HEWLETT PACKARD

HP 9000 Computers

Networking Overview

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Contents

Introduction

This booklet describes key networking concepts and provides an overview of HP-UX networking products. It is divided into four chapters, which provide the following information:

- **Chapter 1** provides general information about the networking concepts that are relevant when using HP-UX network products. It describes network types and terms, protocols, and the families of networking products that are available on HP 9000 systems.
- **Chapter 2** provides information on Hewlett-Packard's TCP/IP networking products. It describes the links, transports, and services that allow HP 9000 computers to communicate in LAN and WAN environments.
- **Chapter 3** provides information on Hewlett-Packard's OSI networking products. It describes the links, transports, and services that allow HP 9000 computers to be integrated into standard, multivendor networks.
- **Chapter 4** provides information on Hewlett-Parkard's SNA networking products. It describes the links, transports, and services that provide HP-to-IBM connectivity in both client/server and standalone environments.

The information provided in this booklet applies to all HP 9000 computer systems. Any exceptions are specifically noted.

Hewlett-Packard Networking Products

The following HP-UX networking products are described in this booklet:

TCP/IP Products

- LAN/9000 Link.
- Token Ring/9000 Link.
- FDDI/9000 Link.
- X.25/9000 Link.
- PPL (Serial Line Internet Protocol) Link.
- NFS Services/9000 (Network File System).
- NS/9000 (Network Services).

OSI Networking Products

- OSI (Open Systems Interconnection) Express MAP 3.0 Link.
- OTS/9000 (OSI Transport Services).
- ARPA Services/9000.
- FTAM (File Transfer, Access, and Management).
- MMS (Manufacturing Message Specification).
- X.400/9000 Messaging Service.

SNA Networking Products.

- SNAplusLink.
- SNAplusAPI.
- SNAplus3270.
- SNPAplusRJE.
- SNAplus3179G.

Note The information in this booklet is current at the time of publication but may change after that. For the latest product and ordering information, call your local HP representative.

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Networking in General

This chapter provides an overview of general networking concepts and introduces the network structure based on links, transports, and services. It also introduces you to the families of networking products available for HP 9000 systems. This chapter includes discussions on the following topics:

- Network types and general networking concepts.
- Network components, such as gateways, routers, and bridges.
- Network architectures.
- Families of networking products available for Hewlett-Packard HP 9000 systems.

Network Types and Terms

Networks and Nodes

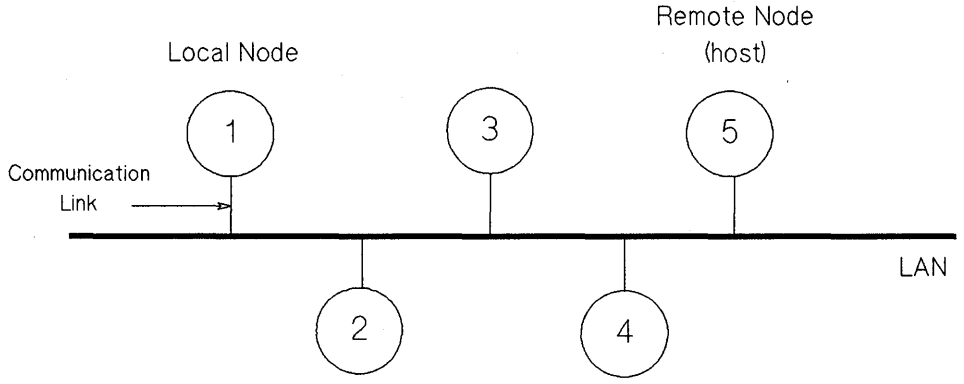
A **network** is a group of computer systems connected so that they can exchange information and share resources such as disc space, printers and plotters.

A **node** or **host** is a computer on a network. The term **local node** refers to the node or host to which your terminal is physically attached. A **remote node** is a computer on the network with which your local node can communicate.

Nodes or hosts on a network are connected by **communication links**. A communication link is the hardware (e.g., cables) and executable software that enable network nodes to exchange data. All network nodes that need to exchange data must be connected by the same type of link.

When computers in a network are geographically remote from each other (across cities, states or countries), the network is called a **Wide-Area Network (WAN)**. When the geographic coverage of a network is much smaller (within a building or spread among closely spaced buildings), it is called a **Local-Area Network (LAN)**.

The illustration shows a local area network (LAN) with five nodes, each represented by a circle. Communication links, represented by lines, join the nodes to the LAN.



Example of a Bus Network

In this example, you are a user logged into node 1 (or host 1). Node 1 is your **local node.** Nodes 2, 3, 4 and 5 are **remote nodes.**

If you send a message from node 1 to node 5, node 1 is the **source node** and node 5 is the **destination node.** Nodes 2, 3, and 4 "see" the message after it is sent from node 1, but pay no attention to it because it is addressed to node 5. So your message follows a route that includes nodes 1 and 5. A **route** is the sequence of network nodes that a message travels through when it is sent from a source node to a destination node.

Bus Networks

The figure on the previous page is an example of a **bus network.** Nodes in a bus network are connected by a linear run of cable. Every node simultaneously reads each message transmitted over the network. The nodes typically process messages addressed to themselves and ignore all other messages.

CSMA/CD Access Method

Ethernet[1] and IEEE 802.3[2] LANs are bus networks. Their network access method is known as Carrier-Sense, Multiple-Access with Collision Detection (CSMA/CD). This means that a node "listens" to see if the network is busy before it transmits. All nodes have equal access to the network and can detect and recover when two nodes attempt to transmit at once.

Ethernet and IEEE 802.3 LANs package the information that moves across the cable differently. An HP 9000 computer can determine if the remote node can communicate using Ethernet or IEEE 802.3 and communicate with it using the same data package format that the remote node is using. This makes it possible to use several of Hewlett-Packard's networking products (NFS Services/9000, NS/9000, and ARPA Services/9000) on IEEE 802.3 and Ethernet LANs simultaneously. LAN/9000 is a CSMA/CD LAN.

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(1) The Ethernet LAN is a local area network system developed by Digital Equipment Corp., Intel Corporation and Xerox Corporation. Ethernet is the de facto standard for office automation and distributed processing LANs.

(2) The IEEE 802.3 LAN is a networking standard similar to Ethernet that is accepted by the Institute of Electrical and Electronic Engineers.

Token Bus Networks

IEEE 802.4 networks use a "token bus" access method. In a token bus network, a special bit pattern called a "token" circulates among the nodes on the network. A node is permitted to transmit only when it holds the token. Therefore, collisions between nodes seeking simultaneous access to the network cannot occur, and all nodes can be guaranteed access to the network within a known time period. MAP 3.0 networks use the IEEE 802.4 specification; this is partly because of the access guarantee, and partly because IEEE 802.4 is especially suited to harsh manufacturing environments. MAP 3.0 is a token bus LAN.

Ring Networks

Ring networks, which are characterized by a closed loop topology and a circulating token, are accessed by only one station at a time, with the station having the token controlling the access. Token Ring/9000 and FDDI/9000 are token passing ring networks.

Token Ring Networks

IEEE 802.5 and FDDI networks use a "token ring" access method. In a token ring network, a token rotates continuously around the ring when the ring is operational. The token is the means by which the right to transmit is passed from one node to another. If a node has data to transmit, it must first capture the token from the ring. After completing the data transmission, the station creates and transmits a new token onto the ring. The token continues to circulate, providing other stations the chance to gain access to the ring, until it is captured by another (or same) station waiting to transmit data. Token Ring/9000 networks use the IEEE 802.5 specification, and FDDI/9000, which is characterized by a fiber-optic dual token ring transmission medium, uses the ANSI X3T9.5 specification.

X.25 Packet Switching Networks

One widespread technology used in wide-area networks (WANs) is known as packet switching. With packet switching, messages are broken down into data packets and

sent across the network. When the packets reach their destination, they are reassembled into the original messages.

A WAN that uses packet switching is called a **Packet Switching Network (PSN).** X.25[3] is a CCITT recommendation that defines the protocol required to access a PSN.

SNA Networks

An SNA network is a group of nodes joined together by data links based on IBM's networking framework, **Systems Network Architecture (SNA).** An SNA network exists to transfer data between end users. SNA defines an end user as the person or program that is the ultimate source or destination of data. SNA networks are structured so that the end user does not have to deal with the details of transferring data.

Each SNA node resides in a hardware device and can contain various **Network Addressable Units.** There are three kinds of Network Addressable Units:

- **System Services Control Points (SSCPs),** control programs that manage a section of the network.
- **Logical Units (LUs),** programs that provide access to a network for an end user.
- **Physical Units (PUs),** programs or sets of programs that control the resources of a node.

(3) Its full name is "CCITT (International Telegraph and Telephone Consultative Committee) Recommendation X.25," and it is defined in "CCITT Red Book Volume VII Data Communications Networks Interfaces Recommendations X.20–X.32, 1984".

Network Concepts

Network Addresses

To send a message, a node must be able to provide a network address for the recipient of the message. That is, every message has to have the identity of the recipient (or a connection identifier) attached.

Different types of networks use different addressing schemes. One type of address identifies a particular hardware card on a particular host; another type of address identifies a software process rather than hardware. The key idea is that a network address specifies the destination for a message.

Protocols

A **protocol** is a set of rules for a particular communication task. It handles the format of information packets, the amount of data they contain, and procedures for exchanging the packets at the interface between the network and the computer. A protocol handler or module is a piece of software that implements a particular protocol.

HP has implemented protocols with wide industry acceptance:

- The TCP/IP protocol supports ARPA, NS, and NFS running over Ethernet, 802.5, FDDI, and Serial Line IP links.
- HP's Open Systems Interconnection (OSI) products are based on standards developed by the International Organization for Standardization (ISO). Examples include FTAM for file transfer and X.400 for messaging.
- HP's SNA products are based on IBM's Systems Network Architecture, first introduced by IBM in 1974 to provide a basic framework for networking products. These products provide connectivity between HP and IBM computers.

Physical Components of the Network

We've already discussed the basic physical components of a simple network. A node is a computer (or other physical device) that has its own network address. The physical components of a link may include coaxial cable or telephone transmission lines. Additional devices are also available to help you route network traffic or link networks together to form internetworks.

Gateways

Networks with different types of hardware and different protocols, such as TCP/IP and OSI, can communicate with each other via a **gateway**. Unlike a router or a bridge, a gateway can translate the protocol of one network to a different protocol used by another network.

Routers

Networks with different types of hardware but the same kind of networking software can communicate with each other via a **router**. A router can store and interpret information about networks and network routes, and forward packets to nodes that are not on directly attached networks.

Bridges

Networks with the same type of LAN hardware and networking software can communicate with each other via a **bridge**. Two networks must be directly attached to each other in order for a bridge to be able to forward packets between them.

Multiplexers

Multiplexers, or **MUXes**, are available to help networks make efficient use of communication channels. MUXes combine digital signals from multiple devices into a single digital signal for transmission over a single channel. There must be a multiplexer on both ends of a transmission link so that signals that are combined on one end can be separated on the other end.

PADs

A **Packet Assember/Disassembler**, or **PAD**, is a device that converts asynchronous character streams into packets that can be transmitted over a packet switching network. This allows workstation-to-computer communications over long distances.

Switches

A **switch** receives messages from various devices on the network and routes them over the network to their appropriate destinations. The public telephone network provides the most obvious example of the use of switching, but switches are widely used in private networks as well.

Contact your Hewlett-Packard sales representative for information on the network components provided by Hewlett-Packard.

Network Architectures

Network Models

A network model is a structured, modular design for networks. Several such design schemes have been developed, including the two on which Hewlett-Packard products are based: the OSI model and the SNA model.

The **Open Systems Interconnection (OSI)** model is the basis for HP's TCP/IP and OSI products. It was developed by the International Organization for Standardization (ISO) and defines seven logically distinct modules, or layers, each of which performs a specific data communication function. For more information on the OSI model, and for a definition of each of its layers, see *Making the LAN Connection* (5957-4624).

HP-to-IBM networks are based on the **Systems Network Architecture (SNA)** model developed by IBM. The SNA model also defines seven layers for data communications, but their definitions are slightly different from the OSI model. For more information on the SNA model, see *Communicating with IBM* (5957-4623).

Links, Transports, and Services

The functions of networking products are often divided into three categories: **links**, **transports**, and **services**. Hewlett-Packard offers products in each of the three categories through each of its product families (TCP/IP, OSI, and SNA).

Links

Links define how networks physically transmit data from one point to another. They include hardware and software for the lower OSI layers. The hardware includes the physical means of transmission such as interface controllers and cable. The software defines the way a network takes raw data and packs it into messages that can be transmitted.

There are seven HP-UX link products:

- **LAN/9000 Link.** LAN links are used in local bus networks such as Ethernet and 802.3 networks.
- **Token Ring/9000 Link.** Token ring links are used to connect to IEEE 802.5 networks.
- **FDDI/9000 Link.** FDDI links are used to connect to fiber-optic, dual-ring, high-speed, local area networks.
- **Point-to-Point (PPL) Link.** PPL links are used to run TCP/IP applications over serial links. PPL is the HP implementation of the Serial Line Internet Protocol (SLIP).
- **X.25/9000 Link.** X.25 links are used for wide-area networks (WANs).
- **HP OSI Express MAP 3.0 Link.** This link is used for LANs in manufacturing environments.
- **SNAplusLink.** This is a wide-area network link for HP-to-IBM communications.

Local area network products such as LAN/9000 Link, Token Ring/9000 Link, and FDDI/9000 Link can be extended via bridges and routers into wide area networks.

Transports

Transports define how networks route data and ensure its integrity. There is often programmatic access to one or more layers of a network model, for use by advanced application developers who need the connectivity and routing provided at these levels. OSI literature often refers to "Transport Services" or "Network Services" at these layers.

There are four HP-UX transport products:

- **TCP/IP Transport.** The transport for TCP/IP networks, which include LANs running ARPA and NFS Services. The TCP/IP transport is part of the LAN/9000, Token Ring/9000, FDDI/9000, and PPL (based on the Serial Line Internet Protocol) link products.
- **OTS/9000 (with XTI).** OTS is HP's primary OSI transport product, supporting X.400 and FTAM. This transport will run over X.25/9000 or LAN/9000 links.
- **HP OSI Express.** This is a MAP 3.0 transport, designed for factory automation networks.
- **SNA Transport.** The transport for SNA networks, providing connectivity between HP and IBM systems. The SNA transport is part of the SNAplusLink product. This transport will also run over X.25/9000 or Token Ring/9000 links.

Services

When you transfer a file, log in to a remote node, or attach a remote file system to your local node, you are using a network service. Services exist at the highest layers of the networking models. OSI literature often uses the term "Application Services" to distinguish services at this layer from lower layer services.

There are ten HP-UX service products:

- **ARPA Services.** These services provide connectivity and communications in a multivendor network.
- **NFS Services.** These services allow HP 9000 computers to share file systems among computers in a multivendor network.
- **NS Services.** This HP proprietary collection of services enables HP 9000 computers to communicate with other HP computers as well as some IBM and DEC computers.
- **X.400.** A standard electronic messaging (mail) service that can be used for multivendor electronic mail.
- **MMS.** The Manufacturing Message Specification, a standard language for communicating with factory automation devices.
- **FTAM.** The File Transfer, Access and Management service, a standard for multivendor environments.
- **SNAplusAPI.** An SNA LU 6.2 application programming interface.
- **SNAplus3270.** Provides 3270 terminal emulation, file transfer, and multiple sessions.
- **SNAplusRJE.** Provides SNA 3770 batch data transfer in an SNA environment.
- **SNAplus3179G.** Provides emulation of an IBM 3179G color graphics display station.

All of the links, transports, and services listed above are described in greater detail in the remaining sections of this booklet.

HP-UX Networking Product Families

Networking products for HP 9000 systems are available in three products families, TCI/IP, OSI, and SNA. Generally, these product families include links, transports, and services. Several of the link products, however, support transports and services from more than one of the product families.

Each of the three product families is described in the following chapters.

2

HP 9000 TCP/IP Networking Overview

This chapter provides an overview of HP's TCP/IP networking products. It also defines terms that apply to TCP/IP networking.

Overview

HP's TCP/IP networking products allow HP 9000 computers to communicate with other computers in LAN and WAN environments. They include the following products:

- **ARPA Services**, a defacto industry standard that provides connectivity and communications in a multivendor network of machines and operating systems.
- **NFS Services**, a collection of networking services that allow HP 9000 computers to share file systems among computers in a multivendor network.
- **NS Services**, an HP proprietary collection of networking services that enable HP 9000 computers to communicate with other HP computers as well as some IBM and DEC computers. While not part of the TCP/IP protocol suite, these products are included here because they make use of the TCP/IP protocol stack.

The above products run over the following link products:

- **LAN/9000 Link**, a local-area network 802.3/Ethernet link.
- **Token Ring/9000**, a local-area network 802.5 link.
- **FDDI/9000 Link**, a high-speed local-area network.
- **X.25/9000 Link**, a wide-area network link.[1]
- **Point-to-Point (PPL)**, a serial line link.

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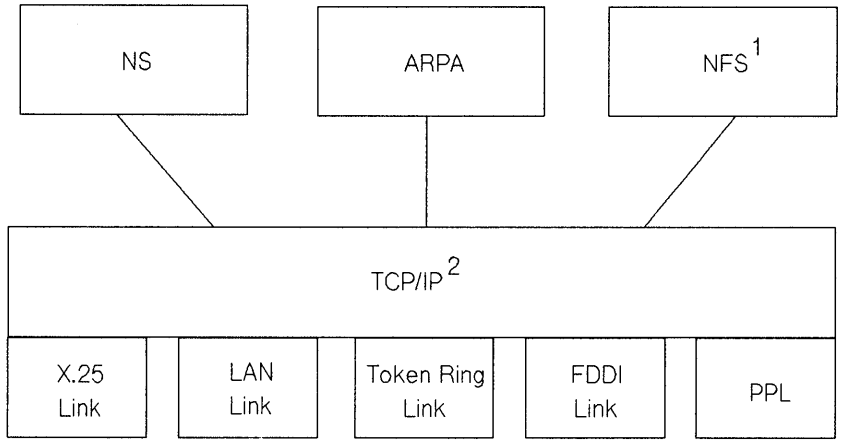
(1) NFS Services are not supported on X.25 links.

The following illustration shows the relationships among TCP/IP products.



1 NFS is not supported over X.25

2 TCP/IP Transport is bundled with the link products

Relationships Between TCP/IP Services, Transports, and Links

The remaining sections of this chapter contain details about each of these products. For the most current information on environments in which you can use the ARPA, NFS, NS, LAN, and X.25 products, contact your local HP representative.

Link and Transport

Five links are available for the TCP/IP product family. Each link product includes all the software required to connect to a network and process communications over the network. Each TCP/IP link includes the TCP/IP transport as part of the product.

The LAN Products

HP LAN Link products, which include **LAN/9000**, **Token Ring/9000**, and **FDDI/9000**, provide HP 9000 computers with network connections to Ethernet or IEEE 802.3 CSMA/CD LANs, IEEE 802.5 LANs, or FDDI LANs. LAN software and hardware provides the basis for network services, and must be installed before running these services over any Hewlett-Packard LAN product.

You can run ARPA services, NFS Services, and Network Services on any LAN link. You can also use LAN products without the NS, ARPA, and NFS products to write customized interprocess communication or application software.

Note You can also run the X.400 and FTAM OSI services over the LAN/9000 link. However, these products must run over the OTS/9000 transport. See chapter 3 for more information.

You can run SNA services over the Token Ring/9000 Link. However, these products must run over the SNA transport. See chapter 4 for more information.

Interprocess Communication

Interprocess communication allows a process to communicate with another process on the same host or a remote host via system calls that access communication connection entities called sockets. The LAN products provide two interprocess communication (IPC) facilities: NetIPC and Berkeley Sockets (BSD IPC).

- **NetIPC** enables processes running on HP 9000 nodes on the network to exchange information among other HP 9000, HP 1000 A-Series, HP 3000 MPE/V and MPE/iX, HP Vectra PC, and IBM PC nodes on the network. NetIPC provides an interface between application layer services, such as ARPA, NFS, or NS, and transport protocols in the transport layer, such as TCP/IP. A module in NetIPC, called the socket registry, translates user-defined names into machine addresses. NetIPC is not supported over Token Ring/9000 Link or FDDI/9000 Link.
- **Berkeley Sockets** (BSD IPC) enable processes running on UNIX nodes on the network to exchange information. HP's implementation of sockets is based on the IPC in the Berkeley Software Distribution of UNIX, version 4.3 (4.3 BSD).

Link Level Access

Link Level Access (LLA) allows you to implement special-purpose network protocols by directly accessing the network interface drivers. LLA may be used on HP 9000 computers. LLA is not supported over Token Ring/9000 Link or FDDI/9000 Link.

The X.25 Product

The X.25/9000 Link product provides HP 9000 computers with a connection to public and private X.25 WANs. The X.25 software and hardware provides the basis for network services, and must be installed before running these services over the WAN.

The X.25 product is certified on major public and private X.25 networks. It complies with the 1980 and 1984 CCITT recommendation for X.25, and with ISO 7776 and 8208.

You can run ARPA Services (except ruptime and rwho) and Network Services on the X.25 link. You may also use the X.25 product without the ARPA and NS products to write customized interprocess communication or application software.

Note You can also run the X.400 and FTAM OSI services over the X.25/9000 Link. However, these products must run over the OTS/9000 transport. See chapter 3 for more information.

You can run SNA services over the X.25/9000 Link. However, these products must run over the SNA transport. See chapter 4 for more information.

Interprocess Communication with Berkeley Sockets

Interprocess communication allows a process to communicate with another process on the same host or a remote host via system calls that access communication connection entities called sockets. The X.25 product provides a Berkeley Sockets Interprocess Communication (BSD IPC) facility that is implemented in one of the following ways:

- Via TCP/IP or UDP/IP at the OSI Transport Layer (Layer 4).
- By directly accessing the X.25 Packet Layer (X.25 Layer 3; OSI Layer 3).

Refer to the *X.25 Programmer's Guide* for details.

TCP/IP Services

The ARPA Services Product

The ARPA Services product provides the ARPA/Berkeley services. These services originated from the Advanced Research Projects Agency (ARPA) and the University of California at Berkeley (UCB).

The ARPA Services are used to communicate in HP-UX, UNIX, and non-UNIX environments. The Berkeley Services are used to communicate in HP-UX or UNIX environments.

The ARPA Services product enables your HP 9000 computer to communicate on a LAN with other HP 9000 computers and computers from other vendors. These include Sun Microsystems, IBM PC/AT, and DEC VAX VMS and Ultrix computers that are running ARPA or Berkeley software from a non-HP supplier. You can also communicate with Sun Microsystems computers over an X.25 WAN.

To run the ARPA Services software, you must first install the LAN products or the X.25 product or both, depending on your system and the services you want to use.

ARPA Services

The ARPA Services product includes the following:

- **File Transfer Protocol** (`ftp`) allows you to transfer files between HP-UX, UNIX, and non-UNIX systems, and perform file management operations on these systems.
- **Telnet** (`telnet`) allows you to log into a remote HP-UX, UNIX, or non-UNIX host if you have an account on the remote host and it is running ARPA software. This service may also be used over a LAN to communicate from your HP 9000 to HP 1000 computers.
- **Bootstrap Protocol** (`BootP`) allows some diskless systems, such as the HP 700/X terminal, to load network and configuration parameters from a server on the network.
- **Trivial File Transfer Protocol** (`TFTP`) allows some diskless systems, such as the HP 700/X terminal, to transfer files containing bootstrap code, fonts, or other configuration information. It can be used in conjunction with BootP.
- **Remote Copy** (`rcp`) allows data and program files and directories to be transferred

between HP-UX or UNIX hosts on the network. This service also allows your HP 9000 to communicate with HP Vectra PCs and IBM PC/ATs over a LAN.

- **Remote Execution** (`rexec`) is used in programs to execute commands on a remote HP-UX or UNIX host.
- **Remote Login** (`rlogin`) allows you to log into a remote HP-UX or UNIX host if you have an account on the remote host.
- **Remote Shell** (`remsh`) allows you to execute a command on a remote HP-UX or UNIX host if you have an account on the remote host. This service also allows your HP 9000 to communicate with HP Vectra PCs and IBM PC/ATs over a LAN. `remsh` is the same command as Berkeley's `rsh`.
- **Remote Who** (`rwho`) allows you to list the users on remote systems that are running the `rwho` daemon. This service is not supported over the X.25 link product.
- **Remote Uptime** (`ruptime`) allows you to list the status of remote systems on the network that are running the `rwho` daemon. This service is not supported over the X.25 link product.
- **fingerd** is an HP-UX command that allows remote users to look up user information about your system over the network.
- **Sendmail** (`sendmail`), when installed and configured, routes internetwork mail. Because this service uses ARPA's standard Simple Mail Transfer Protocol (SMTP), you can use it to route internetwork mail to remote or local HP-UX, UNIX, and non-UNIX environments that support ARPA protocols.
- **BIND** (Berkeley Internet Name Domain) name service is an optional network information lookup service. It is an implementation of the ARPA Domain Name System (DNS). Its hierarchical naming scheme allows you to retrieve host names and addresses for any node on the network. It also provides mail routing capability via a list of hosts that will accept mail for an address.
- **Gated** (`gated`) is a routing daemon that dynamically determines routing over internets from one node to another. It allows you to specify which networks you want to communicate with and which you do not. Gated handles the RIP, EGP, and HELLO routing protocols.

Interprocess Communication

Berkeley Sockets (BSD IPC) provide interprocess communication used with the Berkeley Services part of the ARPA product. Berkeley Sockets are part of the link products and are described in "The LAN Products" and "The X.25 Product" sections of this chapter.

The NFS Services Product

The NFS Services product enables your HP 9000 computer to share files with other nodes on the same LAN. It gives you remote access to file systems on HP 9000 and Vectra computers, and on non-HP computers (Sun Microsystems, DEC VAX VMS and Ultrix, and IBM PC/AT) running NFS software from non-HP vendors.

Once you attach a remote file system with NFS, most of the user commands you use with your local file system (such as `ls`, `rm`, or `cp`) will also work with the remote file system that you just attached. This enables project teams to integrate remote data or files into local applications, and to maintain consistent files among team members.

The NFS Remote Procedure Call (RPC) function and Remote Procedure Call Protocol Compiler (RPCGEN) make writing distributed applications easier. RPC uses eXternal Data Representation (XDR), which translates data into a computer-independent data format that simplifies the sharing of data and applications among HP and non-HP computers.

NFS Services

The NFS Services product includes the following:

- **Network File System** (NFS) provides remote file access to remote file systems for a specified group of hosts.
- **Remote Execution Facility** (REX) allows users to execute commands on a remote host.
- **Network Lock Manager** permits cooperating processes to synchronize access to shared files.
- **Virtual Home Environment** (VHE), an optional service, allows users to configure login environments on remote nodes to mirror login environments on their host nodes.
- **Network Information Service** (NIS), an optional service, is used to centrally administer network data bases. This allows you to administer user id's, group id's, and passwords from one node. No matter which computer on the network requests data, NIS supplies a consistent view of the data on the network at steady state.

The NFS Services also provides these capabilities:

- **Remote Procedure Call** (RPC) allows you to develop applications that access files or processes or execute routines on a remote computer on the network. RPC achieves this by using eXternal Data Representation (XDR).
- **Remote Procedure Call Protocol Compiler** (RPCGEN) assists you in writing RPC applications.
- **eXternal Data Representation** (XDR) translates machine-dependent data formats to a universal data format that can be used by all network hosts using RPC/XDR. This enables HP and non-HP nodes and operating systems to exchange information on the network.

The NS Product

The NS (Network Services) product is an HP proprietary collection of networking services. These services enable your HP 9000 computer to communicate with other HP 9000, HP 3000, HP 1000, and DEC® VAX®/VMS systems that are running NS software. The NS product includes the following:

- **Network File Transfer** (NFT) provides the `dscopy` command to copy files between your HP 9000 and other HP computers on the network using NS software. You may also use NFT to communicate with DEC VAX/VMS computers and IBM PC/ATs that are running NS software.
- **VT3K** provides the ability to have a virtual terminal (VT) session from an HP 9000 workstation to an HP 3000 system. This gives users of HP 9000 workstations access to applications and data bases on HP 3000 MPE V and MPE XL systems that are connected to the same LAN as the workstations.

Interprocess Communication

NetIPC is the interprocess communication facility used with the NS product. It is part of the LAN products and is described in "The LAN Products" section.

TCP/IP Networking Terms

The following terms commonly appear in documents and literature about TCP/IP networks.

IP Addresses

A node can have several network interface cards installed in it. Each of these network interface cards must have a unique **internet address.** The internet address enables a node to recognize communications that are addressed to it.

Because it is easier to refer to nodes by names than by internet addresses, each node on the network is also assigned a name. Depending on the type of network services you are using, you assign node names with either the `hostname` or the `nodename` command.

- The ARPA Services and the NFS Services use the **host name** assigned with the `hostname` command. These services use a routine to map remote host names to internet addresses. The routine accesses the database that is stored in the file `/etc/hosts`, or accessed via Network Information Service (NFS) or BIND (ARPA/Berkeley).

  For you to connect to other hosts, their host names and internet addresses must be in your `hosts` database. For other hosts to connect to your host, your host name and internet address must be in their `hosts` database.

  Note that ARPA Services and NFS Services may also use internet domain-style host names instead of names assigned with the `hostname` command.

- The Network Services (NS) product uses the **node name** assigned with the `nodename` command. NS also uses a different method to map remote host names to internet addresses. It broadcasts a Probe request on the network for the internet address associated with the node name of interest. The host with that node name, or another host responding to Probe requests by proxy, responds with the requested internet address.

Multi-Homing

An HP 9000 computer can physically contain more than one network interface card. This capability is called **multi-homing.** The advantage of multi-homing is that a

computer can have multiple internet addresses. Multiple internet addresses allow you to use the same computer to communicate with many LANs or WANs.

LAN-to-LAN Routers

With the LAN/9000 Link product, an HP 9000 computer can serve as a **LAN-to-LAN router**. As such, it can forward messages between two networks. A router physically contains more than one network interface card. This capability, called **multi-homing**, allows the computer to be connected to multiple networks at the same time. This capability also permits connections in WAN (Wide Area Network), WAN-to-LAN, and WAN-to-WAN configurations.

Subnetting

Subnetting is an internet addressing scheme that allows you to divide a logical network into several smaller physical networks. Dividing your network into smaller subnetworks, if well-planned, increases the overall efficiency of your network by reducing congestion.

Gateways

A network **gateway** is a device used to connect two or more networks together. The gateway routes information among the networks to which it is connected. Sometimes a gateway with the same type of network interface cards is referred to as a router or an IP router. An X.25 to LAN gateway is also referred to as an IP router for the TCP/IP traffic.

3

HP 9000 OSI Networking Overview

This chapter provides an overview of HP's OSI networking products. It also defines terms that apply to OSI networking.

Overview

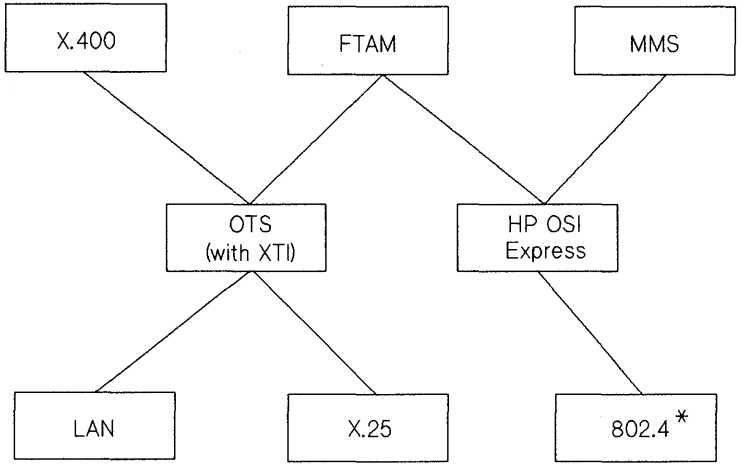
The HP-UX OSI solution is a collection of OSI products developed and integrated to satisfy industry and government requirements for standard multivendor networking. HP's OSI offerings demonstrate a commitment to standards-based, non-proprietary networking for multivendor interoperability. HP-UX OSI products include the following:

- **X.400**, a standard electronic messaging (mail) service that can be used for multivendor electronic mail.
- **FTAM**, the File Transfer, Access and Management service. FTAM is a standard file transfer and file management service that operates in a multivendor environment.
- **MMS**, the Manufacturing Message Specification. MMS is a standard language for communicating with factory automation devices such as robots or programmable language controllers (PLCs).

The above products run over the following link and transport products:

- **OTS**, the OSI Transport Service, which supports both FTAM and X.400 services. OTS includes programmatic access to the transport layer via the X-Open Transport Interface (XTI).
- **X.25/9000 Link**, a wide-area network link.
- **LAN/9000 Link**, a local-area network 802.3 link.
- **HP OSI Express MAP 3.0 Link**, a network link that supports HP's MAP 3.0 services on an IEEE 802.4 network.

The following illustration shows the relationships among these products.



Relationships Between OSI Services, Transports, and Links

The remaining sections of this chapter contain details about each of these products. For the most current information on environments in which you can use these products, contact your local HP representative.

Link and Transport

Several link and transport products are available for use with the OSI product family. Each product includes all the software required to connect to a network and process communications over the network.

The OTS Product

OTS, the OSI Transport Service, is HP's general purpose transport for OSI networking. It can use either the X.25 link or LAN (IEEE 802.3) link, and supports FTAM, MMS, and X.400 services.

OTS includes the X-Open Transport Interface (XTI), which provides programmatic access to layer 4 (Transport) of the OSI network model. XTI provides developers of specialized applications with access to networks conforming to OSI standards. Using XTI is similar to using Berkeley sockets.

The X.25 Product

The X.25/9000 Link product provides a network connection to public and private X.25 packet-switching networks for HP 9000 computers. An X.25 link requires at least OTS (and most often FTAM or X.400) to comprise an OSI communications subsystem.

See chapter 2 for more information on the X.25/9000 Link.

The LAN Product

The LAN/9000 Link product provides OTS with connectivity to an IEEE 802.3 network. OTS uses link-level access (LLA) to the LAN card to gain access to the data link and physical layers of an 802.3 network.

See chapter 2 for more information on the LAN/9000 Link.

OSI Express MAP 3.0 Link

The OSI Express MAP 3.0 Link product provides a network connection to IEEE 802.4 networks for the Manufacturing Message Specification (MMS) product.

OSI Services

The X.400 Product

The X.400 product offers standards-based electronic mail for HP 9000 computers. With X.400, HP-UX mail users can send and receive electronic mail messages throughout a multivendor network. A designated HP-UX system running X.400 serves as a gateway, providing access to the X.400 environment for multiple HP-UX systems.

The X.400 product conforms to OSI specifications, including the 1984 CCITT X.400 specification and related NIST, COS, and European standards (CEPT (A311) and CEN/CENELEC (A3211)). The X.400 product provides format and text conversion, addressing, and other common electronic mail functions.

The interface to X.400 is through the familiar ARPA `sendmail` mail utility. Future releases are expected to support a direct user interface to X.400.

The FTAM Products

HP has implemented the ISO File Transfer, Access and Management Standard (ISO 8571), called FTAM (pronounced *eff' tam*). FTAM provides true multivendor file system interoperability for HP 9000 computers. It permits transfer, access or management of defined file types between HP 9000 and diverse OSI end systems, regardless of their hardware or operating system.

The basic capabilities of FTAM are the following:

- Text and binary file transfer.
- Record-level access to remote files.
- Management of remote files.

HP offers two FTAM implementations, targeted at two distinct markets:

- **HP FTAM/9000** addresses the need for data exchange between dissimilar computers in technical, office, and scientific environments. FTAM/9000 is a fully compliant US GOSIP Version 1 implementation of FTAM. Running over OTS, FTAM/9000 is also compatible with principal European (CEN/CENELEC, UK GOSIP) and Pacific Region (POSI) standards. HP FTAM/9000 is designed to coexist on networks with TCP/IP and ARPA services. In this configuration, TCP/IP and OSI protocol stacks share existing 802.3 or X.25 links.
- **HP MAP 3.0 FTAM** addresses the need for data exchange in multivendor manufacturing environments. FTAM, used with the HP OSI Express MAP 3.0 Link, connects HP 9000 (Series 600, 700, and 800) computers to broadband or carrierband 802.4 MAP 3.0 networks.

HP's FTAM products include three key interfaces:

- An interactive, ftp-like interface.
- A command-line, rcp-like interface.
- A programmatic interface for C.

The MMS Product

HP has implemented the ISO draft standard ISO/DIS 9506, (Manufacturing Message Specification). MMS is the language which MAP-connected cell controllers use to direct the activities of factory-floor devices such as robots, PLCs (programmable logic controllers), and NC (numerical control) machines.

HP MAP 3.0 MMS addresses the need for device and process control in multivendor manufacturing environments. MMS implements comprehensive, direct control of factory-floor devices that conform with MAP 3.0. Control is implemented through specialized communication capabilities such as read/write variables and start/stop/resume programs.

The interface to HP's MMS product is the industry-standard programmatic (C-language) interface, commonly called MMSI. Over 90 functions are available to the MMS application developer. Key functions within MMS include the following:

- Context (connection) management.
- Variable access.
- VMD support.
- Program invocation management.
- Domain management.
- File management.
- Operator communications.

MMS for HP 9000 computers uses the HP OSI Express MAP 3.0 Link, a fully compliant IEEE 802.4 implementation. MMS can also run over IEEE 802.3 networks via the OTS transport.

OSI Networking Terms

The following terms commonly appear in documents and literature about OSI networks.

OSI Addresses

Depending on the service involved, OSI networks use different addressing schemes to identify message destinations. HP's OSI services use one of two addressing methods:

- X.400 uses **Originator/Recipient (O/R)** addresses to specify destinations for messages.
- FTAM and MMS use **Directory Distinguished Names (DDNs)** to identify message destinations.

Each DDN or O/R address is unique, and consists of multiple attributes (such as country, organization, or name) that fully specify the destination. O/R addresses and DDNs are configured by the network manager when the service is installed. The exact configuration procedure depends on which transport (OTS or OSI Express) underlies the service.

CLNS and CONS Networks

CONS stands for Connection Oriented Networking Service. **CLNS** stands for Connectionless Network Service. These terms apply to layers 3 or 4 of the network, and describe how two nodes interact.

In a CONS network, two systems establish a network-layer connection at the beginning of their communication. The connection is broken at the termination of the communication. An analogy can be made to a phone connection, which you establish by dialing and terminate by hanging up. CONS networks are typical where there are a large number of potential destinations available over a less reliable medium. For example, X.400 typically runs transport classes TP2 or TP0 over CONS on an X.25 link.

In a CLNS network, there is no network-layer connection between communicating systems. A courier service might be used to illustrate this type of communication. You give your message to the messenger, and trust it to deliver the message. Similarly, a computer puts its message on the CLNS network, and trusts the network to deliver the message. CLNS networks are typical where the potential destinations

are fewer and well-known, and the delivery medium is highly reliable. For example, HP's FTAM typically runs transport class TP4 over CLNS on an 802.3 (LAN) link.

4

HP 9000 SNA Networking Overview

This chapter provides an overview of HP's SNA networking products. It also defines terms that apply to SNA networking.

Overview

Hewlett-Packard's SNA networking products give users access between HP and IBM systems for interactive, batch and programmatic communications in both client/server and standalone environments.

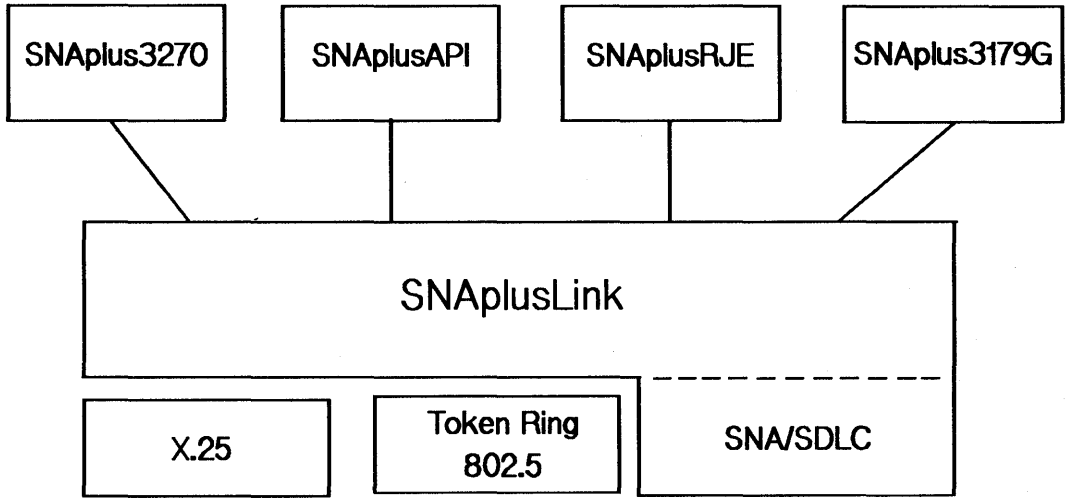
They include the following products:

- **SNAplusAPI**, an SNA LU 6.2 application programming interface for program-to-program communication to an IBM 370 type mainframe processor in an SNA environment.
- **SNAplus3270**, which provides 3270 terminal emulation as well as file transfer, application programming interface and multiple sessions.
- **SNAplusRJE**, which provides SNA 3770 batch data transfer between an HP 9000 computer and an IBM System/370 compatible mainframe in an SNA environment.
- **SNAplus3179G**, which provides emulation of an IBM 3179G color graphics display station.

The above products run over the following link products:

- **SNAplusLink**, a wide-area network link.
- **X.25/9000**, a wide-area network link.
- **Token Ring/9000**, a local-area network 802.5 link.

The following illustration shows the relationships among these products.



Relationships Between SNA Services, Transports, and Links

The remaining sections of this chapter contain details about each of these products. For the most current information on environments in which these products can be used, contact your local HP representative.

Links and Transports

Several link and transport products are available for use with the SNA product family. Each product includes all the software required to connect to a network and process communications over the network.

SNAplusLink

The SNAplusLink product provides the link and transport software necessary for support of the SNA service products. It includes SNA/SDLC link software required for connection to an SDLC network.

The X.25 Product

The X.25/9000 Link product provides a network connection to public and private X.25 packet-switching networks for HP 9000 computers. The SNA transport is also required to support the SNA services.

See chapter 2 for more information on the X.25/9000 Link.

The LAN Product

The Token Ring/9000 Link product provides connectivity to an IEEE 802.5 token ring network. The SNA transport is also required to support the SNA services.

See chapter 2 for more information on the Token Ring/9000 Link.

SNA Services

SNAplusAPI

The SNAplusAPI product includes LU 6.2 API (Application Programming Interface) which enables a program running on an HP 9000 to prompt automatically a remote IBM mainframe to start a CICS application program or to retrieve and send data on one of its databases. The same activity can occur in the opposite direction, with the HP 9000 responding to a remote IBM mainframe. With PU 2.1 providing APPC (Application Program to Program Communication), HP 9000 systems can also communicate directly with peer systems.

Other functions with the SNAplusAPI product are:

- LUA (Logical Unit Application) interface for accessing host applications using LU types 0, 1, 2, or 3. These LU types are used by the host application program to communicate with 3270 type display terminals and printers.
- NetView API to customize the NetView commands for monitoring the status of services, connections and sessions.

SNAplus3270

The SNAplus3270 product allows HP terminals, monitors and printers on the HP 9000 running SNA 3270 to emulate the functions of IBM 3278 terminals and 3287 printers so HP 9000 users can access applications running on an IBM mainframe. SNAplus3270 also supports HLLAPI (High Level Language Application Programming Interface), a programmable interface for automating data transfer operations and repetitive tasks, such as automating startup of host 3270 applications.

Other functions with the SNAplus3270 product are:

- Motif graphical user interface.
- Support for Model 2, 24 x 80; Model 3, 32 x 80; Model 4, 43 x 80; and Model 5, 27 x 132 screen sizes.
- Response Time Monitor which allows users to display statistics on how quickly the IBM host is responding to requests for data.

SNAplusRJE

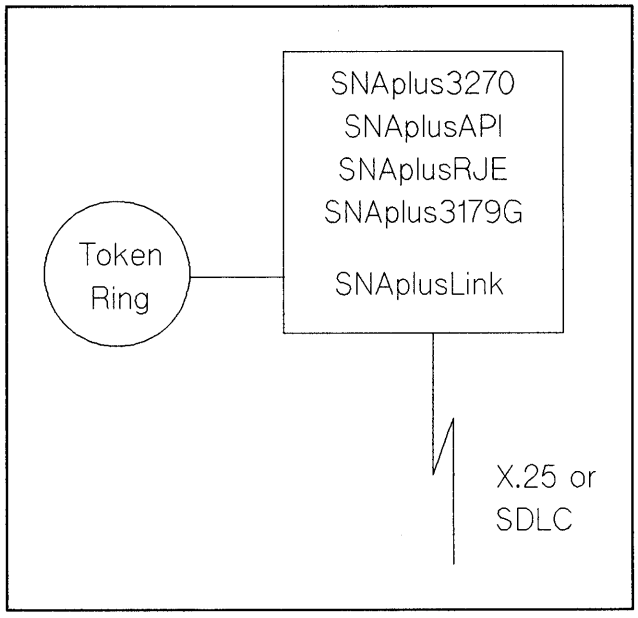
The SNAplusRJE product provides SNA 3770 batch data transfer via user interface commands for submitting a job, displaying job queue and workstation status, and sending and receiving console commands. Post processor support lets users send host, printer and punch output to several destinations.

SNAplus3179G

The SNAplus3179G product allows users to communicate interactively between an HP 9000 and an IBM System/370 or compatible mainframe using SNA and 3270 data stream. Users gain access to the Graphical Data Display Manager (GDDM) and 3270 applications such as TSO and CMS.

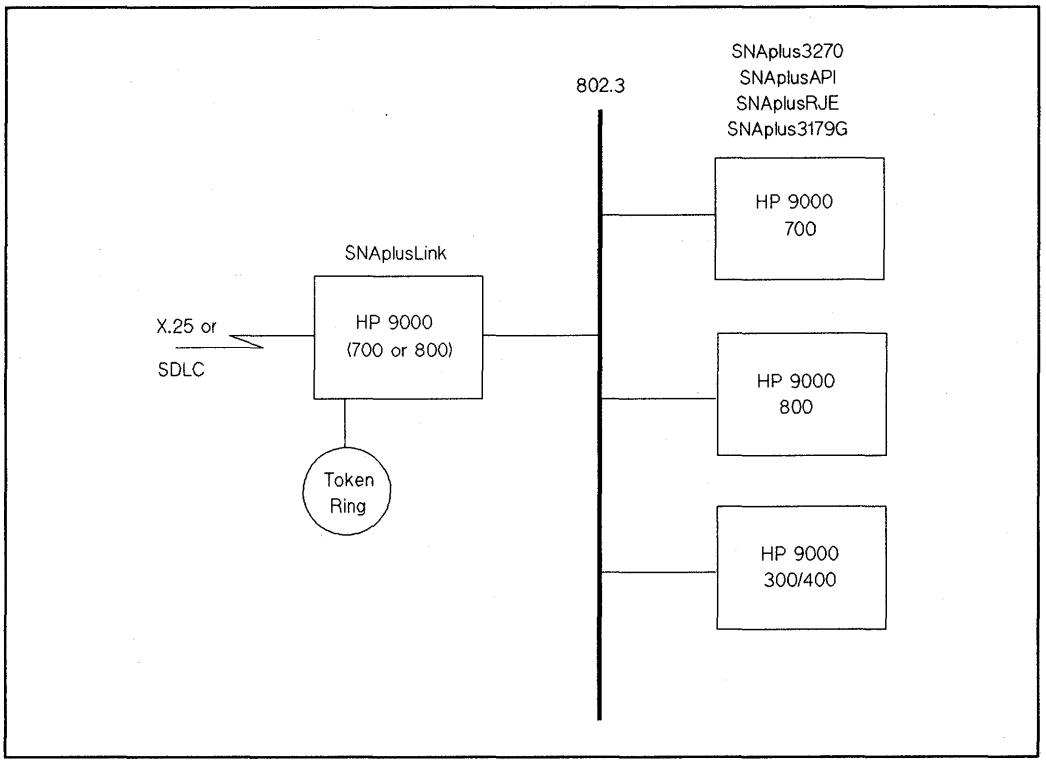
SNA in a Standalone Environment

The figure below illustrates SNA networking in a standalone environment.



SNA in a Client/Server Environment

The figure below illustrates SNA networking in a client/server environment.



SNA Networking Terms

The following terms commonly appear in documents and literature about IBM networks. These terms describe components of an SNA-based network.

Application Subsystem

An application subsystem is software that supports functions such as interactive program development, information retrieval and updating, remote batch job processing, graphic information presentation on displays and printers. Examples of application subsystems include the Customer Information Control System (CICS) and Information Management System (IMS).

Cluster Controller

A cluster controller is a hardware device that controls the input/output operations of devices connected to it, such as terminals and printers.

Communication Controller

A communication controller is a hardware device that manages the physical network, controls communication links, and routes data through the network. Such controllers are also referred to as front end processors.

Distributed Processor

A system on the network that performs functions similar to a host processor with the exception of network management. Functions performed by a distributed processor can include computation, program execution, access to data bases, and directory services.

Host Processor

A system on the network that controls all or part of the network. Host processor functions also can include computation, program execution, access to data bases, and directory services. When there are multiple host processors on a network, some of them can function as distributed processors.

Logical Unit (LU)

A logical unit (LU) is a network addressable unit that provides end users with access to network resources and manages the transmission of information between end users. There can be more than one logical unit per peripheral or host node. Each end user has a logical unit the enables communications with other end users.

Network Management Program

A network management program performs functions such as assisting network operations, detecting and reporting errors on the network, and maintaining statistics about network performance. The primary network management program is NetView.

Physical Unit (PU)

Services to manage and monitor a node's resources are provided by a physical unit that resides in each node. The SNA access method manages the resources for a host node. The network control program manages the resources for a communication controller node.

SNA Access Methods

SNA access methods reside in host processors and perform several services for the network. These include logically controlling the flow of data through a network, providing an interface between application subsystems and a network, and protecting application subsystems from unauthorized access. The Advanced Communications Function/Virtual Telecommunications Access Method (ACF/VTAM) is the most frequently used IBM SNA access method.

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