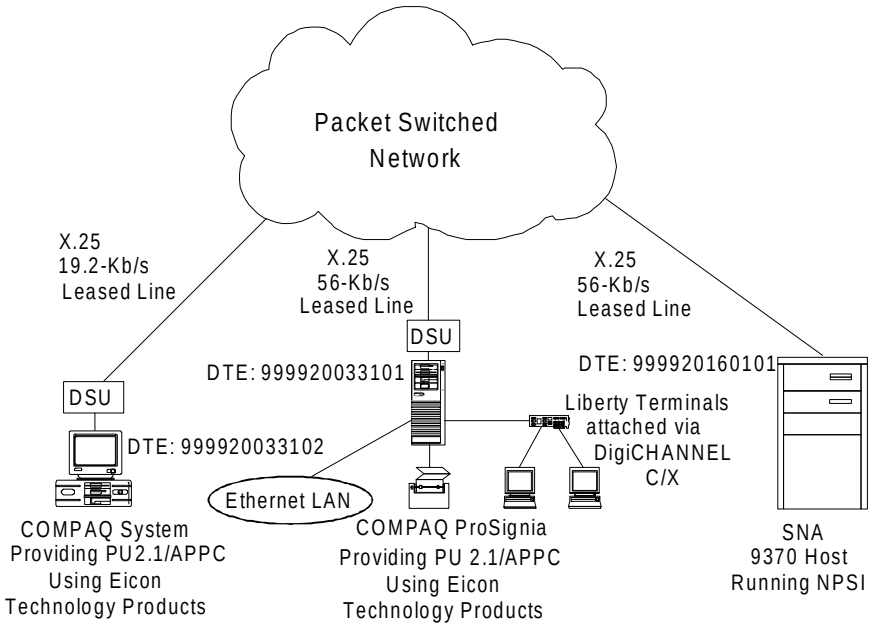


Figure 3-1. SNA Gateway Platform Tested Topology

Chapter 4
SNA Gateway Platform

This chapter provides detailed step-by-step instructions for performing the following:

- Installing the X.25, SNA, and APPC components
- Configuring and verifying the status of each component
- Starting, stopping, and using each component
- Removing the components

For a complete listing of the SNA Gateway Platform X.25 and SNA components, see Table 3-1 in Chapter 3.

Building the Gateway

You must install the EiconCard HSI/PC communications adapter and three software products to build the gateway.

EiconCard HSI/PC Communications Adapter

In the configuration used in this TechNote, we set the EiconCard adapter to the default factory settings, which includes using IRQ 3. The default setting for the COM 2 serial port is also IRQ 3. Therefore, you must disable the COM 2 serial port in both the UNIX kernel and the COMPAQ EISA Configuration Utility.

Disabling the COM 2 Serial Port

To remove the COM 2 port from the UNIX kernel, perform the following steps:

1. Start up the COMPAQ ProSignia using the usual UNIX boot procedure. The following prompt displays on the screen:

```
Type CONTROL-d to proceed with normal startup,
(or give root password for system maintenance):
```

2. Enter the root password.

   This brings the system up in single user mode.

3. At the "#" prompt, enter

   ```
   sysadmsh
   ```

4. Select, in sequence, *System* → *Hardware* → *Card_Serial* from the menus hierarchy.

5. If an entry containing the *interrupt = COM2* string displays, enter

   ```
   r
   ```

   otherwise, enter

   ```
   q
   ```

   and skip to the next section titled *Installing the EiconCard Communications Adapter*.

6. If you entered **r** in the previous step, enter the number of the line containing the string *interrupt = COM2*.

7. Enter **y** after each of the following prompts display:

   "Do you wish to create a new kernel now?"

   "Do you want this kernel to boot by default?"

   "Do you want the kernel environment rebuilt?"

8. Shut down the UNIX operating system before proceeding to the next section by entering the following at the "#" prompt:

   ```
   shutdown -g0 -y
   ```

Installing the EiconCard Communications Adapter

To install the EiconCard adapter, perform the following procedure:

1. Turn off the COMPAQ ProSignia. Then, disconnect the AC power cord.
2. Loosen the thumbscrews on the rear panel, and remove the system side cover.
3. Remove the retaining screw and option slot cover from an available slot.
4. Ensure that the EiconCard is configured with the default dip switch settings (1=off, 2=off, 3=on, 4=on) which represents an I/O address of 380h.
5. Insert the EiconCard into the slot and record the slot number.
6. Secure the board in place with the retaining screw.
7. Replace the cover on the COMPAQ ProSignia.
8. Connect the cable to the back of the Communications Adapter (CA) board.
9. Reconnect the COMPAQ ProSignia AC power cord and any peripheral devices.

Running the COMPAQ EISA Configuration Utility

This section provides the configuration procedures for the EiconCard adapter. For this procedure, you need the COMPAQ System Configuration diskettes that came with the COMPAQ ProSignia.

NOTE: The following instructions are specific to Version 2.10 of the COMPAQ EISA Configuration Utility and might not apply to previous or future versions.

To begin the configuration, complete the following steps:

1. Insert the COMPAQ System Configuration diskette into the diskette drive and turn on the system.
2. When the COMPAQ logo screen displays, press **ENTER**.
3. When the System Configuration Welcome screen displays, press **ENTER** again. The main menu displays on the screen.
4. Select *Configure computer*.
5. From the Steps in configuring your computer menu, select *Step 3: View or edit details.*
6. Position the cursor on *COM2* under the category *Integrated Interfaces* and press **ENTER**.
7. Select *Disabled* from the pop-up menu.
8. Press **F7** to invoke the Advanced menu.
9. Select *View additional system information* menu from the Advanced menu.
10. Select *Available resources* from the View additional system information menu.

11. From the Available Resource screen, verify that the following values are available:

I/O Ports	380
IRQ	3
Memory	
Address	0C8000h
Amount	8k (minimum)

NOTE: The EiconCard supports the use of other values. However, we used the values shown above in this TechNote. Make a note of the values you use; they will be required later in this TechNote.

12. Press **ESC** three times to return to the Step 3: View or edit details menu.
13. Press **F10** to return to the Steps in configuring your computer menu.
14. Select the option *Step 5: Save and exit*.
15. Select the option *Save the configuration and restart the computer*.

    The Reboot screen displays.
16. Remove the System Configuration diskette from the drive and press **ENTER**.

    The COMPAQ ProSignia reboots, and the new configuration is in effect.

SNA PC Gateway Software

Pre-Installation Considerations

Before you install the SNA PC Gateway and Access 3270 products, you must obtain X.25 network and Control Unit (SNA PU and LU) information. You can obtain this information from your X.25 Network Provider and SNA Host Administrator. The following tables list and provide a brief explanation of this information. You will use this information during the configuration procedures for the EiconCard adapter.

Table 4-1
X.25 Parameters

Parameter	Description
Baud Rate	The baud rate between the EiconCard and the X.25 network. Valid range 2.4-384 Kb/s Value used: 56 Kb/s
Line Type	Switched or Non-switched Value used: Non-switched
Modem Interface	X.21, V.35 or RS232 Value used: RS232
Maximum Frame Size (N1)	HDLC frame size (5 bytes larger than X.25 packet size) Value used: 261
Maximum Window Size	Packets sent before acknowledgment received. Value used: 007
Maximum Packet Size	X.25 packet size (5 bytes less than HDLC frame size) Value used: 256
Number Virtual Circuits	Virtual circuit quantity and types that you have been assigned (Permanent Virtual Circuits (PVC), Incoming Virtual Circuits (IVC), Two-way Virtual Circuit (TVC), Out-going Virtual Circuit (OVC)). Values used: PVC=0, IVC=0, TVC=8, OVC=0

Obtain the following configuration information on Control Unit (SNA PUs and LUs) that is shown in the next two tables. You can obtain this information from your SNA host administrator. You will use this information during the configuration procedures for the SNA Gateway and Access products.

Table 4-2
SNA PU Parameters

Parameter	Description
Physical Unit Name	The name of the COMPAQ ProSignia when communicating with the SNA host. Value used: USIS00
Block ID	Maps to a hexadecimal host VTAM PU IDBLK value that is used in the host SNA exchange identifier (XID) command response. Value used: 017
Physical Unit ID	A number used when replying to an SNA exchange ID (XID) command, also referred to as the VTAM PU IDNUM. Value used: A9F67
Control Unit Address	The data link's Station Address at the host (the host "VTAM PU ADDR"). Value used: C1
DTE Address	X.25 address of host. Value used: 999920160101
Facilities	X.25 facilities (for example, reverse charging, packet size negotiation, and so on) Value used: none
Call User Data	Host specific Information. Value used: none

Each terminal or printer that communicates with the SNA host must have an assigned LU number and an LU type. LUs can be requested specifically by the Access 3270 software or assigned dynamically at session request time from an LU pool.

Table 4-3
Logical Unit (LU) Assignments

LU Type	Description
LU Number	A decimal number that serves as the local address of the LU. The first LU is numbered 2. Each subsequent LU is assigned the next available number. Value used: 65
LU Allocation	Identifies the LU for use by a terminal (display) or printer. Valid Values = (D)isplay, (P)rinter, (O)ther (LU6.2) and (N)ot-used Values used: 2-64=D, 65=P, 66=0
Maximum Frame Size	Size of PU buffer Value used: 265
Maximum Number of Frames to Buffer	Number of frames buffered by PU Values used: 007
Independent LU Support	Specifies whether LU sessions can be started without host intervention (APPC). Values used: Y

Installing the SNA PC Gateway For UNIX Software

This section describes the installation procedures for the SNA PC Gateway for UNIX software. To perform the procedures described in this section, you need the SNA PC Gateway for SCO UNIX diskettes.

To install the SNA PC Gateway software, perform the following steps:

1. Start up the COMPAQ ProSignia using the usual UNIX boot procedure. The following prompt displays on the screen:

```
Type CONTROL-d to proceed with normal startup,
(or give root password for system maintenance):
```

2. Enter the root password.

   This brings the system up in single-user mode.

3. At the "#" prompt, enter

   ```
   custom
   ```

4. At the Custom menu, select, in sequence,
   Install → *A New Product* → *Entire Product*

5. When requested, insert the SNA PC Gateway for UNIX Volume 1 diskette, and select *Continue*.

   The custom data files are installed and the product Prep script executes.

6. When prompted to again insert the SNA PC Gateway for UNIX Volume 1 diskette, select *Continue.*

7. When prompted, insert the remaining diskettes and select *Continue*.

   The files are extracted and the EiconCard SNA PC Gateway installation script executes.

8. At the prompt, "Are you installing the EiconCard Base Package on a Micro-Channel System...?" enter

   n

9. At the prompt, "Which of the following Eicon cards are you installing?" indicate the EiconCard HSI adapter by entering

   2

10. At the prompt, "Enter interrupt vector number:" enter

    3

11. At the prompt, "Enter I/O address in hex:" enter

    380

12. At the prompt, "Enter window address in hex:" enter

    c800

13. At the prompt, "Autoload of EiconCard:" enter

    y

14. At the prompt, "Is this information correct?" review your entries and, if correct, enter

    y

    The installation script checks the consistency of the values you entered.

15. The EiconCard driver software configuration portion of the installation script displays the following values:

Number of concurrent requests	128
Number of data buffers	128
Watchdog wake up period (in sec)	30
Load/Select-test timeout period	5

At the prompt, "Is this information correct?" enter

y

16. At the prompt, "Do you wish to create a new kernel now?" enter

y

17. Enter **y** after each of the following prompts display:

"Do you want this kernel to boot by default?"

"Do you want the kernel environment rebuilt?"

You must reboot the kernel to invoke the new configuration. To save time, we rebooted the system after finishing the remaining configuration procedures.

18. To exit, from the Custom menu select: *Quit* → *Yes*.

Configuring the Control Unit, EiconCard, and X.25 Link

Once you successfully install the SNA PC Gateway software, you must configure the Control Unit (SNA PUs and LUs), EiconCard adapter, and X.25 link. This section contains the following two sub-sections:

- The first sub-section provides the configuration procedures for a PU 2.1 with 65 LUs (63 3270 displays, one 3287 printer, and one LU6.2/APPC).
- The second sub-section provides the configuration procedures to configure the EiconCard for SNA/X.25 and optional APPC support.

PU 2.1 with 3270/3287 and LU6.2/APPC Support

While in single user mode, perform the following steps to configure a PU 2.1 with 65 LUs (63 3270 displays, one 3287 printer, and one LU6.2/APPC):

1. At the "#" prompt, enter the following commands:

```
cd /usr/lib/eicon
./sna config
```

2. The first screen displays a message on the 24th line saying, "Configuration File not found, Default values used." Press **F2** to add the first PU definition.
3. For a 3270 definition, press **F2**.
4. To define the PU on an X.25/QLLC line, press **F2**.
5. The Control Unit Configuration screen, which defines a PU, displays. The following four screen images show the configuration used for this TechNote. When you complete filling in the information requested in each screen, press **F4** for the next screen.

```
++++++CONTROL UNIT CONFIGURATION++++++++++++++++++++++++++++++++++
+                                                                 +
+  Physical Unit Name ..............................USIS00        +
+  Block ID (000 - FFF) ................................017      +
+  Physical Unit ID (00000 - FFFFF) ...................A9F67      +
+  Control Unit Address (00 - FF) .......................01      +
+  Physical Unit Protocol Type .........................QLLC      +
+  Virtual Circuit Type ...............................Auto      +
+  DTE Address:  (Channel Number if PVC)                          +
+  999920160101                                                   +
+  Facilities:                                                    +
+                                                                 +
+       Call User Data:                                           +
+                                                                 +
+  Maximum Number of Logical Units .........................065    +
+ LU Allocation (D=Display, P=Printer, O=Other, N=Not used):      +
+ 02.D    06.D    10.D    14.D    18.D    22.D    26.D    30.D   +
+ 03.D    07.D    11.D    15.D    19.D    23.D    27.D    31.D   +
+ 04.D    08.D    12.D    16.D    20.D    24.D    28.D    32.D   +
+ 05.D    09.D    13.D    17.D    21.D    25.D    29.D    33.D   +
+          (c) Copyright EICON TECHNOLOGY Corporation 1989-1992   +
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++


++++++CONTROL UNIT CONFIGURATION++++++++++++++++++++++++++++++++++
+                                                                 +
+                                                                 +
+  01.N                                                           +
+                                                                 +
+  34.D    46.D    58.D    70.N    82.N    94.N   106.N   118.N   +
+  35.D    47.D    59.D    71.N    83.N    95.N   107.N   119.N   +
+  36.D    48.D    60.D    72.N    84.N    96.N   108.N   120.N   +
+  37.D    49.D    61.D    73.N    85.N    97.N   109.N   121.N   +
+  38.D    50.D    62.D    74.N    86.N    98.N   110.N   122.N   +
+  39.D    51.D    63.D    75.N    87.N    99.N   111.N   123.N   +
+  40.D    52.D    64.D    76.N    88.N   100.N   112.N   124.N   +
+  41.D    53.D    65.P    77.N    89.N   101.N   113.N   125.N   +
+  42.D    54.D    66.O    78.N    90.N   102.N   114.N   126.N   +
+  43.D    55.D    67.N    79.N    91.N   103.N   115.N   127.N   +
+  44.D    56.D    68.N    80.N    92.N   104.N   116.N   128.N   +
+  45.D    57.D    69.N    81.N    93.N   105.N   117.N           +
+                                                                 +
+                                                                 +
+                                                                 +
+   (c) Copyright EICON TECHNOLOGY Corporation 1989-1992          +
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```

```
++++++CONTROL UNIT CONFIGURATION++++++++++++++++++++++++++++++++++++
+                                                                   +           +
+
+                                                                   +
+  129.N   145.N   161.N   177.N   193.N   209.N   225.N   241.N  +
+  130.N   146.N   162.N   178.N   194.N   210.N   226.N   242.N  +
+  131.N   147.N   163.N   179.N   195.N   211.N   227.N   243.N  +
+  132.N   148.N   164.N   180.N   196.N   212.N   228.N   244.N  +
+  133.N   149.N   165.N   181.N   197.N   213.N   229.N   245.N  +
+  134.N   150.N   166.N   182.N   198.N   214.N   230.N   246.N  +
+  135.N   151.N   167.N   183.N   199.N   215.N   231.N   247.N  +
+  136.N   152.N   168.N   184.N   200.N   216.N   232.N   248.N  +
+  137.N   153.N   169.N   185.N   201.N   217.N   233.N   249.N  +
+  138.N   154.N   170.N   186.N   202.N   218.N   234.N   250.N  +
+  139.N   155.N   171.N   187.N   203.N   219.N   235.N   251.N  +
+  140.N   156.N   172.N   188.N   204.N   220.N   236.N   252.N  +
+  141.N   157.N   173.N   189.N   205.N   221.N   237.N   253.N  +
+  142.N   158.N   174.N   190.N   206.N   222.N   238.N   254.N  +
+  143.N   159.N   175.N   191.N   207.N   223.N   239.N          +
+  144.N   160.N   176.N   192.N   208.N   224.N   240.N          +
+                                                                  +
+           (c) Copyright EICON TECHNOLOGY Corporation 1989-1992  +
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++


++++++CONTROL UNIT CONFIGURATION++++++++++++++++++++++++++++++++++++
+                                                                   +           +
+
+  Maximum Frame Size in octets (MAXDATA) .................0265  +
+                                                                  +
+  Maximum Number of Frames to Buffer .....................007  +
+                                                                  +
+  Independent LU Support (LU6.2 Only) .....................Y  +
+                                                                  +
+                                                                  +
+                                                                  +
+                                                                  +
+                                                                  +
+                                                                  +
+                                                                  +
+                                                                  +
+                                                                  +
+          (c) Copyright EICON TECHNOLOGY Corporation 1989-1992  +
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```

6. When you complete all four screens, save the configuration by pressing **F1**.
7. To exit the configuration program, press the following, in sequence: **F10**, **F10**, **F1**

EiconCard Adapter

While in single user mode, perform the following steps to configure the EiconCard for SNA, X.25, and APPC support:

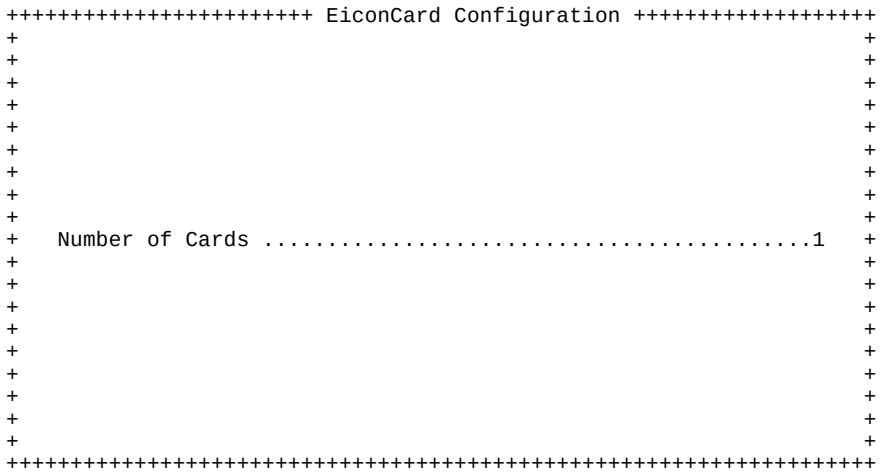
1. At the "#" prompt, enter the following commands:

   ```
   cd /usr/lib/eicon
   ./eccfg
   ```

2. A message displays on the last line of the screen saying, "Configuration File could not be found, default values are being used." Press **ENTER** to continue.

3. The EiconCard Configuration screens display. This series of screens configure the EiconCard for the X.25 network. The following seven screen images show the configuration used for this TechNote. When you complete filling in the information requested in each screen, press **F4** for the next screen.

NOTE: When you complete all seven screens, press **F1** to save the configuration. To exit the configuration program, press the following in sequence: **F10, F1**.



```
++++++++++++++++++++++ EiconCard Configuration ++++++++++++++++++++
+                                                                  +
+                                                                  +
+                                                                  +
+ Card Type ................................HSI/PC                 +
+                                                                  +
+                                                                  +
+ Input/Output Port Address ..............................380 (*)+
+                                                                  +
+ Interrupt Request Level .................................03      +
+                                                                  +
+ Memory Segment Address ..................................C800    +
+                                                                  +
+ Number of Ports ..........................................1      +
+                                                                  +
+                                                                  +
+                                                                  +
+                                                                  +
+                                                                  +
+           (*)  Must Match Hardware Setup.                        +
+                                                                  +
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```

```
+++++++++++++++++ EiconCard Configuration ++++++++++++++++++++++++
+                                                                  +
+                                                                  +
+                                                                  +
+Base Protocol Module ..............................HDLC           +
+                                                   X25            +
+                                                   SNA            +
+                                                   APPC           +
+                                                                  +
+                                                                  +
+                                                                  +
+                                                                  +
+                                                                  +
+                                                                  +
+                                                                  +
+                                                                  +
+                                                                  +
+                                                                  +
+                                                                  +
+                                                                  +
+                                                                  +
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```

NOTE: For the previous screen, the protocol stack is initially shown empty. To build the protocol stack use the space bar (toggle) and the up-down arrow keys. The protocol stack shown is for PU 2.1 with SNA/QLLC and LU6.2/APPC support. For a PU 2.0 without LU6.2/APPC support, remove the line containing the APPC entry.

```
++++++++++++++++++ EiconCard Configuration ++++++++++++++++++++++
+                                                               +
+  Port Name ..................................qllc              +
+  Port Number ..............................................FF  +
+                                                               +
+  Line Type: Switched/Non-Switched ..........................N  +
+  Duplex : Full/Half ........................................F  +
+  Point-to-point/Multi-point ................................P  +
+  Modem Interface .......................................RS232  +
+  Clocking : External/Internal ..............................E  +
+  NRZI Encoding : Yes/No ....................................N  +
+  Line speed (bps) ....................................056000  +
+                                                               +
+  RI  (on)  -> DTR (on) delay (msec) .....................0000  +
+  DSR (on)  -> RTS (on) delay (msec) .....................0000  +
+  DCD (off) -> RTS (on) delay (msec) .....................0000  +
+  CTS (on)  -> Tx  (on) delay (msec) .....................0000  +
+  Tx Idle timeout (msec) .................................0000  +
+  RTS (on)  -> RTS (off) maximum (msec) ..................0000  +
+  RTS (off) -> DCD (on) timeout (msec) ...................0000  +
+  DCD (on)  -> DCD (off) maximum (msec) ..................0000  +
+                                                               +
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```

```
++++++++++++++++++ EiconCard Configuration ++++++++++++++++++++++
+                                                               +
+                                                               +
+                                                               +
+  DTE/DCE Addressing ........................................T  +
+  Active/Passive Link Setup .................................A  +
+  FRMR to RRC/RNRC/REJC with P=0 ............................Y  +
+                                                               +
+  Check-Point-Timer T1 (msec) ............................2900  +
+  Ack-Delay-Timer T2 (msec) ..............................0200  +
+  Idle-Probe-Timer T3 (msec) ............................15000  +
+  Maximum-Frame-Size N1 (octets) .........................0261  +
+  Maximum-Retry-Count N2 .....................................10  +
+  Normal/Extended Sequence ..................................N  +
+  Maximum-Window-Size K .....................................007  +
+                                                               +
+                                                               +
+                                                               +
+                                                               +
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```

```
++++++++++++++++++ EiconCard Configuration ++++++++++++++++++++
+                                                              +
+ Node-Type ..........................................DTE     +
+ Node-Address ..............................999920033101     +
+ Basic/Extended Format Packets ............................E +
+ Sequential Assignment of Virtual Circuits ................Y +
+                                                              +
+ Maximum Window Size ....007      Maximum Packet Size ...0256 +
+ Default Window Size ....002      Default Packet Size ...0256 +
+                                                              +
+ Starting PVC Number ...0001      Number of PVCs .........000 +
+ Starting IVC Number ...0001      Number of IVCs .........000 +
+ Starting TVC Number ...0001      Number of TVCs .........008 +
+ Starting OVC Number ...0009      Number of OVCs .........000 +
+                                                              +
+ Timer T20 (sec) .......................................060 +
+ Timer T21 (sec) .......................................060 +
+ Timer T22 (sec) .......................................060 +
+ Timer T23 (sec) .......................................060 +
+ Idle Timer (sec) ......................................000 +
+ Maximum Retry Count N3 .................................03 +
+                                                              +
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```

```
++++++++++++++++++ EiconCard Configuration ++++++++++++++++++++
+                                                              +
+                                                              +
+ Maximum Number of Physical Units ........................02 +
+ Maximum Number of Logical Units .........................065 +
+ Maximum Frame Size i.e. MAXDATA (octets) ...............0265 +
+ Number of SNA Buffers ...................................130 +
+                                                              +
+ Connection Retry Limit ..................................05 +
+ Connection Retry Timer (sec) ............................020 +
+ Idle Timer for Switched Disconnect (sec) .................060 +
+ Logical Link Setup Timer (sec) ..........................060 +
+ XID Timer (sec) ..........................................3 +
+                                                              +
+                                                              +
+                                                              +
+                                                              +
+                                                              +
+                                                              +
+                                                              +
+                                                              +
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```

```
+++++++++++++++++++++ EiconCard Configuration ++++++++++++++++++
+                                                               +
+                                                               +
+ Maximum RU Size .....................................0256 +
+ Maximum Pacing Window ...............................07 +
+                                                               +
+ Number of APPC Buffers..............................032 +
+                                                               +
+ Maximum Number of Remote (Partner) Logical Units ........032 +
+                                                               +
+ Maximum Number of Mode Entries .....................016 +
+                                                               +
+ Maximum Number of Conversations .....................032 +
+                                                               +
+ Maximum Number of Transaction Programs ..............032 +
+                                                               +
+                                                               +
+                                                               +
+                                                               +
+                                                               +
+                                                               +
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```

! **IMPORTANT:** Before proceeding to the next step, be sure to press **F1** to save the configuration.

4. Reboot the system to invoke the newly created kernel containing the EiconCard driver and configuration information. Enter the following at the "#" prompt:

   ```
   shutdown -g0 -y
   ```

Access for SCO UNIX 3270 Emulation Software

This section describes the installation and configuration procedures for the Access for SCO UNIX 3270 emulation software. To perform the procedures described in this section, you need the Access for UNIX diskette.

Installing

To install the software, perform the following steps:

1. Start up the COMPAQ ProSignia in single-user mode using the usual UNIX boot procedure. The following prompt displays on the screen:

```
Type CONTROL-d to proceed with normal startup,
(or give root password for system maintenance):
```

2. Enter the root password.

   This brings the system up in single user mode.

3. At the "#" prompt, enter

   ```
   custom
   ```

4. At the Custom menu, select, in sequence:
   Install → *A New Product* → *Entire Product*

5. Insert the Access for UNIX diskette when requested and select *Continue*.

   The custom data files install and the product installation script executes.

6. When prompted to again insert the Access for UNIX Volume 1 diskette, select *Continue*.

7. From the Custom menu, select *Quit* *Yes*.

Configuring

Configuring the Access 3270 emulation software is a four-step procedure. First, you must verify that the UNIX streams driver is linked into the kernel and, if not, add it. Second, depending on your requirements, you might have to modify the Access base configuration. Third, you must configure at least one terminal entry into the session table and, as an option, a printer entry. Fourth, you must copy this configuration to the user accounts who will use the Access 3270 software.

Linking the Streams Driver

While in single user mode, perform the following steps to verify/add the UNIX streams driver to the kernel:

1. At the "#" prompt, enter

   ```
   mkdev streams
   ```

2. To select *1. Add streams modules to the kernel* enter

   ```
   1
   ```

3. If the message "Streams are currently configured in system files" displays, follow the next sub-steps. If the message does *not* display, go to Step 4.

   If the message displays, enter

   ```
   n
   ```

   and then enter

   ```
   q
   ```

   to quit.

   Go to the next sub-section, "Modifying Access Base Configuration."

4. At the prompt, "Do you wish to create a new kernel now?" enter

   ```
   y
   ```

5. Enter **y** after each of the following prompts display:

   "Do you want this kernel to boot by default?"

   "Do you want the kernel environment rebuilt?"

6. You must reboot the kernel to invoke the new configuration. At the "#" prompt, enter:

   ```
   shutdown -g0 -y
   ```

7. Start up the COMPAQ ProSignia in single-user mode using the usual UNIX boot procedure. The following prompt displays on the screen:

   ```
   Type CONTROL-d to proceed with normal startup,
   (or give root password for system maintenance):
   ```

8. Enter the root password.

   This brings the system up in single-user mode.

Modifying Access Base Configuration

The following steps modify the Access base configuration. This utility allows you to customize the Access 3270 emulation software. You can customize items such as menu options to display, keyboard mappings, maximum number of concurrent sessions, file transfer permissions and so on, on a per-user basis for your environment.

For this TechNote, the maximum number of concurrent sessions allowed per use was the only base configuration item that we modified. This value was changed from the default of 2 to 64. To modify this value, perform the following steps:

1. To invoke the Access Configuration Utility software, enter

   ```
   access -c
   ```

   The Access for UNIX Configuration Utility main menu displays, along with copyright information.

2. Press **ENTER**.

3. Select, in sequence, *Configure* → *Sessions* from the menu hierarchy.
4. To change the maximum number of concurrent sessions from the default of 2 to 64, enter

   ```
   64
   ```

5. Exit from the configuration utility by selecting *File* → *Exit* from the menu hierarchy. The configuration is automatically saved.

Configuring a 3270 Terminal Entry

The following steps configure a 3270 terminal entry into the session table:

1. To invoke the Access 3270 software, enter

   ```
   access
   ```

   The Access 3270 for UNIX main menu displays, along with copyright information.

2. Press **ENTER**.
3. To define a 3270 display session, select, in sequence, *File* → *New* → *3270* from the menu hierarchy.
4. Enter the following values and select *OK*:

Name	9370Host
PU Name	USIS00
Port Number	(left blank)
LU Number	(left blank)
Connection Type	3270 (read only)
Code Page	English (US)/(Canada) (Press ENTER and select from choice list)
Model Type	2 (Press ENTER and select from choice list)
Comments	(left blank)

5. To exit, press **ESC**.
6. Select *Exit* from the File sub-menu.
7. After the confirmation prompt displays, enter

   OK

Configuring a 3287 Printer Entry

The following steps configure a 3287 printer entry into the session table:

1. Select, in sequence, *File* → *New* → *3287* from the menu hierarchy to define a 3287 printer session.
2. Enter the following values and select *OK*:

Name	9370Host
PU Name	USIS00
Port Number	(left blank)
LU Number	(left blank)
Connection Type	3287 (read only)
Code Page	English (US)/(Canada) (Press ENTER and select from choice list)
Printer name	nec (Press ENTER and select from choice list)
Spooler Options	(left blank)
Printer Options	A submenu without values displays
Print Init	(left blank)
Comments	(left blank)

3. To exit, press **ESC**.

4. Select *Exit* from the File sub-menu.
5. After the confirmation prompt displays, enter

```
OK
```

Copying Configuration Information to User Accounts

The following steps copy the configuration information to all users accounts who will use the Access 3270 software.

1. At the "#" prompt, enter the following commands for each user:

```
mkdir /usr/user/access
copy -rv /access /usr/user/access
chown user /usr/user/access
cd /usr/user/access
chown user * api/* cdir/* config/* screen/*
cd /
```

NOTE: Replace the directory, *user,* with the user account directory to whom you wish to provide this access.

APPC/LU6.2 Software

This section describes the installation procedures associated with the EiconAPPC Developer's Toolkit. The APPC Developer's Toolkit software consists of the SNA APPC Application Program Interface (API) libraries and include files. To perform the procedures described in this section, you need the APPC Developer's Toolkit diskette.

While in single user mode, perform the following steps to install the APPC Developer's Toolkit software:

1. At the "#" prompt, enter

```
custom
```

2. At the Custom menu, select, in sequence:
   Install A New Product Entire Product

3. When prompted, insert the APPC Developer's Toolkit diskette and select *Continue*.

   The custom data files are installed and the product installation script executes.

4. When prompted again to insert the Access for SCO UNIX Volume 1 diskette, select *Continue*.

5. To exit, from the Custom menu, select: *Quit* *Yes.*

Using the Gateway

This section describes procedures to determine the status and start and stop the following:

- EiconCard adapter
- X.25 connection
- PUs
- 3270 display sessions
- 3287 printer sessions
- APPC applications

This section also describes the procedures to resolve communication problems and to perform keyboard remapping.

Determining the EiconCard Adapter Status

You can determine the status of the EiconCard adapter at anytime. Specifically, you can determine the port and memory segment addresses, the IRQ being used and if the communication protocols are downloaded. To determine the status of the EiconCard, enter the following at the "#" prompt:

/usr/lib/eicon/ecaddr

Example:

```
# ./ecaddr
Card 0: HSI/PC            set       loaded  port 0380  segment c800  interrupt 03
Card 1: UNKNOWN not set  not loaded  port 0000  segment 0000  interrupt 00
Card 2: UNKNOWN not set  not loaded  port 0000  segment 0000  interrupt 00
Card 3: UNKNOWN not set  not loaded  port 0000  segment 0000  interrupt 00
```

Determining the X.25 Connection Status

View the status of the HDLC link-level connection by entering the following command at the "#" prompt:

/usr/lib/eicon/ecstats -hdlc

A successful connection occurs when both the Line State and Protocol State fields display: *Connected.*

To view the status of the X.25 packet-level connection, perform the following:

1. At the "#" prompt, enter the command:

   /usr/lib/eicon/ecstats -x25

   A successful connection occurs when the Packet Level State fields display: *Ready.*

2. The commands presented in the previous steps produce a "snapshot" of the current status. Therefore, continually repeating these commands provides you with an ongoing status. For example, create a continuously looping script named **ecstats.sh** which contains the following:

```
cd /usr/lib/eicon
while [ 1 ]
        do
        clear
        ./ecstats $1
        sleep 5
        done
```

3. Invoke this script by entering the following at the "#" prompt:

```
ecstats.sh [-hdlc,-x25]
```

To obtain a complete listing (trace) of all packets transmitted and received, along with other important X.25 link information, perform the following:

1. At the "#" prompt, enter the command:

```
/usr/lib/eicon/ectrace -x25 -start -b 64000
```

   The command initializes a trace buffer on the EiconCard. A trace of the X.25 packets is stored into a 64-Kbyte buffer on the EiconCard. Note that the X.25 and 64000 parameters might contain different values. Once you enter this command, allow enough time for the same amount of data to be placed into the buffer.

2. To view the buffer, enter the following command at the "#" prompt:

```
/usr/lib/eicon/ectrace -x25 | more
```

   The listing contains detailed information concerning the X.25 line traffic.

3. To turn off the trace facility, enter the following at the "#" prompt:

```
/usr/lib/eicon/ectrace -x25 -stop
```

Starting and Stopping the X.25 Connection

This section describes the procedures to start and stop the X.25 connection.

Automatic Starting and Stopping

The installation process for the SNA PC Gateway software creates startup and shutdown scripts and places them in appropriate directories. The following scripts automatically execute during normal UNIX multiuser startup (*init 2*) and shutdown:

- Startup: /etc/idrc.d/EtEC
- Shutdown: /etc/idsd.d/EtEC

Manual Starting and Stopping

You can manually start and stop the X.25 link. You usually start or stop the X.25 link after you perform an EiconCard or X.25 link reconfiguration with this command:

```
/usr/lib/eicon/eccfg
```

For startup, at the "#" prompt, enter:

```
/usr/lib/eicon/ecload -v
```

For shutdown, at the "#" prompt, enter:

```
/usr/lib/eicon/echalt -d 0
```

NOTE: The following informational messages display, indicating a successful startup:

```
Self-test ok
Loading snaq.imq: 249
Card 0 port 0 status: ok
```

If the last message displays "Card 0 port 0 status: Modem not ready (no DSR)", check your modem cable connections.

Starting and Stopping the PU(s)

The SNA PC Gateway software supports up to 32 PUs per EiconCard adapter. Each PU starts and stops independently of other PUs. This section describes the procedures to start, stop, and determine the status of the PUs.

Automatic Starting and Stopping

The installation of the EiconCard driver automatically creates a startup and shutdown script and places them into directories which are searched by the UNIX daemon *init*. Therefore, you can place the commands shown above into the following existing scripts to startup and shutdown the PU automatically:

For startup, place the following commands at the end of the script */etc/idrc.d/EtEC:*

```
cd /usr/lib/eicon
./sna start USIS00
```

For shutdown, place the following commands at the beginning of the script */etc/idsd.d/EtEC:*

```
cd /usr/lib/eicon
./sna delete USIS00
```

Manual Starting and Stopping

To manually start PUs, enter the following commands:

```
cd /usr/lib/eicon
./sna start USIS00
```

To manually stop PUs, enter the following commands:

```
cd /usr/lib/eicon
./sna delete USIS00
```

NOTE: In the above commands, the USIS00 parameter corresponds to the PU 2.1 name defined for this TechNote during the SNA PC Gateway configuration process and might not apply to your configuration.

Determining Status of PUS and LUS

To determine the status of each PU and its associated LUs, perform the following steps:

For the status of PUs, enter the following commands:

```
cd /usr/lib/eicon
./sna status
```

These commands display the status of all PUs.

For the status of LUs, enter the following commands:

```
cd /usr/lib/eicon
./sna status USIS00
```

These commands display the status of all LUs for the specified PU.

NOTE: In the above commands, the USIS00 parameter corresponds to the PU 2.1 name defined for this TechNote during the SNA PC Gateway configuration process and might not apply to your configuration.

Starting and Stopping 3270 Sessions

The SNA Gateway Platform supports up to 63 concurrent 3270 sessions. This section describes the procedures to start and stop them.

Starting a Session

To start an Access 3270 display session, perform the following steps:

1. At the "#" prompt, enter

   access

2. Press **ENTER** at the copyright information screen.
3. From the Access for UNIX main menu, select *File* *Open*.
4. From the Directory File menu, select *3270 9370Host*.
5. Select *OK* to confirm your choice.

   The login screen displays for the host you are accessing.

   NOTE: The 3270 9370Host parameter corresponds to the session name defined for this TechNote in the Access configuration process and might not apply to your configuration.

Stopping a Session

To stop an Access 3270 display session, perform the following steps:

1. Press **ESC** from within the session until the Access for UNIX main menu displays.
2. Select *File* → *Close* from the menu.
3. From the Active Session screen, highlight the 3270 session you wish to close.
4. After the confirmation prompt, select *OK*.

Starting and Stopping 3287 Sessions

This section describes the procedures to start and stop 3287 printer sessions.

Starting a Session

To start an Access 3287 printer session, perform the following:

1. At the "#" prompt, enter

   ```
   access
   ```

2. At the copyright information screen, press **ENTER**.
3. From the Access for UNIX main menu, select *File* → *Open*
4. From the Directory File menu, select *3287 9370Host.*
5. Select *OK* to confirm your choice.

   The login screen displays for the host you are accessing.

   NOTE: The 3287 9370Host parameter corresponds to the session name defined for this TechNote in the Access configuration process and might not apply to your configuration.

Stopping a Session

To stop an Access 3287 printer session, perform the following steps:

1. Press **ESC** from within the session until the Access for UNIX main menu displays.
2. Select *File* → *Close* from the menu.
3. From the Active Session screen, highlight the 3287 session you wish to close.
4. After the confirmation prompt, select *OK*.

Resolving Communication Problems

Occasionally, you might experience communications problems during a 3270 session. You usually see the prolonged appearance of a "COM 501," "COM 504," or "COM 510" message on the 3270 status line. If you experience problems, perform the following:

1. Check the cables to and from the modem and/or telephone jack for proper installation.
2. If you are using a dial-up line, redial the host.
3. Contact your host administrator to verify that the host communications link is still active.
4. Exit the Access 3270 program and restart it using the communication logging option. This logs all communications to a file which you can then send to Eicon Technology for analysis (See Appendix B, "Vendor Contact Information" for address and phone numbers). To turn logging on, enter the following at the "#" prompt:

   ```
   access -l filename
   ```

Keyboard Mappings

The Access 3270 emulation software provides keyboard remapping functionality at two levels. The first is the configuration level which you can use by entering **access -c** at the "#" prompt and by copying the modified configuration files to all user accounts who use Access (previously described in this chapter in the "Configuring"section).

The second level of keyboard remapping is on a per-user basis. You can locate it from the Access main menu. The following steps pertain to both levels. To view or modify the mapping, perform the following steps:

1. To view or edit the current keyboard mapping, from the Access main menu select *Keyboard → Keymap*
2. To change the keyboard mappings, modify the key sequences associated with the action you want.

LU6.2/APPC Applications

You can develop SNA LU6.2/APPC applications by using the EiconAPPC Developers Toolkit. This section describes the procedures to use the **sample.c** LU6.2/APPC program provided with the Toolkit.

The program, **sample.c**, contains the functionality required to send and receive data using APPC over LU6.2 sessions. This program accepts a command line parameter that governs the operating mode of the program. The program can operate in a "listen mode" (LM), which can be thought of as a server, or "call mode" (CM), which can be thought of as a client.

The program first starts in LM on one of the network nodes. Next, it starts in CM on the same or another node. In both modes the program defines a PU, local and remote LUs, mode of operation, and starts the PU. Next, the LM "sleeps" until it receives data from the CM (a hard-coded string containing numbers and characters).

Once the CM program sends the data, the LM receives it, displays it, and sends data (a smaller hard-coded string containing numbers and characters) back to the CM which displays it. At this point, both programs shut down their respective LUs and PUs and terminate normally. This program exercises a good portion of the APPC verb set functionality from the Toolkit and can serve as a base to modularize and build upon.

To verify the LU6.2/APPC functionality of the Eicon products, we configured the SNA Gateway Platform and another COMPAQ system configured as a PU2.1 with APPC support to the X.25 network. We successfully compiled, linked, and executed the **sample.c** program on both systems. You can run the program in both LM and CM modes on the same node or run each on a separate node, as was done for this TechNote.

After successfully installing the Toolkit, the **sample.c** program resides in the following directory:

/usr/lib/eicon/samples/appc/sample.c

The **sample.c** source code required a few modifications to support the tested topology, described in Chapter 3. We made the following changes in the modules listed below:

- call_out():

  original: strcpy(address,"3113012345678");
  changed: strcpy(address,"999920033102");

  The DTE address of the node executing the program in LM. We modified this statement to contain the address of PU2.1 node 2. If both copies of the program were to run in the same node, this must contain that node's address.

  original: strcpy(facility,"0101");
  changed: strcpy(facility,NULL);

  The requested X.25 PDN services. We modified this statement not to request the Reverse Charge facility.

- call_in():

  original: strcpy(facility,"0101");
  changed: strcpy(facility,NULL);

  The requested X.25 PDN services. We modified this statement not to request the Reverse Charge facility.

The program **sample.c** incorporates source code preprocessor directive statements. Specifically, if compiled with DEBUG or STATS set to *on*, additional code is generated for the executable program. If compiled with the DEBUG option set to *on*, the program pauses before each call to an APPC library module and waits for you to press **ENTER** before proceeding.

If you compile **sample.c** without the DEBUG option, the program executes without requiring intervention. If you compile with the STATS option set to *on*, the program displays the values contained in the data structures used by the APPC modules. These options are not mutually exclusive.

To compile and link the program, use one of the following command lines:

- DEBUG/STATS not set:

```
cc -W0 sample.c -lEappc -lEec -osample
```

- DEBUG/STATS set to *on*:

```
cc -W0 -DDEBUG -DSTATS sample.c -lEappc -lEec -osample
```

To execute the program, perform the following steps:

1. On both nodes, enter the following commands to shut down and then reload the protocol stack to the EiconCard:

```
cd /usr/lib/eicon
./echalt
./ecload -v
```

   NOTE: In the above commands, the EiconCard is shut down and therefore might impact users logged onto the system. It is not necessary to perform the shutdown, but it is the easiest way of putting the system in a "known" state.

2. On the LM node, enter the following command to start **sample.c** in the listen mode:

```
/usr/lib/eicon/samples/appc/sample listen
```

3. On the CM node, enter the following command to start **sample.c** in the call mode:

```
/usr/lib/eicon/samples/appc/sample call
```

As each copy of the program executes, it displays the name of the APPC verbs it is executing and the status value returned from those calls. It also displays the data received.

Removing the Gateway Components

This section describes the removal procedures for the SNA Gateway Platform X.25 and SNA components.

Removing the Eicon Technology products is a two-step procedure. You must first remove the APPC Developer's Toolkit software, the Access 3270 emulation, and the SNA PC Gateway software, in that order, and then rebuild the kernel.

Removing the EiconAPPC Developers Toolkit Software

To remove the Eicon APPC Developer's Toolkit software, perform the following steps:

1. Boot the COMPAQ ProSignia in the normal UNIX boot procedure to the following prompt:

```
Type CONTROL-d to proceed with normal system startup,
(or give root password for system maintenance):
```

2. Enter the root password.
3. At the "#" prompt, enter

   ```
   custom
   ```

4. Select *Remove* from the menu.
5. Select *EiconAPPC Developers Toolkit* from the menu.
6. Select *EiconAPPC Developers Toolkit set* from the menu.
7. At the prompt, "Do you wish to continue?" select *Yes*.

   The product remove script is executed and the product is removed.

8. From the Custom menu, select: *Quit* → *Yes.*

Removing the Access for SCO UNIX 3270 Emulation Software

To remove the Eicon Access for SCO UNIX 3270 emulation software, perform the following steps:

1. Boot the COMPAQ ProSignia in the normal UNIX boot procedure to the following prompt:

```
Type CONTROL-d to proceed with normal system startup,
(or give root password for system maintenance):
```

2. Enter the root password.
3. At the "#" prompt, enter

   ```
   custom
   ```

4. Select *Remove* from the menu.
5. Select *Access for UNIX* from the menu.
6. Select *Entire Access for UNIX Set* from the menu.
7. At the prompt, "Do you wish to continue?" select *Yes*.

   The product remove script is executed and the product is removed.

8. From the Custom menu, select: *Quit* *Yes*.

Removing the SNA PC Gateway for SCO UNIX Software

To remove the Eicon SNA PC Gateway for SCO UNIX software, perform the following steps:

1. At the "#" prompt, enter

   ```
   custom
   ```

2. Select *Remove* from the menu.
3. Select *EiconCard SNA PC Gateway* from the menu.
4. Select *Entire EiconCard SNA PC Gateway Set* from the menu.
5. When prompted, "Do you wish to continue?" select *Yes.*

   The remove script is executed and the product is removed from the system.

6. When each of the following prompts displays, enter **y**:

   "Do you wish to create a new kernel now?"

   "Do you want the kernel to boot by default?"

   "Do you want the kernel environment rebuilt?"

7. From the Custom menu, select: *Quit* → *Yes.*
8. At the "#" prompt, enter

   ```
   shutdown -g0 -y
   ```

   When the COMPAQ ProSignia restarts, the new UNIX kernel is invoked.

Removing the EiconCard HSI/PC Adapter

To remove the EiconCard HSI/PC adapter, perform the following steps:

1. Shutdown UNIX by entering the following at the "#" prompt:

   ```
   shutdown -g0 -y
   ```

2. When the message "Save to Power Off" displays, turn off the COMPAQ ProSignia. Then, disconnect the AC power cord and any peripheral devices.
3. Loosen the thumbscrews on the rear panel, and remove the system side cover.
4. Remove the retaining screw securing the Communications Adapter (CA) in the slot.
5. Remove the CA from the slot.
6. Replace the slot cover and secure it using the retaining screw.
7. Replace the cover on the COMPAQ ProSignia.
8. Reconnect the AC power cord and any peripheral devices.

Appendix A
Acronyms

API	Application Program Interface
APPC	Advanced Program to Program Communications
APPN	Advanced Peer-to-Peer Network
CC	Cluster Controller
CICS	Customer Information Control System
CM	Call Mode
DCE	Data Circuit-Terminating Equipment
DSU	Digital Signaling Unit
DTE	Data Terminal Equipment
HDLC	High-level Data Link Control
HSI	High Speed Interface
IVC	Incoming Virtual Circuit
LAPB	Link Access Procedure Balanced
LM	Listen Mode
LU	Logical Unit
MLP	Multi-Link Procedure
NAU	Network Addressable Units
NCP	Network Control Program

NPSI	NCP Packet Switch Interface
OSI	Open Systems Interconnection
OVC	Out-going Virtual Circuit
PDN	Public Data Network
PLU	Primary Logical Unit
PU	Physical Unit
PVC	Permanent Virtual Circuit
QLLC	Qualified Logical Link Control
RJE	Remote Job Entry
SAA	System Application Architecture
SDLC	Synchronous Data Link Control
SLP	Single Link Procedure
SLU	Secondary Logical Unit
SNA	Systems Network Architecture
SSCP	System Services Control Point
TG	Transmission Group
TIC	Token-ring Interface Card
TP	Transmission Priority
TVC	Two-way Virtual Circuit

VM	Virtual Machine (Operating System)
VTAM	Virtual Telecommunications Access Method
WAN	Wide Area Network

Appendix B
Vendor Contact Information

Use the following information to contact the vendors referred to in this TechNote:

Eicon Technology Corporation

In Canada:
2196 - 32nd Avenue (Lachine)
Montreal, Quebec, Canada
H8T 3H7
Telephone (514) 631-2592
Faxsimile: (514) 631-3092

In the US:
14755 Preston Road
Suite 620
Dallas, TX 75240
Telephone: (214) 239-3270
Faxsimile: (214) 239-3304

Kingsway Business Park
Oldfield Road, Hampton
Middlesex TW12 2HD
United Kingdom
Telephone: 44(81) 941-7122
Faxsimile: 44(81) 941-0548

DigiBoard
6400 Flying Cloud Drive
Eden Prairie, MN 55344
Telephone: (612) 943-9020
(800) 344-4273

SCO
400 Encinal Street
P. O. Box 1900
Santa Cruz, CA 95061-1900
Telephone: (408) 425-7222
(800) 726-8649

Compaq Computer Corporation
Compaq ToolKits and TechNotes
20555 SH 249
P. O. Box 692000 MC 13 01 02
Houston, TX 77269-2000
Telephone: (800) 345-1518

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